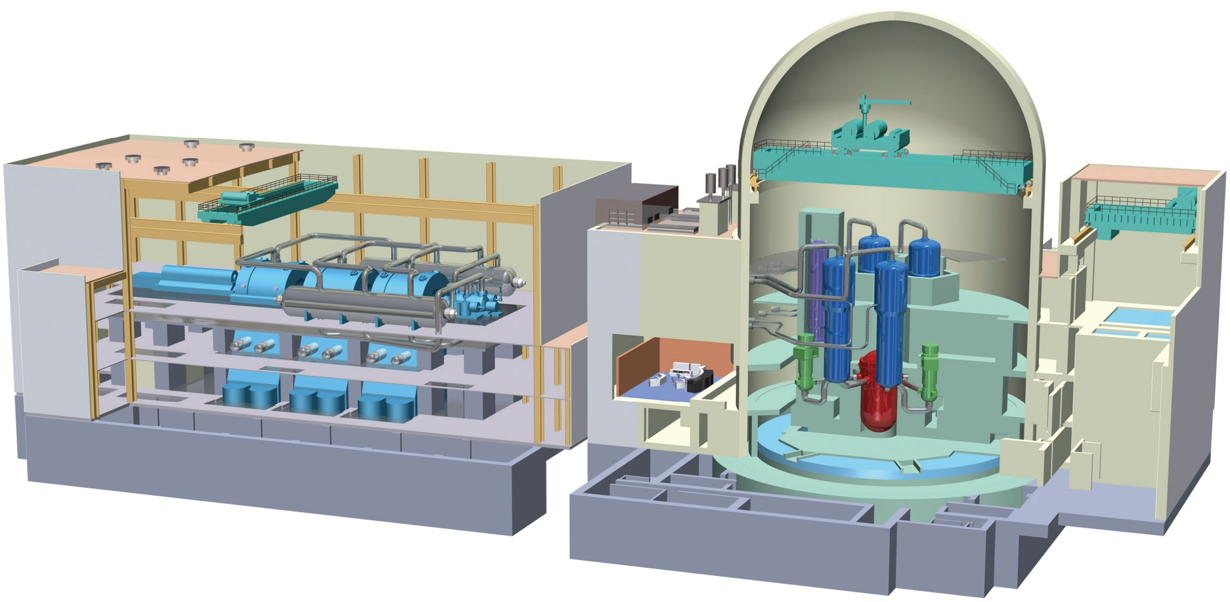
DESIGN CONTROL DOCUMENT FOR THE
US-APWR
Chapter 19
Probabilistic Risk Assessment and Severe Accident Evaluation

MUAP- DC019

REVISION 1

AUGUST 2008



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ACRONYMS AND ABBREVIATIONS

A/B	auxiliary building
AAC	alternative alternating current
ac	alternating current
ACL	accident class
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASEP	accident sequence evaluation program
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
BHEP	basic human error probability
BNL	Brookhaven National Laboratory
C/V	containment vessel
CCDP	conditional core damage probability
CCF	common cause failure
CCFP	conditional containment failure probability
CCW	component cooling water
CCWS	component cooling water system
CD	complete dependence
CDF	core damage frequency
CET	containment event tree
CFR	Code of Federal Regulations
CI	containment isolation
COL	Combined License
COLA	Combined License Application
CPET	containment phenomenological event tree
CRMP	configuration risk management program
CS	containment spray
CS/RHR	containment spray/residual heat removal
CSET	containment system event tree
CSNI	Committee on the Safety of Nuclear Installations
CSS	containment spray system

CVCS	chemical and volume control system
DAS	diverse actuation system
dc	direct current
DCD	Design Control Document
DDT	deflagration to detonation transition
DVI	direct vessel injection
ECCS	emergency core cooling system
ECOM	error of commission
EF	error factor
EFW	emergency feedwater
EFWS	emergency feedwater system
EOM	error of omission
EOP	emergency operating procedure
EPRI	Electric Power Research Institute
ESF	engineered safety features
ESWS	essential service water system
ESX	ex-vessel steam explosion
ET	event tree
FAB	feed and bleed
FLML	failure to maintain water level
FMEA	failure modes and effects analysis
FP	fission product
FSAR	Final Safety Analysis Report
FSS	fire protection water supply system
FT	fault tree
FV	Fussell Vesely
FWLB	feed-water line break
FWS	feedwater system
GTG	gas turbine generator
HCLPF	high confidence of low probability of failure
HD	high dependence
HE	human error
HELB	high-energy line breaks
HEP	human error probability

HHI	high head injection
HHIS	high head injection system
HPME	high pressure melt ejection
HRA	human reliability analysis
HSI	human-system interface
HVAC	heating, ventilation, and air conditioning
HX	heat exchanger
I&C	instrumentation and control
ICDP	incremental core damage probability
IE	initiating event
IEEE	institute of electrical and electronic engineers
IFPRA	Internal flood probabilistic risk assessment
IHL	induced hot leg rupture
ITAAC	inspection, test, analysis, and acceptance criteria
JAERI	Japan Atomic Energy Research Institute
JNES	Japan Nuclear Energy Safety Organization
JRC	Joint research Centre
KZK	Kernforschungszentrum Karlsruhe
LD	low dependence
LERF	large early release frequency
LHSI	low-head safety injection
LOCA	loss-of-coolant accident
LPSD	low-power and shutdown
LRF	large release frequency
M/D	motor driven
MAAP	modular accident analysis program
MCCI	molten core concrete interaction
MCR	main control room
MELB	moderate-energy line break
MSIV	main steam isolation valve
MSRV	main steam relief valve
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NRC	U.S. Nuclear Regulatory Commission

NUREG	NRC Technical Report Designation (Nuclear Regulatory Commission)
OECD	Organization for Economic Cooperation and Development
PCCV	prestressed concrete containment vessel
PCT	peak cladding temperature
PDS	plant damage state
PGA	peak ground acceleration
POS	plant operational state
PRA	probabilistic risk assessment
PRSV	pressurizer safety valve
PS/B	power source building
PSF	performance shaping factor
PWR	pressurized-water reactor
R/B	reactor building
RAP	reliability assurance program
RAW	risk achievement worth
RCS	reactor coolant system
RF	recovery factors
RG	Regulatory Guide
RHR	residual heat removal
RHRS	residual heat removal system
RICT	risk-informed completion time
RLE	review level earthquake
RMAT	risk management action time
RMTS	risk-managed technical specifications
RO	reactor operator
RPS	reactor protection system
RTNSS	regulatory treatment of non-safety-related systems
RV	reactor vessel
RWSAT	refueling water storage auxiliary tank
RWSP	refueling water storage pit
RWST	refueling water storage tank
RY	reactor-year
SAMDA	severe accident mitigation design alternative
SAMG	severe accident management guideline

SBO	station blackout
SDV	safety depressurization valve
SG	steam generator
SI	safety injection
SIS	safety injection system
SMA	seismic margin analysis
SRO	senior reactor operator
SRP	Standard Review Plan
SSC	structure, system, and component
SSE	safe-shutdown earthquake
STA	shift technical advisor
T/B	turbine building
T/D	turbine driven
TEDE	total effective dose equivalent
THERP	technique for human error rate prediction
ZD	zero dependence

19.0 Probabilistic Risk Assessment and Severe Accident Evaluation

The US-APWR probabilistic risk assessment (PRA) has been developed in accordance with Title 10, Code of Federal Regulations (CFR), Part 52.47 (a) (Reference 19.0-1). The primary purposes of the US-APWR PRA and severe accident evaluations are as follows:

- To describe the design-specific PRA (10 CFR 52.47(a)(27) [Reference 19.0-1])
- To describe and analyze design features for the prevention and mitigation of severe accidents, e.g., challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass(10CFR52.47(a)(23) [Reference 19.0-1])

The primary objectives of the US-APWR PRA and severe accident evaluations are as follows:

- To identify and address potential design and operational vulnerabilities (i.e., failures or combinations of failures that are significant risk contributors that could drive the risk to unacceptable levels with respect to the U.S. Nuclear Regulatory Commission [NRC] goals)
- To reduce or eliminate known weaknesses of existing operating plants that are applicable to the new design, by introducing appropriate features and requirements
- To select among alternative features, operational strategies, and design options
- To develop an in-depth understanding of the design's robustness and tolerance of severe accidents initiated by either internal or external events
- To examine the risk-significance of specific human errors associated with the design, and characterize the significant human errors in preparation for better training and more refined procedures
- To determine how the risk associated with the design compares against the NRC goals of less than 1E-04/year for core damage frequency (CDF) and less than 1E-06/year for large release frequency (LRF)
- To determine containment performance against the NRC containment performance goal, which includes a deterministic goal that containment integrity be maintained for approximately 24 hours following the onset of core damage for the more likely severe accident challenges and a probabilistic goal that the conditional containment failure probability (CCFP) be less than approximately 0.1 for the composite of core damage sequences assessed in the PRA
- To assess the balance of preventive and mitigate features of the design, including consistency with guidance in SECY-93-087 (Reference 19.0-2) and the associated staff requirements memoranda

- To demonstrate whether the plant design represents a reduction in risk compared to existing operating plants

- To demonstrate that the design addresses known issues related to the reliability of core and containment heat removal systems at some operating plants

- To support regulatory oversight processes and programs that will be associated with plant operations (e.g., technical specifications, reliability assurance, human factors, maintenance rule, regulatory treatment of non-safety-related systems [RTNSS])

- To identify and support the development of design requirements, such as inspections, tests, analysis, and acceptance criteria (ITAACs), reliability assurance program (RAP), technical specification, and Combined License (COL) action items and interface requirements.

This chapter is structured in the following manner:

- PRA results and insights including internal and external event evaluation during full-power operations and during low power and shutdown operations (Section 19.1). External events evaluated include seismic, internal fire, and internal flood. Level 1 and Level 2 results are reported. This section also discusses the uses and applications of the PRA, PRA quality, design, and operational features that are intended to improve plant safety, and PRA input to design programs and processes.

- Severe accident evaluations including an assessment of preventive and mitigate features (Section 19.2). This section also discusses containment performance capability, accident management, and considerations of potential design improvements under 10 CFR 50.34 (f) (Reference 19.0-3).

- A description of open items, confirmatory items, and COL items (Section 19.3).

The PRA results indicate the US-APWR design meets the US-APWR and NRC safety goals. The quality and level of detail of the PRA is sufficient to provide confidence in the results such that the PRA may be used in regulatory decision-making to support risk-informed applications.

The primary requirements, guidance, policies, and standards utilized to complete the PRA and severe accident evaluations are as follows:

- 10 CFR 52.47 (Reference 19.0-1)

- 10 CFR 50.34 (Reference 19.0-3)

- NRC Policy Statement 50 FR 32138 (Reference 19.0-4)

- NRC Policy Statement 51 FR 28044 (Reference 19.0-5)

- NRC Policy Statement 52 FR 34884 (Reference 19.0-6)

- NRC Policy Statement 59 FR 35461 (Reference 19.0-7)
- NRC Policy Statement 60 FR 42622 (Reference 19.0-8)
- Regulatory Guide (RG) 1.200 (Reference 19.0-9)
- RG 1.206 (Reference 19.0-10)
- SECY-90-016 (Reference 19.0-11)
- SECY-93-087 (Reference 19.0-2)
- SECY-06-0220 (Reference 19.0-12)
- NUREG-0800 (Reference 19.0-13)
- American Society of Mechanical Engineers (ASME) RA-S-2002 (Reference 19.0-14)
- ASME RA-Sa-2003 (Reference 19.0-15)
- ASME RA-Sb-2005 (Reference 19.0-16)
- American National Standards Institute (ANSI)/American Nuclear Society (ANS)-58.21-2007 (Reference 19.0-17)

A description of the design-specific PRA and design features for the prevention and mitigation of severe accidents are included in this chapter. Reference 19.0-18 provides a detailed description of the PRA and severe accident analysis.

19.0.1 References

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19.0-8 The Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities, NRC Policy Statement 60 FR 42622, U.S. Nuclear Regulatory Commission, Washington, DC, August 1995.

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19.0-10 Combined License Applications for Nuclear Power Plants (LWR) Edition, Regulatory Guide 1.206, Rev. 0, U.S. Nuclear Regulatory Commission, Washington, DC, June 2007.

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19.0-12 Final Rule to update 10 CFR Part 52,"Licenses, Certifications, and Approvals for Nuclear Power Plants" (RIN AG24), SECY-06-0220, U.S. Nuclear Regulatory Commission, Washington, DC, letter issued October 31, 2006.

19.0-13 Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, U.S. Nuclear Regulatory Commission, Washington, DC, June 1996.

19.0-14 Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications, ASME RA-S-2002, American Society of Mechanical Engineers, New York, NY, April 2002.

19.0-15 Addenda to ASME RA-S-2002, ASME RA-Sa-2003, American Society of Mechanical Engineers, New York, NY, December 5, 2003.

19.0-16 Addenda to ASME RA-S-2002, ASME RA-Sb-2005, American Society of Mechanical Engineers, New York, NY, December 2005.

19.0-17 American National Standard External-Events PRA Methodology, ANSI/ANS-58.21-2007, American Nuclear Society, La Grange Park, IL, 2007.

19.0-18 Tanaka, F., et al., US-APWR Probabilistic Risk Assessment, MUAP-07030 Rev.1, Mitsubishi Heavy Industries, September 2008.

19.1 Probabilistic Risk Assessment

The scope of the US-APWR PRA includes a Level 1 and Level 2 PRA for internal and external events(including flooding, fire, and seismic) at full-power, low-power and shutdown (LPSD) conditions.

The Level 1 evaluation of internal events at full-power conditions is based on the basic methodology and approach given in ASME RA-S-2002 and associated addenda (Reference 19.1-1, 19.1-2, 19.1-3) and is comprised of the following technical elements:

- Initiating event analysis
- Event tree analysis
- System dependencies
- Success criteria analysis
- System analysis
- Data analysis
- Common cause analysis
- Human reliability analysis (HRA)
- Quantification and insights

The evaluation of internal events at LPSD conditions uses the same basic methods as the evaluation of internal events at full-power. A representative set of initiating events is chosen and modeled for a bounding set of plant operational states (POSs).

The evaluation of a flooding external event is based on the basic methodology and approach given in ASME RA-S-2002 and associated addenda, NUREG/CR-2300, and NRC technical report designation NUREG-1150 (Reference 19.1-1, 19.1-2, 19.1-3, 19.1-4, 19.1-5). A qualitative evaluation identifies flood areas and sources and a quantitative evaluation evaluates initiating events and flood scenarios.

The evaluation of a fire external event is based on the basic methodology and approach given in National Fire Protection Association (NFPA) 805 and NUREG/CR-6850 (Reference 19.1-6, 19.1-7). A qualitative evaluation identifies fire compartments and components and a quantitative evaluation evaluates initiating events and fire scenarios.

The evaluation of a seismic external event is based on a seismic margin analysis (SMA) consistent with ANSI/ANS 58.21-2007 (Reference 19.1-8). The SMA model is based on the internal events of the PRA model expanded to account for structural dependencies.

Other external events (high winds and tornadoes, external floods, transportation accidents, nearby facility accidents, and aircraft crashes) are subject to screening criteria consistent with ANSI/ANS 58.21-2007.

The Level 2 PRA results in LRFs for internal events at full power and the evaluation involves the following:

- Plant damage state (PDS) analysis
- Accident progression analysis
- Quantification

The primary guidance for this analysis is ASME RA-S-2002 and addenda, NUREG/CR-2300, and RG 1.200 (Reference 19.1-1, 19.1-2, 19.1-3, 19.1-4, 19.1-9). MAAP version 4.0.6 (Reference 19.1-10) is employed to evaluate severe accident phenomena.

The Level 2 evaluation of the flooding and fire external events at full-power conditions is based on the same approach as for internal events. Fault trees are modified to take into account flood/fire induced failures of severe accident mitigation features and these fault trees are mapped into the internal events through the associated PDSs.

For events at LPSD, the LRFs are conservatively assumed to be the same as the core damage frequencies, with a simple bounding technique.

19.1.1 Uses and Applications of the PRA

19.1.1.1 Design Phase

The US-APWR PRA is an integral part of the design process and has been used to optimize the plant design with respect to safety. The PRA models and results have influenced the selection of design alternatives such as four train core cooling systems, an in-containment refueling water storage pit (RWSP), and full digital instrumentation and control (I&C) systems.

The US-APWR is expected to perform better than current operating plants in the area of severe accident performance since prevention and mitigation of severe accidents have been addressed during the design stage, taking advantage of PRA results and severe accident analysis. The PRA results indicate that the US-APWR design results in a low level of risk and meets the CDF, LRF, and containment performance goals for new generation pressurized water reactors (PWRs).

At the design phase, the PRA results have been used as information providing input to technical specifications (Chapter 16), RAP (Chapter 17, Section 17.4), the security plan, and other design areas. PRA insights are utilized to develop risk-managed technical specifications (RMTS) and surveillance frequency control program (SFCP) in accordance with Reference 19.1-11 and 19.1-44, respectively.

19.1.1.2 Combined License Application Phase

19.1.1.2.1 Uses of Probabilistic Risk Assessment in Support of Licensee Programs

The PRA in the COLA phase will be used to support licensee programs such as the human factors engineering program (Chapter 18) and the severe accident management program. The PRA in the COLA phase will also be utilized to support implementation of 10 CFR 50.65 (Reference 19.1-12), the maintenance rule, and the technical specification. The PRA models and results will be utilized to support elements of the reactor oversight process including the mitigating systems performance index and the significance determination process.

The PRA may require updating to assess site-specific information (e.g., ultimate heat sink) and associated site-specific external events (high winds and tornadoes, external floods, transportation, and nearby facility accidents).

19.1.1.2.2 Risk-Informed Applications

As discussed in Subsection 19.1.1.1, PRA insights are utilized to develop site-specific risk-managed technical specifications, RAP, and other risk-informed applications.

19.1.1.3 Construction Phase

The PRA may require updating during the construction phase to reflect site-specific characteristics or design changes. The PRA may also be used to support licensee programs or risk-informed applications as appropriate.

19.1.1.3.1 Uses of Probabilistic Risk Assessment in Support of Licensee Programs

The PRA in the construction phase will be used to support licensee programs such as the human factors engineering program (Chapter 18) and the severe accident management program.

19.1.1.3.2 Risk-Informed Applications

The updated PRA will be reflected to risk-informed applications currently planned for implementation during the construction phase.

19.1.1.4 Operational Phase

The PRA will be used during the operational phase to support licensee programs or risk-informed applications as appropriate, such as the risk-managed technical specification (RMTS) discussed in chapter 16.

19.1.1.4.1 Uses of Probabilistic Risk Assessment in Support of Licensee Programs

The PRA will be used in the operational phase to support licensee programs such as the human factors engineering program (Chapter 18), the severe accident management program, the maintenance rule, and the reactor oversight program.

19.1.1.4.2 Risk-Informed Applications

The PRA will be updated to reflect risk-informed applications during the operational phase.

19.1.2 Quality of PRA

The quality of the PRA for the US-APWR is measured in terms of its appropriateness with respect to scope, level of detail, and technical acceptability. RG 1.200 (Reference 19.1-9) was reviewed to ensure that the quality of the US-APWR PRA is consistent with the NRC's expectations. The quality of the PRA is sufficient to provide confidence in the results, such that the PRA may be used in regulatory decision-making and to support risk-informed applications.

The following methods are utilized during development of the PRA to ensure that pertinent requirements of 10 CFR 50, Appendix B (Reference 19.1-13) are met:

- Use of qualified personnel
- Use of procedures that ensure control of documentation, including revisions, and provide for independent review, verification, or checking of calculations and information
- Documentation and maintenance of records, including archival documentation, as well as submittal documentation
- Use of procedures that ensure appropriate attention and corrective actions are taken if assumptions, analyses, or information used previously are changed or determined to be in error.

19.1.2.1 PRA Scope

The scope of the US-APWR PRA includes a Level 1 and Level 2 PRA for internal and external events (including flooding, fire, and seismic) at full-power, and LPSD conditions.

19.1.2.2 PRA Level of Detail

The US-APWR realistically reflects the actual plant design, planned construction, anticipated operational practices, and relevant operational experience. The approach, methods, data, and computer codes that are used, as documented throughout this chapter, are compliant with industry standard codes and practices. The level of detail is sufficient to ensure that the impacts of designed-in dependencies are correctly captured. The level of detail of the PRA is sufficient to provide confidence in the results such that the PRA may be used in regulatory decision-making to support risk-informed applications.

19.1.2.3 PRA Technical Adequacy

The quality of the methodologies, processes, analyses, and personnel associated with the US-APWR PRA comply with the provisions for nuclear plant quality assurance. Toward this end, the US-APWR PRA adheres to the recommendations provided in RG 1.200 pertaining to quality and technical adequacy. The US-APWR incorporates the technical elements of an acceptable PRA shown in Table 1 of RG 1.200 (Reference 19.1-9), and is consistent with the technical characteristics and attributes given in Tables 2 and 3 of RG 1.200, entitled “Summary of Technical Characteristics and Attributes of a PRA,” and “Summary of Technical Characteristics and Attributes of an Internal Flood and Fire Analysis and External Hazards Analysis,” respectively. The PRA has been developed in accordance with industry consensus standards as described in Section 19.0, and has been subjected to a peer review process as defined in ASME-RA-S-2002 and associated addenda (Reference 19.1-1, 19.1-2, 19.1-3) and as outlined in the Nuclear Energy Institute (NEI) peer review guide (Reference 19.1-14).

19.1.2.4 PRA Maintenance And Upgrade

The objective of the PRA maintenance and upgrade program is to ensure that the PRA will be maintained and upgraded so that its representation of the as designed, as-to-be built, and as-to-be operated plant is sufficient to support the applications for which the PRA is being used. The PRA will be under configuration control and the program will contain the following key elements:

- A process for monitoring PRA inputs and collecting new information
- A process that maintains and upgrades the PRA to be consistent with the as-built, as-operated plant
- A process that ensures that the cumulative impact of pending changes is considered when applying the PRA
- A process that evaluates the impact of changes on previously implemented risk-informed decisions that have used the PRA
- A process that maintains configuration control of computer codes used to support PRA quantification
- Documentation of the program

PRA maintenance involves updating of PRA models to reflect plant changes such as modifications, procedure changes, or plant performance. A PRA upgrade involves the incorporation into the PRA model of new methodologies or significant changes in scope or capability. Those changes could include items such as new human error analysis methodology; new data update methods; new approaches to quantification or truncation; or new treatments of common cause failure (CCF).

During operation, PRA will be maintained and updated in accordance with approved station procedures on a periodic basis not to exceed two refueling cycles.

Changes in PRA inputs or discovery of new information will be evaluated to determine whether the new or changed information warrants a PRA maintenance or upgrade. Changes that would impact risk-informed decisions will be prioritized to ensure that the most significant changes are incorporated as soon as practical. Other changes will be incorporated during the next PRA update.

Changes to the PRA due to PRA maintenance and PRA upgrade will meet the risk assessment technical requirements detailed in Section 4 of ASME RA-S-2002 and associated addenda (Reference 19.1-1, 19.1-2, 19.1-3). Upgrades of the PRA will receive a peer review in accordance with the requirements detailed in Section 6 of ASME RA-S-2002 and associated addenda, but will be limited to aspects of the PRA that have been upgraded.

The PRA will be updated to reflect plant, operational experience, and PRA modeling changes, consistent with the NRC-endorsed standards, such as those described in Section 19.1, in existence six months prior to the issuance of the maintenance update, which will be scheduled in compliance with 10 CFR 50.71 (Reference 19.1-15) specified criteria and intervals.

19.1.3 Special Design/Operational Features

Design and operational features of the US-APWR that result in improved plant safety as compared to currently operating nuclear power plants, include the following:

- Mechanical four train systems with direct vessel injection (DVI) system design
- Elimination of the need for low-head safety injection (LHSI) pumps by utilizing an advanced accumulator injection system
- Elimination of recirculation switching by an in-containment RWSP
- Enhanced safety through the use of four trains of safety electrical systems
- Upgraded piping design pressure for the residual heat removal system (RHRS)

The major unique features of the US-APWR related to PRA scope are

- Four train core cooling - High reliability due to four advanced accumulators and a four train high head safety injection system
- In-containment RWSP - Elimination of recirculation switchover enhances reliability of long-term core cooling after a loss-of-coolant accident (LOCA)
- Full Digital I&C - Diverse actuation system (DAS) installed as a counter-measure against common cause failures in software of safety I&C
- Four train safety-related systems separated by physical barriers

The four train system design reduces the US-APWR system dependencies when compared to those associated with current United States PWRs. System dependencies are discussed in Subsection 19.1.4.1. The upgraded design pressure of the RHRS results in a negligible frequency of occurrence of an interfacing system LOCA

19.1.3.1 Design/Operational Features for Preventing Core Damage

Key preventive features that are intended to minimize initiation of plant transients, arrest the progression of plant transients, and prevent severe accidents include the following safety systems:

- High head safety injection system (Chapter 6, Section 6.3)

  The high head safety injection system consists of four independent and dedicated SI pump trains. The SI pump trains are automatically initiated by a SI signal, and supply borated water from the RWSP to the reactor vessel via direct vessel injection line. This system provides safety injection function during LOCA events and feed and bleed operation. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

  During plant shutdown, high head safety injection system provides RCS makeup function in case RHR function is lost. This function is addressed in the ET of LPSD Level 1 model discussed in Subsection 19.1.6.1.

- Accumulator tank injection (Chapter 6, Section 6.3)

  There are four accumulators, one supplying each reactor coolant cold leg. The accumulators incorporate internal passive flow dampers, which function to inject a large flow to refill the reactor vessel in the first stage of injection, and then reduce the flow as the accumulator water level drops. Thus the accumulators provide integrated function of low head injection system in the event of LOCA. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

- Charging injection (Chapter 9, Subsection 9.3.4)

  Charging injection is provided by the chemical volume control system. The charging and letdown system provides a function to maintain programmed water level in the pressurizer and maintain appropriate reactor coolant inventories in reactor coolant system (RCS) during all phases of plant operation. In case small leak of the reactor coolant occur without generating safety injection signal, the volume of the reactor coolant can be recovered with the charging pump, provided that the water of the refueling water storage pit (RWSP) is supplied to the tank. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

  During plant shutdown, charging injection provides RCS makeup function in case RHR function is lost. This function is addressed in the ET of LPSD Level 1 model discussed in Subsection 19.1.6.1.

- RHRS/containment spray system (CSS) (Chapter 5, Subsection 5.4.7 and Chapter 6, Subsection 6.2.2)

  The CS/RHRS consists of four independent subsystems, each of which receives electrical power from one of four safety buses. Each subsystem includes one CS/RHR pump and one CS/RHR heat exchanger, which have functions in both the CS system and the RHRS. CS/RHRS provides multiple functions such as, (1) containment spray to decrease pressure and temperature in the CV, (2) alternate core cooling in case all safety injection systems fails at the LOCA, (3) RHR operation for long term core cooling, and (4) heat removal function for long term C/V cooling. These functions are addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

  During plant shutdown, RHRS provides function to remove decay heat from the RCS. This function is addressed in the ET of LPSD Level 1 model discussed in Subsection 19.1.6.1.

- Reactor trip (Chapter 7, Section 7.2)

  Reactor trip signal is provided by the RPS, which consists of four redundant and independent trains. Four redundant measurements using sensors from the four separate trains are made for each variable used for reactor trip. In addition, diverse actuation system is provided as a countermeasure against software failure of the digital I&C system. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

- Emergency feedwater system (EFWS) (Chapter 10, Subsection 10.4.9)

  EFWS consists of two motor-driven pumps and two steam turbine-driven pumps with two emergency feedwater pits. The EFWS supplies feedwater to the steam generators at a sufficient flow rate required for the transient conditions or postulated accidents and hot standby. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

- Pressurizer control (Chapter 5, Subsection 5.4.12)

  The pressurizer is sized to have sufficient volume to accomplish the preceding requirements without the need of power-operated relief valves. Safety depressurization valves (SDVs) are provided at top head of the pressurizer in order to cool the reactor core by feed and bleed operation when loss of heat removal from steam generator (SG) occurs. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

- Main steam isolation (Chapter 10, Section 10.3)

  MSIVs are installed in each of the main steam lines to (1) limit uncontrolled steam release from one steam generator in the event of a steam line break, and to (2) isolate the faulted SG in the event of SGTR. These functions are addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

- Component cooling water (Chapter 9, Subsection 9.2.2)

  The CCW system provides cooling water required for various components during all plant operating conditions, including normal plant operating, abnormal and accident conditions. During plant operation, CCW provides cooling water for the thermal barrier of the RCP to maintain RCP seal integrity. The CCW also functions as the heat sink for the CS/RHR system as well as the alternative containment cooling. These functions are addressed in the Level 1 model discussed in Subsection 19.1.4.1.1 and Subsection 19.1.6.1.

- Gas turbine generators (Chapter 8, Section 8.3)

  Four class 1E gas turbine generators (GTGs) are provided to supply power to their dedicated safety bus as a counter measure against loss of offsite power. When loss of offsite power occurs, GTGs automatically start and would accept load in less than or equal to 100 seconds after receiving the start signal. This function is addressed in the ET of Level 1 model discussed in Subsection 19.1.4.1.1 and Subsection 19.1.6.1.

The following non-safety systems are also considered key preventive features:

- Alternate containment cooling (Chapter 9, Subsection 9.4.6)

  In the case of the loss of containment cooling at accident conditions, alternative containment cooling utilizing containment fan cooler system is performed by connecting the component cooling water (CCW) system to the containment fan cooler system. Alternate containment cooling provides long term C/V cooling by natural convection in C/V. This function is addressed in the ET of at power Level 1 model discussed in Subsection 19.1.4.1.1.

- Alternate ac power source (Chapter 8, Subsection 8.4.1.3)

  In addition to the class 1E GTGs, two non-class 1E GTGs are provided to supply power to permanent buses. These two GTGs also functions as an alternative ac power source (AAC), which can supply power to any two of the four safety buses in case class 1E GTGs fail during loss of offsite power. To minimize the potential for common cause failures with the class 1E GTGs, different rating GTGs with diverse starting system are provided. Furthermore, the auxiliary and support systems for the AAC GTGs are independent and separate from the class 1E GTGs to minimize the potential for common cause failures. This function is addressed in the ET of Level 1 model discussed in Subsection 19.1.4.1.1 and Subsection 19.1.6.1.

19.1.3.2 Design/Operational Features for Mitigating the Consequences of Core Damage and Preventing Releases from Containment

The containment system features and human actions that are provided to mitigate the consequences of an accident and to prevent containment failure include the following safety systems:

- Containment isolation (Chapter 6, Subsection 6.2.4)

  The containment prevents or limits the release of fission products to the environment. The containment isolation system establishes and preserves the containment boundary integrity. Failure of containment isolation system leads to large release of fission products. This function is addressed in the CSET of Level 2 model discussed in Subsection 19.1.4.2.1.

- Containment spray (Chapter 6, Subsection 6.2.2)

  The containment spray system is designed to perform two major functions, i.e. (1) containment heat removal and (2) fission product removal. As for the features for mitigation of the consequences of core damage and prevention of release from containment, the above function (1) is expected. This function is addressed in the Level 1+ model discussed in Subsection 19.1.4.2.1.

  The containment spray system also takes a fundamental role for the reactor cavity flooding. The fundamental design concept of the US-APWR for severe accident termination is reactor cavity flooding and cool down of the molten core by the flooded coolant water. Therefore, dependable systems are provided to properly flood the reactor cavity during a severe accident. Containment spray water flows into the reactor cavity through the drain line provided between the SG loop compartment and the reactor cavity. This function is addressed in the CSET of Level 2 model discussed in Subsection 19.1.4.2.1.

The following non-safety systems/functions are also considered key mitigative features:

- Hydrogen ignition system (i.e. Igniters) (Chapter 6, Subsection 6.2.5)

  For controlling postulated hydrogen generation during a severe accident, glow type igniters are provided. Igniters are a proven technique to control combustible gases to prevent violent detonation, do not limit their effectiveness by accumulation of aerosols, and have good capability in terms of gas amount and controlling speed to control combustible gas. They are also compact in size and easy to maintain. The location to arrange igniters is carefully determined through accident progression analyses in order to enhance the effectiveness to control hydrogen. This function is addressed in the CSET of Level 2 model discussed in Subsection 19.1.4.2.1.

- Firewater injection into reactor cavity (Chapter 9, Subsection 9.5.1)

  This design feature constitutes the reactor cavity flooding system together with the containment spray water injection through the drain line. The fire protection water supply system (FSS) is provided outside of containment and in stand-by status during normal operation. The system line-up is modified for emergency operation during a severe accident and provides firewater from outside to the reactor cavity. This function is addressed in the CSET of Level 2 model discussed in Subsection 19.1.4.2.1.

- Reactor cavity floor area (Chapter 3, Subsection 3.8.5)

The geometry of the reactor cavity is designed to ensure adequate core debris coolability. Sufficient reactor cavity floor area is provided to enhance spreading of the core debris. This ensures that an adequate interface is maintained between the core debris and coolant water and that the thickness of the deposited core debris is reduced to diminish the heat flux transmitted from the core debris to the reactor cavity floor concrete. Generic Letter No. 88-20 issued by NRC in 1988 states "…assessments (should) be based on available cavity (spread) area and an assumed maximum coolable depth of 25 cm. For depths in excess of 25 cm, both the coolable and noncoolable outcomes should be considered." In order to address this discussion, the debris spreading behavior is carefully reviewed in handling the US-APWR core debris coolability issue at the design stage. The calculated result is utilized as one of the sources for quantification of the CPET of Level 2 model discussed in Subsection 19.1.4.2.1.

- Reactor coolant system (RCS) depressurization (Chapter 5, Subsection 5.4.12)

  In addition to the safety depressurization valves which are provided for core damage prevention by such as feed and bleed operation, severe accident dedicated RCS depressurization valves are provided to mitigate the consequences of core damage. High pressure melt ejection and temperature induced steam generator tube rupture can be avoided by reducing the primary system pressure after core melt. The function of RCS depressurization is addressed in the CSET and the above mentioned two physical phenomena in relation to failure of RCS depressurization are addressed in the CPET of Level 2 model, as discussed in Subsection 19.1.4.2.1.

- Core debris trap (Chapter 3, Subsection 3.8.5)

  Core debris trap is provided in the reactor cavity in order to decrease the amount of core debris dispersion to the upper compartment in the event of high pressure melt ejection and subsequent direct containment heating. Accordingly the containment atmosphere temperature rise by the limited amount of core debris is not very significant. The effect of this design feature is not explicitly addressed in the Level 2 PRA however the direct containment heating is considered in the CPET as discussed in Subsection 19.1.4.2.1.

- Alternative containment cooling (Chapter 9, Subsection 9.4.6)

  This is a system to depressurize containment by promoting natural circulation in containment. The containment fan cooler is a system provided to stabilize the containment environmental condition during normal operation through forced air circulation by fan. However, the electrical power of fan may not be available during a severe accident. Natural circulation is instead credited to adequately mix the containment atmosphere. The containment fan cooler employs non-essential chilled water as the coolant under normal operation. Since this non-essential chilled water cannot be available under severe accident conditions, the system line-up is switched from the chilled water system to the CCW system which supplies CCW to the containment fan cooler as coolant. Although CCW is not as cold as chilled water, it is sufficiently colder than the containment atmosphere under severe accident conditions. This temperature difference between the containment fan cooler and containment atmosphere causes condensation of surrounding steam. This condensation mechanism promotes more natural circulation flow because of the pressure difference due to condensation of steam. This enhances continuous containment depressurization. The function of alternative containment cooling is addressed in the CSET of Level 2 model discussed in Subsection 19.1.4.2.1.

- Firewater injection to spray header (Chapter 6, Subsection 6.2.2 and Chapter 9, Subsection 9.5.1)

  The FSS is also utilized to promote condensation of steam. The FSS is lined up to the containment spray header when the CSS is not functional, and provides water droplet from top of containment. This will temporarily depressurize containment. However, the FSS does not contain a heat exchanger, and thus has no ability to remove heat from containment to terminate the containment pressurization. Instead, this design feature can be expected to temporarily increase the heat sink in containment and extend the critical time of containment failure. The effect of this design feature is not explicitly addressed in the Level 2 PRA however this function is utilized to address the recovery of CSS and CSS/RHRS HX of the CSET of Level 2 model as discussed in Subsection 19.1.4.2.1.

19.1.3.3 Design/Operational Features for Mitigating the Consequences of Releases from Containment

Key mitigating features that are intended to minimize offsite doses/consequences include the following safety systems:

- Containment spray (Chapter 6, Subsection 6.5.2)

  As discussed in the Subsection 19.1.3.2, the CSS has two major functions, and as for the features for mitigation of the consequences of release from containment, the function (2) is expected.

The following non-safety systems/functions are also considered key mitigative features:

- Firewater injection to spray header (Chapter 6, Subsection 6.5.2 and Chapter 9, Subsection 9.5.1)

  Similar to the CSS, firewater spray also has two functions, and as for the features for mitigation of the consequences of release from containment, the function (2) of CSS is expected.

19.1.3.4 Uses of the PRA in the Design Process

PRA was used in the design process to achieve the following objectives.

- Identify features and requirements introduced to reduce or eliminate the known weakness/vulnerabilities in current rector designs.
- Indicate the effect of new design features and operational strategies on plant risk.
- Identify PRA-based insights and assumptions used to develop design requirements.

The basic design concept of the US-APWR is similar to current PWRs. However, special design features are introduced to enhance safety of the plant. Special design features are described in the previous Subsections 19.1.3.1 through 19.1.3.3. PRA is used to select among alternative designs and to quantify its effect on risk reduction by elimination of weakness/vulnerabilities. The US-APWR establishes the following accident measures guided by the use of PRA. These measures are diverse compared to the above safety systems.

Prevention of Beyond-Design-Basis-Accidents progression:

- Measures against ATWS - The safety grade reactor protection system is highly reliable due to the independent four train design. The DAS, which has functions to prevent ATWS, is installed as a countermeasure to CCF of the digital I&C systems and thus will preclude ATWS events.
- Measures against Mid-Loop Operation - To prevent over-drain during mid-loop operation, a loop water level gage and an interlock (actuated by the detection of water level decrease), act to isolate water extraction.
- Measures against station blackout - Diversity of emergency power sources to mitigate station blackout. The system is installed for achieving Safe Shutdown to a cool down state after station blackout.
- Additional Protection against an Interfacing system LOCA - Higher rated piping of residual heat removal systems reduces the occurrence of interfacing system LOCA. Even if residual heat removal system isolation valves open due to malfunction during normal operation, reactor coolant from main coolant pipe would flow to refueling water storage pit without pipe break outside containment.

Mitigation of severe accidents:

- Measures against severe accident after core damage - Special features for prevention and/or mitigation of severe accident phenomena such as hydrogen combustion, core debris coolability, temperature-induced SGTR, high pressure melt ejection and direct containment heating, and long-term containment overpressure.

Design improvements to reduce or eliminate weaknesses in current plants were investigated for each categorized causes of core damage or large release. Major improved design features adopted in the US-APWR to reduce or eliminate weaknesses in current reactor design is summarized in Table 19.1-1.

PRA was also used to confirm that the safety goals are achieved. Through the PRA study, PRA-based insights and key assumptions are identified to support the design process. PRA-based insights are shown in Subsections 19.1.4 through 19.1.6 and the key assumptions supporting this conclusion are given in 19.1.7.1, respectively.

19.1.4 Safety Insights from the Internal Events PRA for Operations at Power

19.1.4.1 Level 1 Internal Events PRA for Operations at Power

A description of the Level 1 internal events PRA for operations at power including the results of the PRA analysis is provided in the following subsections.

19.1.4.1.1 Description of the Level 1 PRA for Operations at Power

The methodology used to develop the US-APWR Level 1 PRA model for operation at power includes the use of fault trees and event trees, which are quantified using a fault tree linking process. The result of the fault trees linking quantification are a CDF and a list of dominant accident sequences and dominant cutsets.

The Level 1 evaluation of internal events at full-power conditions is comprised of the following technical elements:

- Initiating event analysis
- Event tree analysis
- System dependencies
- Success criteria analysis
- System analysis
- Data analysis
- Common cause analysis
- Human reliability analysis
- Quantification

Each of the technical elements is discussed below.

<u>Initiating event analysis</u>

An initiating event is defined as a disturbance which causes an upset condition of the reactor plant challenging reactor systems and requiring operator performance of safety functions that are necessary and sufficient to prevent core damage. Such events result in challenges to plant safety functions, and postulated failures in these systems, equipment, and operator response could lead to an end state involving core damage and/or radionuclide release.

Initiating events analyzed are selected to have a reasonable degree of completeness in the coverage of events that may occur in a plant. Moreover, to facilitate an efficient but realistic estimation of CDF, initiating events are grouped so that events in the same group have similar mitigation requirements.

In meeting these objectives, the following selection criteria are considered in the initiating event analysis:

- They result from a systematic process that is capable of producing an exhaustive set of events that could cause an initiating event
- They are unique from each other in terms of their impact on the plant (i.e., their impact on pressure and temperature, their need for protective plant response, their impact on inventory and cooling, their impact on front line and support systems and their capability to support plant safety functions, and their potential for producing core damage with different potential for containment challenge, failure, or bypass)
- Each event in a group represents a set of similar but distinguishable occurrences
- The events in a group are represented by the event that has the most severe impact on the plant capability to support safety functions

In order to satisfy the event selection criteria, initiating event analysis is carried out in two basic steps.

The first step is the identification of initiating events. An exhaustive screening evaluation of initiating events is performed to identify plant-specific initiating events. For the full power operation PRA, an initiating event is defined as any event that results in a plant transient condition that results in a reactor trip. An exhaustive list of SSC's in the plant is compiled and failure modes and effects analysis (FMEA) is performed to identify events that can be considered as an initiating event. The list of initiating events identified by exhaustive screening is then compiled from deterministically selected events and events considered in relevant PRA studies.

The second step is the initiating event grouping. The goal is to define the minimum set of events that captures the initiating events with uniquely different challenges on the plant safety functions. Initiating events provided in the exhaustive list are categorized into groups dictates the structure of the event sequence model. Dependencies between causes of the initiating events and the systems that are available to mitigate the consequences of the initiating event must be adequately defined in the initiating event grouping process. A representative event is chosen from the group to bound performance within the group.

Initiating events identified by this process, along with the frequencies of the events, are shown in Table 19.1-2. Internal fire and flooding events are identified and initiating event sequences are presented in Subsections 19.1.5.2 and 19.1.5.3. Initiating events during LPSD are identified and evaluated in Subsection 19.1.6.

Event tree analysis

The accident sequences that may stem from the initiating events are modeled in the form of event trees. The event trees are generally time sequences of response potential and depict the probabilistic response of the plant to a postulated disturbance. The response is depicted as nodes that represent the non-safety and safety systems potential response or use. The model includes support systems and operator actions that either respond to the initiating events or mitigate failure of other systems although this detail is often in the fault trees.

Accident sequence development involves, for each functional initiating event category, defining the safety functions and the systems and operator actions that are potentially available to support each safety function for inclusion in the event trees. Event trees are developed that trace the event sequences from initiating event to end states. The event trees are defined so as to capture the diversity of plant response and severity.

The success criteria for each event tree top event are defined in order to support the development of fault trees for the system functions and human reliability evaluations (for those top events that include operator actions). Fault tree definition includes the development of dependency matrices that identify the dependencies among front line systems (Table 19.1-3), front line to support system dependencies (Table 19.1-4), support system to support system dependencies (Table 19.1-5 and Table 19.1-6), and the dependencies between initiating events and systems.

An event sequence model structure has been developed that facilitates the identification of functional, physical, and human dependencies between the causes of the initiating events and the causes of system and operator action failures that violate any of the event tree top event success criteria.

The event sequence development begins, from a plant response perspective, with everything operating and progresses to display critical and important failure paths in a logical progression. Event depictions are generally left to right decisions in the time order of plant response.

An event tree based sequence modeling approach is generally used with each event type based upon the initiator being developed in a unique tree. Safety functions necessary to achieve safe shutdown are modeled. Safety functions are derived from past PWR PRAs and from an evaluation of the plant response to the initiating event.

Event trees developed for each initiating event are shown in Figure 19.1-1.

The event tree end states result in a set of accident classes (ACLs). The ACLs are described in Table 19.1-7. The ACLs are the initial conditions for the containment event tree (CET) and allow for grouping of similar core damage sequences by considering the similarity from the Level 1 PRA system event tree. This similarity includes core damage state, accident progression in containment, availability of mitigation features, and other accident development features.

ACLs are classified by considering the following parameters, which may influence the accident progression in containment and the potential fission product release to the environment.

- Initiating event and primary system pressure
- Containment intact or failed at core damage
- Accident progression in containment
- Loss of support system as initiating events

The identification of ACLs is a combination of letters or symbols identifying plant conditions within each of the parameters above. The first classification in the ACL designation is associated with the parameter initiating event and primary system pressure and may be one of the following:

- A – Large and medium break LOCA (low primary system pressure)
- S – Small break LOCA (medium primary system pressure), including transient-induced SLOCAs and primary system depressurization by manually opening the SDVs
- T – Transient and SGTR with isolation of the failed SG, both with failure of manual opening of the SDVs for RCS depressurization (high primary system pressure)
- G – Containment bypass (intermediate primary system pressure)

The second classification in the ACL designation is associated with the parameter containment intact or failed at core damage and may be one of the following:

- E – Intact containment at core damage (containment and containment isolation failure possible after core damage)
- L – Containment fails before core damage

The third classification in the ACL designation is associated with the parameter accident progression in containment and may be one of the following:

- D – Potentially dry condition in reactor cavity; alternative containment cooling by containment fan cooler system is failed
- F – Potentially dry condition in reactor cavity; alternative containment cooling by containment fan cooler system is activated
- W– Wet condition in reactor cavity; no containment spray (CS) activation
- S – Wet condition in reactor cavity; CS activated although no heat removal

- HF– Wet condition in reactor cavity by emergency core cooling system (ECCS); alternative containment cooling by containment fan cooler system is activated, heat removal success
- HS– Wet condition in reactor cavity by CS; alternative containment cooling by containment fan cooler system is activated and heat removal success
- I – Wet condition in reactor cavity; CS activated and heat removal success
- C – Containment failure before core damage

The fourth classification in the ACL designation is associated with the parameter loss of support system initiating events. This classification only appears in ACLs in which the initiating event is a loss of offsite power (LOOP) or loss of component cooling water (CCW), and may be one of the following:

- ‘(Prime) – The initiating event is a LOOP. Recovery of alternating current (ac) power supply does not occur before core damage
- ‘’(Double Prime) – The initiating event is a loss of CCW and this includes common cause failures of all CCW to restart after power recovery. Recovery of the CCWS does not occur before core damage.

System dependencies

The systems that are included in the systems analysis for internal events are provided in Table 19.1-8. Simplified diagrams of major systems are shown in Figure 19.1-2.

System dependencies are classified according to the following system interdependencies:

- Frontline systems to frontline systems
- Supporting systems to frontline systems
- Supporting systems to supporting systems

Tables 19.1-3 through 19.1-6 provide a summary of the system dependencies.

Success criteria

The approach used in this success criteria analysis is based on the ASME PRA standard Addendum B requirements. The technical portions of the success criteria determination are based on the following:

- The definition of core damage

Core damage is defined as the uncover and heat-up of the reactor core to the point at which prolonged oxidation and severe fuel damage involving a large fraction of the core is anticipated.

- The specific plant parameter of core damage

The US-APWR specific plant parameter of core damage is based on a “core-predicted core peak node temperature of greater than 2,200°F using a code with detailed core modeling” (ASME PRA standard SC-A2 [Category II/III (b)] [Reference 19.1-1, 19.1-2, 19.1-3]). And “Core-predicted core peak node temperature < 1400°F using a code with simplified core modeling” (This criteria is severe than ASME PRA standard SC-A2 Category II/III (b) PCT>1800°F) [Reference 19.1-1, 19.1-2, 19.1-3]).

- The specification of key safety functions for core damage

Five safety functions are identified and specified for each initiating event. The general safety functions specified for meeting the success criteria are as follows:

- Reactivity control
- RCS pressure control
- RCS inventory control
- Decay heat removal (core cooling)
- Containment heat removal and CI

Table 19.1-9 shows the relation of these plant safety functions and the initiating events.

- The identification of mitigating systems

The mitigating system and operator actions in accident sequences are determined as given in Tables 19.1-10 and 19.1-11.

- The specification of appropriate mission time

In order to specify an appropriate mission time for modeled accident sequences, thermal/hydraulic analysis and engineering judgment are used. Twenty-four hours was selected as an allowable mission time for the sequences. If a stable plant condition cannot be achieved within 24 hours for a specific sequence, additional evaluation of that sequence is performed to determine an appropriate PDS, to extend the mission time, and/or to model additional system recovery.

- The bases for features and operating procedures

The US-APWR mainly utilizes active safety features and is operated by the same operating philosophy of existing PWR plants. Therefore, the base for features and operating procedures utilizes current existing PWR plant experience.

- Plant thermal/hydraulic analysis for success criteria

  Plant thermal/hydraulic analysis for PRA success criteria have been performed, resulting in the criteria given in Table 19.1-13. The minimum required thermal/hydraulic analysis for basic determination of success criteria and design support thermal/hydraulic analysis is conducted to specify the final success criteria.

- The use of engineering judgment

  In the DCD phase of the US-APWR design, many portions of the detailed design and the operation procedures have not determined. Therefore, engineering judgment is used in areas where thermal hydraulic analysis cannot be performed for success criteria determination. An example is the determination of time before core uncovery at reactor coolant pump (RCP) seal LOCA. Time before core uncovery at RCP seal LOCA is determined based on engineering judge considering the temperature resistance of RCP seal O-ring and its leakage rate under severe temperature conditions.

- The initiating events grouping and thermal/hydraulic analysis

  An initiating event group for thermal/hydraulic analysis is determined for individual initiating events, as shown below. The approach of the representative thermal/hydraulic analyses to determine accomplishment of the success criteria is to evaluate the most severe event among initiating events in a group and the available mitigating functions by considering minimum requirements for system functioning.

  - Emergency letdown line break, Pressurized safety valve stuck open and RCP seal LOCA have less severe success criteria than RCS line break LOCA because all ECCS trains are available.

  - General transient, LOOP, etc. have less severe than Loss of Feedwater success criteria for EFWS.

- The analysis model and computer codes

  MAAP 4.0.6 code as well as analysis results described in Chapter 15 are used to determine success criteria.

- The results of the thermal/hydraulic analysis

  A representative result of the thermal/hydraulic analysis is given in Table 19.1-12.

- Determination of success criteria

Final success criteria, shown in Table 19.1.13, are determined from the design, engineering judgment and thermal/hydraulic analysis results in a manner that allows a margin for the uncertainties that attribute models of the thermal/hydraulic analyses and grouping of initiating events

Systems analysis

The systems analysis provides for treatment of the causes of system failure and unavailability modes represented in the initiating events analysis and sequence definition.

The fault tree models include contributions due to the following:

- Random component failures
- Outages for maintenance and test
- Support systems
- CCFs
- Human errors in failing to restore equipment to its operable state
- Human errors in failing to perform procedural actions

Fault trees are developed to the level of detail for which existing data can be applied. For active systems, passive failures that are potentially significant are included.

General assumptions and conditions applied to system analysis are summarized below.

General modeling conditions

- Models reflect the design as intended to be built, as intended to be operated, including how portions that are similar to existing designs have performed during their installed operating history
- Systems which participate in the necessary response to events or which provide critical support to such systems are to be modeled
- Models reflect the success criteria for the systems to mitigate each identified accident sequence
- Models capture the impact of dependencies, including support systems and harsh environmental impacts

Conditions concerning level of detail

- The level of detail in the model matches one for one the simplified diagrams and includes key active components and potential misaligned components based upon data availability

- Models include contributions due to random component failures; outages for maintenance and test; support systems; CCFs; human errors to restore equipment to its operable state; and human errors to fail to perform procedural actions

- Models include both active and passive components and failure modes that impact the function of the system

- A complete treatment of CCFs, intersystem and intra-system dependencies, as well as dependencies on POSs is provided

- The fault tree is developed to the level of detail for which existing data can be applied

Failure modes of components modeled are summarized below

- Models include both active and passive components and failure modes that impact the function of the system

- Random component failure modes are modeled to a level of detail consistent with the existing database

- Reduced or single data value modeling is performed for systems that are best characterized from system failure data

- Large external leak of piping and valves that occurs before an initiating event is not considered. A large external leak can be detected in a relatively short period and will be fixed. The unavailability of the system due to a large external leak before the initiating event is considered as unavailability caused by an outage for maintenance

- Plugging in flow lines are likely to occur in components such as valves and orifices rather than in piping. Therefore, the pipe plugging is not modeled as long as the plugging of components is explicitly modeled

- The plugging of closed valves during standby condition is not considered. The plugging during standby condition may affect valve operability during an open demand, but this effect is considered as "failure to open" failure mode. However, plugging after an open demand is explicitly modeled

- Probabilities of failures that occur during standby states are evaluated from test and maintenance intervals. Test and maintenance intervals are assumed to be bounded by the Technical Specification in Chapter 16. For systems that will be tested only during plant shutdown, a 24-month test interval, which is consistent with plant shutdown interval, is assumed

Data analysis

For each component type and failure mode, the failure rates are extracted from available generic data sources. The following steps are performed to develop the appropriate data set for the US-APWR PRA:

- Potential sources of generic failure data are collected from the following:
  - NUREG/CR-6928, "Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants," Idaho National Laboratory, February 2007 (Reference 19.1-16).
  - NUREG/CR-4550 Analysis of Core Damage Frequency: Internal Events Methodology, Volume 1, Revision 1, January 1990 (Reference 19.1-17).
  - NUREG/CR-4639, "Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR)," 1990 (Reference 19.1-18).
  - Advanced Light Water Reactor Requirements Document, Volume III, Appendix A to Chapter 1, "PRA Key Assumptions and Ground rules," Revisions 5 and 6, December 1993 (Reference 19.1-19).
  - PLG-0500, "Database for Probabilistic Risk Assessment of Light Water Nuclear Power Plants," 1989 (Reference 19.1-20).
  - Institute of electrical and electronic engineers (IEEE) Std. 500 "Guide to the Collection And Presentation of Electrical, Electronic, Sensing Component, And Mechanical Equipment Reliability Data For Nuclear power Generating Stations," Appendix D, 1984 (Reference 19.1-21).
  - WASH-1400 (NUREG 75/014)"Reactor Safety Study: An Assessment of Accident Risks in US Commercial Nuclear Power Plants," 1975 (Reference 19.1-22).
  - Nuclear Information Center "Estimation of Component Failure Rates for PSA on Nuclear Power Plants 1982 – 1997," February 2001 (Reference 19.1-23).
- A list of component types, failure modes, failure rates, and error factors (EFs) is developed for each source
- The component types are identified for US-APWR PRA.
- The most applicable failure modes and failure rates are selected for the US-APWR PRA study.

Table 19.1-14 shows an example of the component random failure data set for the US-APWR PRA. Most of the mechanical component failure data and unavailability data are taken from NUREG/CR-6928 (Reference 19.1-16). The electrical, electronic, and sensing component failure data are derived from IEEE Std. 500 (Reference 19.1-21). When failure data are not specified in NUREG/CR-6928 or IEEE Std. 500, data are taken from WASH-1400 (Reference 19.1-22) or other sources.

The mechanical component boundaries are consistent with corresponding basic event definitions. Component boundaries are defined by generic data sources, so that the boundaries of the basic events are set to be consistent with the component boundaries.

In the PRA, beta and gamma distributions are used for the random component failure data taken from NUREG/CR-6928. Unavailability due to test and maintenance is derived from NUREG/CR-6928. Other data set sources use lognormal distributions.

Common cause analysis

Multiple Greek Letter methodology is applied to calculate the probability of common cause events. The Multiple Greek Letter parameters are estimated by applying impact vectors based on generic industry data. To develop uncertainty distributions for the Multiple Greek Letter parameters, a Bayesian framework in accordance with NUREG/CR-5485 (Reference 19.1-24) is used.

The methodology for CCF analysis is based on NUREG/CR-4780 (Reference 19.1-25) and NUREG/CR-5485. Generic data for CCF reported in NUREG/CR-5497 (Reference 19.1-26) are applied to evaluate the CCF parameters.

CCFs can result from various mechanisms. The causes of these events correspond to failure mechanisms that have been determined from analysis of nuclear plant service experience and fall into several broad categories such as the following:

- Design/manufacturing/construction
- Procedural error
- Human actions/plant staff error
- Maintenance and test
- Abnormal environmental stress

Redundant and active components as well as groups of non-identical active components that have the potential for CCF mechanisms are prime candidates for the CCF analysis. The component types that are considered for common cause analysis include those for which there is documented evidence of common cause experience as well as those that have the characteristics of redundant active components. The components considered are as follows.

System	Component Types
Electrical systems	Emergency power generators, circuit breakers, batteries, battery chargers, and inverters
Reactor trip system and ESF system	Bi-stables, reactor trip breakers, relays, shunt trip coils, sensors, logic modules, and control rods
Heating, ventilation and air conditioning (HVAC) systems	Chiller units (including compressors), dampers, air handling units, fans, and reactor containment fan coolers units
Mechanical systems	Pumps, motor-operated valves, air-operated valves, check valves, relief valves, safety valves, heat exchangers, strainers, and traveling screens

Common cause events for other component groups in a system may be defined if the event would be an important contributor to system reliability and if the components in the group can be linked to conceivable CCFs such as those defined previously.

A set of components are defined as a common cause component group when they are of the same type (pumps, valves, etc.), and when they meet the following conditions:

(1) Same initial conditions (such as normally open, normally closed, energized, and de-energized)

(2) Same use or function (such as system isolation, flow modulation, parameter sensing, and motive force)

(3) Same failure mode (such as failure to open on demand, and failure to start on demand)

(4) Same minimal cutset (failure of multiple components that appear in the same cutset)

Treatment of intersystem CCFs is consistent with capability category I and II of ASME RA-S-2002 and associated addenda. CCFs across systems are not included in the CCF model, because they are quite different in terms of the environment, operation or service, design, and maintenance.

Some component dependencies are explicitly modeled as separate events in the fault trees to avoid double counting. Such dependencies are not included in the common cause analysis. Dependencies that are not considered in the common cause analysis are functional dependencies, human errors, maintenance and testing unavailability, and external events.

Once the common cause groups of components have been defined, the fault tree is modified so that each fault tree basic event representing the failure of a member of a common cause group is expanded to include additional events which are combined under an “OR” gate. The PRA software used in the US-APWR PRA has a “CCF-groups” function, which automatically creates possible combinations of CCF events in the fault tree based on the common cause group defined by the user. This function is utilized to model common cause events in the fault tree.

Human reliability analysis

Human reliability analysis (HRA) consists of qualitative and quantitative assessments of the occurrences of human failure events in the context of PRA. The task of performing HRA relies on knowledge of plant system design, plant operations and human factors (operator training, human-system interface [HSI], emergency operating procedures [EOPs], and severe accident management guidelines [SAMGs]). Performance of HRA is a task which is highly interactive with other PRA tasks like fault tree and event tree analysis. HRA estimates the failure probabilities of plant personnel actions identified in fault tree analysis or event tree analysis. The estimated human error probabilities are inputs to the fault tree or event tree models.

HRA addresses three types of human interactions, including actions before and after an initiating event, and actions that may cause or lead to an initiating event:

- Type A: Pre initiating event human interactions

  These actions take place before an initiating event, routine activities (e.g. test, maintenance, or calibration). If these actions are not completed correctly, the error may impact the availability of equipment necessary to perform in the system function modeling included in the PRA.

- Type B: Initiating event related human interaction

  These actions take place before an initiating event (including type A) if not completed correctly may cause an initiating event. In many cases these contributors to initiating event frequency are included in the data base and are therefore included in the quantification of the PRA. Specific Type B events are also considered in the context of the low power shutdown (LPSD) PRA model.

- Type C: Post initiating event human interaction

  These actions take place after an initiating event are evaluated to determine the likelihood of error or conversely task completion. The operator responses required for each of the accident sequences according to procedures including the EOPs are modeled when they are risk significant and evaluated probabilistically in this analysis. Type C human interactions are categorized into type Cp and type Cr. Type Cp are the action required to operate the mitigation system, and type Cr represents the recovery actions for failed equipment, or realignment of systems.

Most of the human interactions modeled in the US-APWR PRA are type C. Analysis of type C human interactions is performed based on documented assumptions because the sufficient plant specific information on EOPs, time-related issues (time available and time required to complete the actions specified), and HSI for advanced digital control room etc. is not fully available as the initial model is being developed. Simplified task definitions and analyses are nonetheless developed by the system analysts and to assure accuracy reviewed by the procedure developer assigned to the US-APWR project. Revised and updated evaluations of the identified operator actions and human error probabilities will be performed as additional US-APWR design information becomes available.

US-APWR HRA is performed according to the following major steps:

Step 1 - Identify the human interactions

Step 2 - Characterize human actions and develop the subtasks

Step 3 - Quantify the human error probabilities

Step 4 - Evaluate the dependency between human failure events.

Step 5 - Document the human reliability analysis results

- Identification of human interactions (Step1 and Step2)

  The human interactions to be explicitly modeled in the PRA are systematically identified for each human interaction type.

  - Type A human interactions

    Type A human failure events are characterized as below:

    (1) Misalignment of PRA components in its normal operational or standby status after the test and maintenance (valve misalignment, or control switch mispositioned)

    (2) Miscalibration after calibration activities

    Misalignments of components are in many cases easily detected by the plant personnel in the control room during plant operation. In addition, they are immediately corrected after detection. Therefore, there is very low probability that these rare misalignment situations and an initiating event occur at the same time. In US-APWR HRA, these kinds of type A human failure events are screened out, and not explicitly modeled in the PRA. The exclusion of type A human failure events from the PRA model and the bases for these decisions are as follows.

    a. Misalignment of the remote-operated valves (e.g. motor-operated valves, air-operated valves) after test and maintenance. Remote-operated valve open/close position is monitored in main control room.

b. Misalignment of the pump and gas turbine generator after test and maintenance. The control switch position (auto-position, start/stop-position, and manual-position) of the pump and gas turbine generator is monitored in main control room.

c. Misalignment of the manual valves for which a flow meter is installed on the same flow line. The personnel in the main control room can monitor these manual valves open/close position by the monitoring the flow meter.

d. Misalignment of the locked-management manual valves. The probability of this error is considered to be very low because these valves are locked with correct position after the test and maintenance.

Type A human failure events that should be explicitly modeled in PRA model are searched for across all systems and components.

- Type B human interactions

Type B human interactions are identified if it is judged that an initiating event would occur caused by the human failure event that is not already included in the data and it is therefore necessary to evaluate human error probability. In a low power shut down risk assessment, it is evaluated that the initiating event of “over-drain” event and “LOCA” occurs caused by human failure event during plant maintenance. The identified type B human failure event in low power shut down is:

(1) Drain operation failure causes “over-drain” event, and

(2) RCS valve operation failure causes LOCA.

- Type C human interactions

Type Cp human interactions are identified in event tree and fault tree analysis based on success criteria. Type Cp human interaction modeled in the PRA are considered in the event tree analysis and fault tree analysis. Type Cr human interactions are identified for the risk significant contributors if it is judged that it is possible to perform the type Cr actions in the context of the accident scenario.

- Quantification of human error probabilities (Step 3)

The design certification phase HRA provides human error probabilities (HEPs) and the analysis for Type A and Type C human interactions is based on the NUREG/CR-4772 “Accident Sequence Evaluation Program HRA Procedure” (ASEP) (Reference 19.1-27), and the HEP analysis for Type B human interactions is based on NUREG/CR-1278 “Technique for Human Error Rate Prediction” (THERP) (Reference 19.1-28) approach.

- Type A human interactions

A basic HEP (BHEP) of .03 was selected as a conservative HEP for type A human errors. The BHEP of.03 do not include any recovery factors (RF), and represents a combination of a generic HEP of .02 assessed for an error of omission (EOM) and a generic HEP of .01 assessed for an error of commission (ECOM), with the conservative assumption that an ECOM is always possible if an EOM does not occur. The estimated HEP that is used for PRA model considers the recovery factors and dependence effect on the BHEP.

- Type B human interactions

The probabilities of type B human failure events are estimated based on NUREG/CR-1278 (Reference 19.1-28). HEP is taken directly from NUREG/CR-1278. Assume to be under optimum condition, and any PSF is not considered.

- Type C human interactions

The probabilities of type C human failure events are estimated based on ASEP procedure (Reference 19.1-27). The basic HEP and recovery factors by the second person who checks the performance off the original performer are given in the ASEP procedure, and they are assigned to each subtask failure of type C human failure events. The basic HEP values for Type C subtask errors are summarized in Table19.1-15, and the recovery factors are summarized in Table 19.1-16 together with the application criteria. As shown in these two tables, a basic HEP is adjusted on the basis of “Stress Level” and “Task Type”. Modified HEP values are obtained by considering the recovery factors. An example of human error probability (HEP) quantification for “Feed and Bleed” operator action, a type C human interaction, is as follows:

HPIOO02FWBD - Feed and bleed operation failure (not involve S-signal)

The HPIOO02FWBD evaluates the probability of failure to recognize the need and failure to start the safety injection pump and open the RCS depressurization valves in a Non-LOCA event. The following assumptions are used as input to quantify the HEP of HPIOO02FWBD operator action.

- EOP Type: Symptom-oriented
- Behavior Category: Rule-based
- Task Type: Step by step
- Stress Level: Moderately high
- Recovery: Main control room (MCR) - SRO-1 and SRO-2

The HPIOO02FWBD operator action HEP quantified as follows:

Item No.	Subtask description	Basic HEP	Recovery factor		Modified HEP
		RO	SRO-1	SRO-2	
Cognition aspects					
1	Identify the loss of the secondary core cooling function	0.02	0.2	0.2	8.0E-4
Action aspects					
2	Start the safety injection pump (1 out of 4)	0.02	0.2	0.2	8.0E-4
3	Open the RCS depressurizing valve (1out of 2)	0.02	0.2	0.2	8.0E-4
Total HEP = Item 1 + Item 2 + Item 3					2.4E-3 (EF=5)
Total HEP (Mean)					3.8E-3 (EF=5)

- Assessment of dependency between human failure events (Step 4)

The dependency assessment refers to the dependency between the type C human failure events, the dependency between the type A (or B) and type C human failure events is considered to be negligible. The dependence level between human failure events in the same sequence is assessed, and a joint human error probability that reflects that dependence is calculated. All of the event trees for the US-APWR are reviewed to search the possible combinations of type C human failure events. Whenever a type C human failure event is addressed, all previous nodes addressed on the sequence are reviewed. If any previous human failure event is in the same sequence, then subsequent human failure events are considered as candidates for dependency evaluation.

- Dependency level evaluation

The determination process of dependency level between multiple human failure events follows the philosophy of The SPAR-H Human Reliability Analysis Method," NUREG/CR-6883 (Reference 19.1-29). This study yields the four dependency levels; low dependence, moderate dependence, high dependence, and complete dependence. The dependency level depends on following factors crew (same or different), time (close or not close), location (same or different), and cues (additional or no additional). The decision tree to determine the dependency level between multiple human failure events is shown in Figure 19.1-3. The dependency level is fundamentally determined by the criteria of Figure 19.1-3, but if the error is the 3rd error in the sequence, then the dependency level is at least moderate, and if the error is the 4th error in the sequence, then the dependency level is at least high, and if there are more error in the sequence, then the dependency level “complete” is assigned.

- Conditional HEP evaluation

  Once the dependency levels for each case are evaluated, the basic human error probabilities without dependency “Unconditional HEP” are modified to account for the dependency for each dependency level. The conditional human error probability “Conditional HEP” is calculated by applicable equation as follows, according to NUREG/CR-1278 (Reference 19.1-28).

  Low dependency; Cond. HEP = (1 + 19 x N) / 20
  Moderate dependency; Cond. HEP = (1 + 6 x N) / 7
  High dependency; Cond. HEP = (1 + N) / 2

  Where N is the unconditional human error probabilities

Quantification

Event sequence quantification is carried out by the following steps.

Step 1: Develop a model on PRA quantification software

Core damage quantification of the US-APWR PRA uses the RiskSpectrum® PRA code (Reference 19.1-30). The purpose of this step is to incorporate the models and data into the RiskSpectrum® code and prepare the model for preliminary quantification in Step 2. This preparation includes model logic debugging and setting parameters for the quantification.

Step 2: Develop preliminary point estimate quantification

The purpose of this step is to perform a preliminary quantification to complete the debugging of model logic and input errors. A conservative screening value (0.1) is used for the human action in this preliminary quantification step.

Step 3: Perform truncation convergence analyses

The purpose of this step is to determine the appropriate level for accident sequence frequency cutoff values that achieves a balance between accuracy and efficiency of the PRA applications. The US-APWR PRA uses a truncation value of 1.0E-15.

Step 4: Define and analyze sequence groups

The purpose of this step is to determine appropriate sequence groups to ACLs which are the initial conditions for the CET and are classified by considering the similarity of core damage sequences.

Step 5: Final point estimate quantification

The purpose of this step is to incorporate revisions to the logic model from Steps 1 through 4 to effect a final point estimate quantification of each sequence and each end state identified in Step 4 with use of appropriate truncation values determined in Step 3. Sequence frequencies, function probabilities, and end state frequencies are reviewed as well as the contributing cutsets to each of these.

Step 6: Perform accident sequence frequency importance, uncertainty, and sensitivity analysis

The purpose of this step is to perform the risk importance and uncertainty analysis. The uncertainty analysis includes parameter uncertainties and selected modeling uncertainties.

Key assumptions in Level 1 PRA for operations at power

Key assumptions in Level 1 PRA for operations at power are summarized below.

- US generic data are applied for component reliability data
- The reliability of gas turbine generators adopted in US-APWR is expected to have higher reliability than current diesel generators (Reference 19.1-31). However taking into account the lack operating experience, reliability data of diesel generators are conservatively applied to gas turbine generators
- Reliability of DAS is assumed to be equal or lower than 0.01 per demand. Complete dependency is assumed between different functions of DAS
- Probability of more than 4 control rods fail to insert into the core due to mechanical failure assumed as 1.0E-07 per demand
- Application software failure, which results in loss of all trains of signals are assumed to occur 1.0E-05 per demand. DAS is independent from application software failure
- Support software failure, which is a failure of operation system and result in degradation of all application software, is assumed to occur 1.0E-07 per demand. Support software failures degrade all signals of the digital system. DAS is independent from support software failure
- US generic data are applied to component unavailability due to test and unplanned maintenance
- Surveillance test interval and refueling outages are consistent with Technical Specifications provided in Chapter 16
- RCP seal LOCA is assumed to occur 1 hour after both thermal barrier and RCP seal injection function is lost. Once RCP seal LOCA occurs, core will be uncovered if RCS makeup injection is absent

- In loss of component cooling water events, non-essential chilled water system or FSS provide alternate component cooling water to charging pumps in order maintain RCP seal water injection. Operator action is necessary to supply alternate component cooling water to charging pumps

- If emergency feedwater pumps cannot feed water to two intact SGs, operators will attempt to open the cross tie-line of emergency feedwater pump discharge line in order to feed water to two SGs by one pump

- Motor-driven emergency feedwater pumps require room cooling for operation. On the other hand, turbine-driven emergency feedwater pumps are operable regardless of the availability of room cooling

- Loss of room cooling in ESF pump rooms (CS/residual heat removal (RHR) pumps and SI pumps) does not degrade the operability of the systems since room temperature increase within the mission time is tolerable

- Common cause failure between emergency power supply systems and alternative ac power supply systems (AAC) are minimized by their design characteristics. Common cause failure of gas turbine generators and circuit breakers do not occur across safety power system and AAC

- The CS/RHR system has the function to inject the water from RWSP into the cold leg piping by switching over the CS/RHR pump lines to the cold leg piping (Alternate core cooling operation) if all safety injection systems fail. Alternate core cooling operation may be required under conditions where containment protection signal is valid. In such cases, alternate core cooling operation is prioritized over containment spray, because prevention of core damage would have higher priority than prevention of containment vessel rupture. However, in the case of Large LOCA, it is assumed that alternate core cooling is not available because of insufficient time to switch over to alternate core cooling mode

- Emergency operating procedures (EOPs) for operator actions credited in the PRA are symptom-oriented and operators are well trained and practiced against the events written in EOPs. Since the EOPs are symptom-oriented, “Cognition error” ,that is diagnosis failure of abnormal events, is unlikely to occur.

- MCR crew members consist of the following team members at all times during the evolution of an accident scenario:

  - Reactor operator (RO)

  - Senior reactor operator (SRO)

  - Shift technical advisor (STA)

  The RO operates the plant during normal and abnormal situations, and SRO and STA check the action of the RO. If the RO commits an error during the operation, SRO or STA would correct the circumstances. However, when there is not enough available time to take corrective action, recovery credit is not considered.

- For operator actions at local area (action that take place outside control room) auxiliary operators (licensed and non-licensed) are available:

  - The auxiliary operator 1

  - The auxiliary operator 2

  Normally the auxiliary operators are stational in the MCR. If the local manipulation of equipment is required to mitigate accidents or to prevent core damage, the auxiliary operator moves to the appropriate area in the reactor building or auxiliary building, to access equipment such as manual valves. It is assumed that auxiliary operator 1 operates equipments and auxiliary operator 2 checks the actions of auxiliary operator 1. If auxiliary operator 1 commits an error during the operation, auxiliary operator 2 corrects it

- Misalignment of remote-operated valves (e.g. motor-operated valves, air-operated valves), pumps and gas turbine generators after test and maintenance will be fixed before initiating events occur. Remote-operated valve open/close positions and control switch positions are monitored in the main control room, so they will be detected in a short time

- The controls and displays available in the US-APWR control room are superior to conventional control room HSIs and, therefore, human error probabilities in the US-APWR operation would be less than those in conventional plants

19.1.4.1.2 Results from the Level 1 PRA for Operations at Power

This subsection provides the results from the Level 1 PRA for operations at power

Sixteen separate initiating event categories are defined to accurately represent the US-APWR design. Six of the initiating events are related to LOCA and ten of the initiating events are related to non-LOCA events.

The US-APWR PRA developed a total of 514 potential core damage event sequences for internal initiating events at power. These core damage sequences are the combination of initiating event occurrences and subsequent successes/failures of mitigation systems/operator actions. The failure probabilities for the modeled front line and support systems are given in Tables 19.1-17 and 19.1-18, respectively. The unreliability of EFWS under various loss-of-main feedwater transients, which is required in 10 CFR 50.34(f)(1)(ii)(A), is given in Table 19.1-17.

The total means CDF for the US-APWR is 1.2E-06/RY. The portion of each initiating event in the CDF is summarized in Table 19.1-19 and Figure 19.1-4. The conditional core damage probability given initiating event occurs is described in Table 19.1-20.

Table 19.1-21 shows the top 100 sequences. The list of identifiers for these sequences is shown in Table 19.1-22. As can be seen in Table 19.1-21, the top 100 sequences contribute more than 99% to the total CDF. The top ten dominant core damage sequences account for 90% of the total CDF.

Table 19.1-20 shows that four initiating events account for approximately 90 percent of the total CDF. These events are as follows:

- Loss of offsite power (LOOP)
- Loss of component cooling water (LOCCW)
- Reactor vessel rupture (RVR)
- Small pipe break LOCA (SLOCA)

The first two events account for 49.3% and 25.6% of the total CDF, respectively. The contribution of the other initiating events is less than 10% of the total CDF. Table 19.1-23 shows the top 40 cutsets.

LOCA events, excluding reactor vessel rupture, dominate 8% of the CDF. The US-APWR features a four train safety system and in-containment RWSP, which improves the reliabilities of RCS inventory control and decay heat removal. Accordingly, frequencies of core damage scenarios that stem from LOCA events are reduced.

74% of the CDF are related with accident scenarios involving RCP seal LOCA. RCP seal LOCA may occur due to total loss of CCW, which can be caused by total loss of ac power, random failures of ESWS and CCWS after plant trip or an initiating event. If operations to provide alternate component cooling water supply to charging pumps fail, RCP seal LOCA will occur. In such accident scenarios, safety functions to mitigate RCP LOCA are unavailable, and therefore the core will be damaged.

The dominant accident sequences (those contributing greater than 5% to CDF) are described below:

(1) LOOP with reactor trip. The emergency power supply system (emergency power generator) and alternative ac power source fail to operate and loss of total ac power occurs. EFWS (turbine-driven pumps) succeeds. Offsite power does not recover within 1 hour, and RCP seal LOCA occurs since RCP seal cooling and RCP seal injection is lost during loss of total ac power. In addition, functions to mitigate RCP seal LOCA are also unavailable due to loss of power. Liquid level in the RCS decreases, and 2 hours after initiation of RCP seal LOCA (3 hours after LOOP), core is uncovered. The frequency of this sequence is 5.0E-07/RY and accounts for 42.1 % of the total CDF.

(2) LOCCW with reactor trip: EFWS successfully functions, but RCP seal LOCA occurs due to failure of the alternate component cooling of the charging pump utilizing FSS or non-essential chilled water system. In addition, functions to mitigate RCP seal LOCA are also unavailable due to loss of CCW. RCS inventory

gradually decreases, and finally the core is damaged. The frequency of this sequence is 2.6E-07/RY and accounts for 21.6 % of the total CDF.

(3) Reactor vessel rupture occurs. This event directly leads to core damage since the reactor vessel can no longer maintain RCS coolant inside. The frequency of this sequence is 1.0E-07/RY and accounts for 8.5 % of the total CDF.

(4) LOOP with reactor trip: Emergency power supply and EFWS successfully function, but CCWS pumps fail to restart and loss of CCW flow occurs. Alternate component cooling of charging pump utilizing FSS or non-essential chilled water system fails and eventually RCP seal LOCA occurs. In addition, functions to mitigate RCP seal LOCA are unavailable due to loss of CCW. RCS inventory gradually decreases, and finally the core is damaged. The frequency of this sequence is 6.2E-08/RY and accounts for 5.3 % of the total CDF.

The top 20 cutsets for these sequences are shown in Tables 19.1-24, 19.1-25, and 19.1-26. Each of the other event sequences represents less than 5% of the total CDF. Cutsets for the reactor vessel rupture event are not listed here because the initiating event is assumed to directly lead to core damage.

Importance analyses have been performed to determine the following:

- Basic event importance
- CCF importance
- Human error importance
- Component importance

The results of importance are organized by a Fussell Vesely (FV) importance and risk achievement worth (RAW). Risk significant basic events which have FV importance equal or greater than 0.005 and RAW equal or greater than 2.0 are listed in Tables 19.1-27 and 19.1-28, respectively.

The top five most significant basic events, based on the FV importance, are as follows:

OPS----PRBF (Failure of offsite power recovery within 1 hour) – This basic event applies only to a condition where total loss of ac power occurs after LOOP. If offsite power does not recover within 1 hour, RCP seal LOCA is assumed to occur. The plant CDF is decreased by a factor of 42% if the probability of this failure is set to 0.0.

OPS---- PRCF (Failure of offsite power recovery within 3 hour) – This basic event applies only to condition where total loss of ac power occurs after LOOP. If offsite power does not recover within 3 hours, core damage is assumed to occur due to RCP seal LOCA. The plant CDF is decreased by a factor of 42% if the probability of this failure is set to 0.0.

EPSOO02RDG (Fail to connect alternative ac to safety bus) - This basic event applies only to SBO conditions where the emergency power generators have failed to supply power. If the operator fails to connect alternative ac power to safety buses, total loss of ac power occurs. The plant CDF is decreased by a factor of 24% if the probability of this failure is set to 0.0.

ACWOO02FS (Fail to supply alternate component cooling water from FSS) - This basic event applies to conditions where loss of CCW has occurred. If the operator fails to supply alternate component cooling water to the charging pump cooling line, RCP seal injection function is lost. Eventually, RCP seal LOCA occurs. The plant CDF is decreased by a factor of 24% if the probability of this failure is set to 0.0.

ACWOO02CT-DP2 (Fail to supply alternate component cooling water from non-essential chilled water system) - This basic event applies to conditions where loss of CCW has occurred. If the operator fails to supply alternate component cooling water to the charging pump cooling line, RCP seal injection function is lost. Eventually, RCP seal LOCA occurs. The plant CDF is decreased by a factor of 23% if the probability of this failure is set to 0.0.

The top five most significant basic events, based on the RAW, are as follows:

RTPCRDF (Rod injection failure of more than 4 rods) –The plant CDF would increase approximately 8.5E+04 times if the probability of this failure were set to 1.0. If more than 4 control rods fail to drop into the core, control rods can not provide sufficient negative reactivity to trip the plant.

EPSCF4BYFF (CCF of 3 class 1E batteries involving train A and D) - The plant CDF would increase approximately 3.5E+04 times if the probability of this failure were set to 1.0. If this failure occurs after loss of offsite power, 3 safety buses fail to be isolated from the faulted offsite power. Eventually, three safety buses will lose vital power. One safety bus may be available, but only one SG is supplied feed water because the cross tie-line valves at the emergency feedwater pump discharge line cannot open due to loss of dc power. Accordingly, sufficient decay heat cannot be removed from SGs.

RTPBTSWCCF (CCF of support software) - The plant CDF would increase approximately 1.0E+04 times if the probability of this failure were set to 1.0. The importance of this failure is due to loss of all digital instruments which will result in failure of various signals including plant trip signal and emergency core cooling system actuation signal.

EPSCF4CBTD6H-ALL (CCF of all 6.9kV income circuit breaker to open) - The plant CDF would increase approximately 7.4E+03 times if the probability of this failure were set to 1.0. If this failure occurs after loss of offsite power, safety buses cannot be supplied power since they are not isolated from the faulted offsite power. Accordingly, loss of total ac power will occur.

SWSCF4PMYR-FF (CCF of all essential service water pump to run) - The plant CDF would increase approximately 5.6E+03 times if the probability of this failure were set to 1.0. If this failure occurs all trains of essential service water will be lost, which leads to total loss of component cooling water.

Common-cause importance

The ten most risk-important common cause basic events are given in Table 19.1-29 for FV importance and in Table 19.1-30 for a RAW.

The most significant CCF basic event based on FV importance is CCF of all emergency power generators. The second most significant CCF basic event is CCF of all 6.9kV income circuit breakers.

The top nine most significant CCF basic events based on the RAW are the same as the basic events ranked in top ten most significant basic events based on the RAW.

Human error importance

The ten most risk-important human error basic events are given in Table 19.1-31 for FV importance and in Table 19.1-32 for RAW.

The most significant human error basic event based on FV importance is **EPSOO02RDG (Fail to connect alternative ac power source)**, with a FV importance of 2.4E-01.

Nine human error basic events have a RAW larger than 2.0E+00. The most significant human error basic event based on RAW is **ACWOO02FS (Fail to supply alternate component cooling water from FSS)**, with a RAW of 1.3E+01. The plant CDF would increase approximately 13 times, if the probability of this failure were set to 1.0.

Component importance

The ten most risk-important hardware single failure events are given in Table 19.1-33 for FV importance and in Table 19.1-34 for RAW.

No single failure basic events have a FV importance greater than 2.0E-02. The most significant single failure basic event based on FV importance is EFWPTADFWP1A, which represents the failure of safety turbine-driven emergency feedwater pump to run, with a FV importance of 1.7E-02.

There are more than 400 basic events that have a RAW greater than 2.0E+00. The most significant single failure basic event is a rod injection failure. The plant CDF would increase approximately 8.5E+04 times if the probability of this failure were set to 1.0.

Analysis has been performed to determine the sensitivity of CDF to the following:

- On power maintenance
- Human error rate
- Gas turbine generator reliability
- Design and operation

On power maintenance

Sensitivity analysis of system unavailability is performed to study the impact of on power maintenance on plant CDF for internal initiating events at power.

- Case 01: One safety train out of service

  If one safety train is out of service throughout the year, the CDF is 5.0E-06/RY, which is approximately four times the CDF of the base case. Increment of CDF from base line CDF is 3.8E-06/RY in this case.

- Case 02: One safety train and one accumulator out of service

  If one accumulator is taken out of service while one safety train is out of service, CDF will be 9.0E-06/RY. Increment of CDF from one safety train out of service is 3.8E-06/RY. If this CDF increment continues 24 hours, incremental conditional core damage probability (ICDP) is 2.0E-08.

- Case 03: One safety train and another safety injection pump out of service

  If one safety injection pump is taken out of service while one safety train is out of service, CDF will be 3.9E-05/RY. Increment of CDF from one safety train out of service is 3.7E-05/RY. If this CDF increment continues 72 hours, ICDP is 3.1E-07.

- Case 04: One safety train and another class 1E gas turbine generator out of service

  If one class 1E gas turbine generator is taken out of service while one safety train is out of service, CDF will be 7.3E-06/RY. Increment of CDF from one safety train out of service is 5.7E-06/RY. If this CDF increment continues 72 hours, ICDP is 4.7E-08.

Human error rate sensitivity

Sensitivity analysis of operator action failure probabilities is performed to study the impact of human errors on plant CDF for internal initiating events at power.

- CASE 05: All HEPs set to 0.0

  In this sensitivity analysis, all operator actions are assumed to succeed. The resulting CDF is 4.8E-07/RY. The ratio of the sensitivity case frequency to the base frequency is 0.4.

- CASE 06: All HEPs set to 1.0

In this sensitivity analysis, all operator actions are assumed to fail. The resulting CDF is 1.6E-03/RY. The ratio of the sensitivity case frequency to the base frequency is approximately 1400.

Gas turbine generator reliability

Sensitivity analysis of gas turbine generator reliability is performed to study the impact of its uncertainty on plant CDF for internal initiating events at power.

- CASE 07: Common cause failure of gas turbine generators

  In this sensitivity analysis, CCF parameters of general components are applied to gas turbine generators. In the base case, CCF parameters of diesel generators are applied to gas turbine generators. In this case, CCF parameters based on the generic prior reported NUREG/CR-5485 is applied to gas turbine generators. The resulting CDF is 9.3E-07/RY. This CDF is 23% lower than the base case CDF.

- CASE 08: Gas turbine generator failure data

  In this sensitivity analysis, generic failure data of gas turbine generators reported are applied. In the base case, failure data of diesel generators are applied to gas turbine generators based on judgment that gas turbine generators of US-APWR has higher reliability than current diesel generators. In this case, reliability data of gas turbine generators reported in NUREG/CR-6829 is applied to safety and non-safety gas turbine generators. The resulting CDF is 1.5E-06/RY. This CDF is 25% higher than the base case CDF.

Design and operation

Sensitivity analysis of design and operation is performed to study the impact of key design and operation on plant CDF for internal initiating events at power.

- CASE 10: Emergency feedwater pit capacity

  If each EFW pit, which has 50% capacity to perform cold shutdown, is enlarged to have 100% capacity to perform cold shutdown, the CDF will be 1.1E-06/RY. This CDF is 5% lower than the base case CDF.

- CASE 11: Operation of emergency feedwater pump discharge line cross tie-line valves

  If the emergency feedwater pump discharge line cross tie-line valves, which are opened when emergency feedwater pumps fail to supply at least 2 SGs, are kept closed regardless of emergency feedwater pump failures, the CDF will be 2.0E-06/RY. This CDF is 69% higher than the base case CDF.

The major conclusions of the importance and sensitivity analyses are:

- Basic events that are related to failure to prevent RCP seal LOCA are important.
- The CCF basic events are important individually, as well as a group with respect to plant CDF. This is expected for a plant with highly redundant safety systems.
- The CDF is 5.0E-06/RY if one safety train is out of service all year. This compares well with existing plants, even where periodic online maintenance is performed. Even if one accumulator and one safety train is out of service, the CDF is still below 1.0E-05/RY.
- If one safety train and another safety injection pump are simultaneously taken out of service, the CDF is 3.9E-05/RY. The four train safety system of the US-APWR enables to maintain CDF below a considerable value under conditions where two trains of a safety system are out of service.
- If no credit is taken for operator actions, the CDF is 1.6E-03/RY, while if operator actions are assumed to succeed, the CDF is 4.8E-07. CDF of US-APWR is sensitive to the reliability of operator actions.
- Reliability data of gas turbine generators does not have significant impact on CDF. If the reliability of generic diesel generators is applied the CDF increases 25%. However, the reliability of gas turbine generators that will be installed in US-APWR are expected to be higher than current gas turbine generators.
- Uncertainty of the CCF parameters regarding gas turbine generators does not have significant impact on CDF. Currently, there are no generic data for CCF parameters of gas turbine generators but this issue has little impact on US-APWR PRA.
- If each of the emergency feedwater pit capacity is increased, the CDF is reduced 5%. Therefore increasing the capacity of EFW does not lead to significant reduction in the CDF.
- If operations to open emergency feedwater pump discharge line cross tie-line valves are not credited, the CDF increases more than 50%. Operation to open these valves when emergency feedwater pump failure occurs is important to reduce CDF.

A PRA study involves many sources and types of uncertainty. Some are quantifiable and can be propagated through the model to generate an uncertainty distribution. Others deal with issues such as the state of knowledge and are difficult to quantify. Key sources of uncertainty and key assumptions made in the development of the PRA model for internal events at power are provided in next. They are identified and assessed for their impact on the results of the PRA.

The assessed areas of uncertainty include parametric uncertainty, modeling uncertainty, and completeness uncertainty.

Parametric uncertainty involves gathering information on the uncertainty associated with parametric values and propagating these through modeling formalisms. This process results in a better understanding of the variability of the mean or expected value of the distribution and the range of outcomes possible. A parametric uncertainty evaluation has been performed that propagates the uncertainty distribution through the model to produce the mean value of CDF using Monte Carlo simulation.

The result of the parametric uncertainty quantification for the total CDF is summarized in Figure 19.1-5. The mean, median, lower 5th percentile, and upper 95th percentile of the distribution are calculated. The error factor (EF) is estimated by the square root of the ratio of the 95th percentile to the 5th percentile.

The plant CDF uncertainty range is found to be 2.9E-06/RY – 3.0E-07/RY for the 95% to 5% interval. This indicates that there is 95% confidence that the plant CDF is no greater than 2.9E-06/RY. The EF for the total CDF is 3.1.

Modeling uncertainty involves key assumptions and key decisions made in developing the model. Table 19.1-35 lists key sources of uncertainty and key assumptions made in the development of the PRA model along with a qualitative assessment of the items pertaining to modeling uncertainty.

Completeness uncertainty is associated with the possibility of unaccounted for initiating events. Extensive effort has been put forth to identify a comprehensive set of initiating events, yet it is recognized that rare events may arise which cause plant response. Such events may not be adequately captured in the database as failure mechanisms may not be known and conditions in which they might arise have not occurred. Rare initiating events are considered in this study even if they have not occurred yet.

The insights from PRA results are following:

- The CDF for operations at power is 1.2E-06/RY which is less than that PWRs currently operating. The design features of US-APWR such as the four train safety system, independent four train electrical system, in-containment RWSP and alternate ac power source reduce the risk of core damage.

- The conditional CDF under conditions where one safety system train is out of service is below 1.0E-05/RY. Highly redundant safety system enables to maintain CDF below considerable value even when one train is out of service.

- LOCA events are not major contributors to CDF. This is due to adoption of four train safety system design and in-containment RWSP, which improves the reliabilities of RCS inventory control and decay heat removal.

- LOOP events are dominant contributors of the CDF. However, the CDF resulting from LOOP initiating event is less than 1.0E-06/RY. This is a result of the adoption of independent four train electrical system design and diverse ACC power source coping for SBO.

19.1.4.2 Level 2 Internal Events PRA for Operations at Power

A description of the Level 2 internal events PRA for operations at power including the results of the analysis is provided in the following subsections.

19.1.4.2.1 Description of the Level 2 PRA for Operations at Power

The Level 1/Level 2 interface establishes the connection between the Level 1 PRA event tree model and the Level 2 PRA event tree model, i.e. CET. This subsection describes the Level 2 PRA for operations at power beginning with ACL logic model described in Subsection 19.1.4.1.1.

The failure end states of the Level 1 PRA event trees result in ACLs that are initial conditions of the CET. ACLs are classified as a combination of (1) initiating event and primary system pressure, (2) containment intact or failed at core damage, (3) accident progression in containment, and (4) loss of support system initiating events. In total 28 ACLs are defined for the US-APWR PRA, as shown in Table19.1-7. The logic tree for ACL classification is shown in Figure 19.1-6.

The CET is developed to model each ACL and track the potential influence of accident progression in the C/V. Top events used in the CET are decided through arranging and combining those events.

The CET development considers:

- Containment failure timing that determines the characteristics of fission product release to environment in terms of the public risks
- Important phenomena in containment that may cause containment failure
- Recovery of safety system and accident management operations that may contribute to prevent containment failure

The CET consists of two portions, the CSET and the CPET. The interface between CSET and CPET is defined as PDS, which form the end states of the CSET and the initial conditions of the CPET. The CET end states determine whether the intact containment or the large release. Figure19.1-7 illustrates the analysis process of Level 2 PRA, including the interfaces between it and the Level 1 PRA.

The CSET models the containment systems and functions that are provided to mitigate the consequences of an accident and to prevent containment failure. The CPET models the physical phenomena in containment that influence to containment failure and fission product release to the environment.

The CSET quantification is performed by the same computational code, RiskSpectrum®, employed for the Level 1 event tree quantification by the linking of the CSET with the Level 1 PRA event tree model. This is done because fault trees used in the CSET are the same trees already modeled in the Level 1 PRA. Additionally, the CSET has the same support systems and HRA dependencies considered in the Level 1 PRA fault trees. These dependencies between Level 1 PRA and CSET are simultaneously modeled and quantified by employing Riskspectrum® code. This concept is defined as the Level 1+ model, as shown in the Figure 19.1-7.

The CPET quantification is on the other hand performed by using spreadsheet models.

PDSs are defined as the initial conditions of the CPET that group similar accident sequences obtained from CSET taking into consideration core damage status, accident progression in containment, availability of mitigation features, etc.

PDSs are classified taking into consideration the following parameters that influence accident progression in containment and postulated fission product release behavior to the environment.

- Primary system pressure at RV failure

  In considering RCS depressurization after core damage, PDSs are classified as to whether primary system pressure is high, medium, or low at the time of RV failure. Primary system pressure influences the probability of temperature induced SGTR and temperature induced hot leg rupture before RV failure, and the probability of containment failure with various phenomena at RV failure.

  As primary system pressure is related to ACL, accident sequences are grouped as follows.

  1, 2, 3: Accident sequences which result in RV failure at low pressure state

  Low pressure state is defined as the state in witch the primary system pressure is lower than the pressure at which high pressure melt ejection occurs upon RV failure.

  The ACLs represented by Axx are classified as this group of PDS, but other sequences except Axx which result in RCS depressurization after core damage are also included.

  4, 5, 6: Accident sequences which result in RV failure at medium pressure state

  Medium pressure state is defined as the state in which high pressure melt ejection may occur upon RV failure, but that pressure is lower than the pressure at which TI-SGTR occurs and results in containment bypass.

  The ACLs represented by Sxx are classified as this group of PDS.

  7, 8, 9: Accident sequences which result in RV failure at high pressure state

  High pressure state is defined as the state that high pressure melt ejection may occur upon RV failure, and temperature induced SGTR may occur and result in containment bypass.

  The ACLs represented by Txx are classified as this group of PDS.

- Reactor cavity flooding status

  PDSs are classified as to whether water is injected into the reactor cavity before RV failure or after RV failure, or not injected. The presence of water in the reactor cavity influences the probability of ex-vessel steam explosion and the probability of direct containment heating. If water is available when RV fails, the possibility of ex-vessel steam explosion has to be considered although direct containment heating does not occur, and vice versa if water is not available when RV fails.

  Accident sequences are grouped by the reactor cavity flooding status as follows.

  1, 4, 7: Accident sequences in which water is not injected into the reactor cavity

  The ACLs represented by xxD and xxF, except the sequences in which firewater is injected directly into the reactor cavity, are classified as this group of PDS.

  2, 5, 8: Accident sequences in which water is injected into the reactor cavity after RV failure

  The ACLs represented by xxW, xxHF, except the sequences in which firewater is injected directly into the reactor cavity, are classified as this group of PDS.

  3, 6, 9: Accident sequences in which water is injected into the reactor cavity before RV failure

  The ACLs represented by xxS, xxHS, xxI and the sequences in which firewater is injected directly into the reactor cavity are classified as this group of PDS.

- Containment status at core damage

  PDSs are classified as to whether containment is intact at the time of core damage, whether containment is isolated at the time of core damage, whether containment fails prior to core damage, or whether the containment is bypassed. Containment status at core damage influences the fission product release behavior during early periods.

  Accident sequences are grouped by containment status at time of core damage as follows:

  A-H: Accident sequences in which containment is intact at the time of core damage

  The ACLs represented by xxD, xxF, xxW, xxS, xxHS, xxHF, xxI that containment is isolated at core damage are classified as this group of PDS.

I-J: Accident sequences in which containment is not isolated at the time of core damage

The ACLs represented by xxD, xxF, xxW, xxS, xxHS, xxHF, xxI, xxC that containment is not isolated at core damage are classified as this group of PDS.

K: Accident sequences in which containment fails before core damage.

The ACL represented by xxC that containment is isolated at core damage is classified as this PDS.

L: Accident sequences in which containment bypass exists.

The ACL represented by G is classified as this PDS.

- Igniter status

PDSs are classified as to whether igniters are functional to properly control combustible gases. Igniter status influences the probability of containment failure due to combustion of highly concentrated combustible gases. This element is not considered for the sequences of containment isolation failure at core damage, containment failure before core damage, and containment bypass since combustible gases do not concentrate within containment for these three sequences.

A-D: Accident sequences in which igniters are functional

E-H: Accident sequences in which igniters are not functional

- CSS status

PDSs are classified as to whether CSS is functional. CSS status influences the release of radioactive substances to the environment. This element is not considered for the sequences of containment failure before core damage since CSS is not functional for these sequences. Also, this element is not considered for the sequences of bypassed containment since CSS status has little affect on release of radioactive substances to the environment during these sequences.

A, B, E, F, I: Accident sequences in which CSS is functional

C, D, G, H, J: Accident sequences in which CSS is not functional

- Containment heat removal status

PDSs are classified as to whether containment heat is removed through either the CS/RHR HX or the alternative containment cooling by containment fan cooler system. Containment heat removal status influences the possibility of containment failure due to over-pressure.

In addition, as containment heat removal status is not important for the fission product release behavior in the cases of containment isolation failure, containment failure before core damage or containment bypass at core damage, PDSs are not classified in such accident sequences.

A, C, E, G: Accident sequences in which containment heat is removed

B, D, E, H: Accident sequences in which containment heat is not removed

In total, 72 PDSs are defined for the US-APWR on the basis of the PRA through the above-explained PDS classification methodology, as the combination of (1) primary system pressure (2) reactor cavity flooding status (3) containment status at core damage (4) igniter status (5) CSS status (6) containment heat removal status. The defined PDSs are shown in Table 19.1-36.

For development of the CET, the items to be considered are the following physical phenomena and available countermeasures against severe accident.

Following are the physical phenomena which influence containment failure modes.

- RV failure
- Hydrogen mixing and combustion
- Core debris coolability
- Steam explosion (in- and ex-vessel)
- High pressure melt ejection (direct containment heating and rocket-mode RV failure)
- Temperature induced SGTR
- MCCI
- Early and late containment overpressure failure

The containment system features and human actions available to mitigate the consequences of an accident and to prevent containment failure are as follows:

- Water injection to RV
- Hydrogen ignition system (i.e., igniters)
- Firewater injection into the reactor cavity
- RCS depressurization
- Containment isolation

- CSS
- Alternative containment cooling by containment fan cooler system
- Firewater injection to spray header
- Recovery of safety system

For simplicity of the CET development and quantification, the following assumptions are made:

- Although water injection into the RV will be described in the procedure manual for the severe accident, the RV is assumed to fail regardless of the status of water injection into the RV
- Ex-vessel cooling by the reactor cavity water is not credited in the US-APWR PRA due to its inherently high uncertainty
- Although high point venting from the RV may promote water injection after core damage, the possibility of this process is ignored for simplicity.
- Recovery of the CSS is considered only in case of loss of electric power and loss of CCW or essential service water for simplicity
- Firewater injection to spray header is considered for increasing time margin of the recovery of CCW or essential service water for simplicity
- Equipment survivability is not considered as a top event as it is confirmed separately, including the influence due to hydrogen combustion

As the top events of the CSET, the following containment system features and human actions are selected. The detailed descriptions are shown in Table19.1-37 and the system dependency matrix is shown in Table19.1-38. Simplified diagrams of major systems are shown in Figure 19.1-2.

- Containment isolation

  The containment prevents or limits the release of fission products to the environment. The containment isolation system establishes and preserves the containment boundary integrity. Failure of the containment isolation system leads to large release of fission products

- RCS depressurization

  RCS depressurization prevents temperature-induced SGTR, direct containment heating, and rocket-mode RV failure that lead to large release of fission products. Only the depressurization valves for severe accident are considered in the evaluation

- Hydrogen control

The function of the hydrogen ignition system is to prevent violent detonation of highly concentrated flammable gas that could cause loss of containment integrity

- Reactor cavity flooding

  Water injection into the reactor cavity prevents core-concrete interaction that leads to containment failure. The injection systems include CSS and firewater injection to the reactor cavity

- Recovery of CSS and CS/RHR HX

  Recovery of CSS and CS/RHR HX is credited only by the recovery of support system. The support system includes electric power supply, CCWS, and ESWS. Firewater injection to the spray header delays containment failure and increases the probability of the recovery of CCWS and ESWS

The CSET is not concerned with the status of CSS and alternative containment cooling by containment fan cooler system. These systems are modeled in the Level 1 PRA because of their influence in the prevention of core damage.

The RV is assumed to fail regardless of the status of water injection into the RV (including insufficient amount of water injection, injection due to depressurization after core damage, and recovery of SIS or alternative core injection system). Injection to the RV is not included as a top event in the consideration of accident progression.

The start states of the CSET correspond to the ACL and the top events are arranged in the anticipated order they apply the system. The end states are assigned to one of the PDSs.

Figure 19.1-8 shows an example CSET for one of the ACLs.

The CET end states are assigned to the intact containment or the large release. The large release is defined as any containment failure occurrence after the accident. The containment failure modes include containment bypass, containment isolation failure, containment failure due to energetic phenomena, basemat melt through, and containment overpressure failure. The energetic phenomena mean hydrogen combustion, in- or ex-vessel steam explosion, direct containment heating, and rocket-mode RV failure. The large release is also defined independent of the elapsed time from the onset core damage.

The US-APWR containment ultimate capability is discussed in Subsection 19.2.4. It is calculated as 216 psia in accordance with a simple assumption that containment fails at yield strain. This is a conservative assumption.

As the top events of CPET, the following physical phenomena are selected:

- Temperature-induced hot leg rupture before temperature-induced SGTR and vessel melt through (Event IHL)

If temperature-induced hot leg rupture occurs earlier than temperature-induced SGTR, then the primary system is depressurized and temperature-induced SGTR is prevented.

- No temperature-induced SGTR before temperature-induced hot leg rupture and vessel melt through (Event BP)

  Occurrence of temperature-induced SGTR leads to large release of fission products.

- No containment failure from in-vessel steam explosion (Event ISX)

  Containment failure due to in-vessel steam explosion leads to large release of fission products. It is assumed that this failure is considered only in low pressure sequences and does not occur in intermediate or high pressure sequences. It has been reported in various existing studies, such as ALPHA experiments, as in-vessel steam explosions are not observed when the system pressure is higher than 150psia (Reference 19.1-32)

- No containment failure from hydrogen-burn before vessel melt through (Event HB1)

  Containment failure due to hydrogen combustion before RV failure leads to large release of fission products.

- No containment failure from ex-vessel steam explosion (Event ESX)

  Containment failure due to ex-vessel steam explosion leads to a large release of fission products.

- No containment failure from direct containment heating and rocket-mode reactor vessel failure (Event DH)

  Occurrence of high pressure melt ejection brings possibility of direct containment heating and rocket-mode reactor vessel failure. Containment failure due to direct containment heating or rocket-mode reactor vessel failure leads to large release of fission products

- No containment failure from hydrogen-burn after vessel melt through (Event HB2)

  Containment failure due to hydrogen combustion at RV failure leads to large release of fission products. In considering additional generation of hydrogen due to various phenomena after vessel melt through, it is defined as a separate top event from HB1.

- Debris quenched, cooled long-term and containment cooled (Event EVC)

  Failure of debris cooling leads to the occurrence of MCCI and eventually potential basemat melt through or containment failure due to overtemperature or overpressure. Failure of containment heat removal leads to the containment failure regardless of debris cooling. These containment failures lead to large release of fission products.

The start states for the CPET correspond to PDS. Selected top events are arranged in accordance with the anticipated order of the accident progression and the end states are assigned to large release or intact containment. In the arrangement of top events, the timing of containment failures that influence release characteristics of fission products to the environment and physical phenomena that cause containment failure are taken into account. Figure19.1-9 shows the US-APWR CPET.

In addition, fission products are always released to the environment in the case of the containment isolation failure (2I, 3I, 5I, 6I, 8I, 9I, 1J – 9J), containment failure before core damage (1K, 4K), and containment bypass (4L). These PDSs have already resulted in containment failure, and fission products are released at core damage. Therefore, CPET is not developed for these PDSs.

19.1.4.2.2 Results from the Level 2 PRA for Operations at Power

This subsection provides the results from the Level 2 PRA for at power operations.

The set of 28 accident classes is used to start the Level 2 quantification process. Each ACL is assigned to Level 1 PRA event tree end states and used to link the Level 1 PRA event tree model and the CSETs. Linking and quantification are performed by RiskSpectrum® code.

The conditional probability of each CET end state for each PDS is quantified by spreadsheet models of the CPET. Failure fractions of the top event of CPET are quantified according to the following methods.

- Quantification by applying the results of PRAs previous to the US-APWR PRA
- Quantification by analyzing the load due to the physical phenomena concerned and by comparing it with pressure capacity
- Quantification by substituting the qualitative evaluation results according to the accident progression analysis by MAAP4.0.6 code with examination of the knowledge about severe accident phenomena and evaluation examples in previous PRAs

The frequency of LRF for each PDS is quantified by multiplying the CDF by the conditional probability for each PDS. The LRF is quantified by summing all frequencies of large release for each PDS. Additionally, the CCFP is defined as ratio of LRF to CDF, and is summed over all PDS frequencies.

The CDF, LRF, and CCFP are summarized as follows:

CDF = 1.2E-06/RY

LRF = 1.0E-07/RY

CCFP = 0.09

The dominant cutsets of LRF are shown in Table19.1-39. This information is quantified by the addition of the CCFP for each PDS to the top event of the CSET end states and by RiskSpectrum® code.

The dominant cutsets that contribute greater than 1% to LRF are described below.

(1) LOOP with reactor trip. Emergency ac power supply system and AAC power source fail and lead to SBO. EFWS (turbine-driven pumps) succeeds. However, RCP seal LOCA occurs due to RCP seal cooling failure. Also, recovery of power systems within 3 hours fails and results in core damage.

The containment isolation before core damage succeeds. However, RCS depressurization fails due to loss of emergency power supply. Also reactor cavity flooding fails due to loss of electrical power after core damage. The recovery of power system by the commencement of MCCI fails and results in containment failure. The frequency of this cutset is 1.4E-08/RY and accounts for 13.1 % of LRF.

(2) LOCCW with reactor trip. EFWS succeeds. Both alternate CCW supply by the non-essential chilled water and by the FSS fail to operate and result in RCP seal LOCA due to RCP cooling failure. Consequently, it results in core damage.

The containment isolation, RCS depressurization, and reactor cavity flooding succeeds. However firewater injection to the spray header fails to operate due to human error. Recovery of CCWS fails and therefore results in containment failure. The frequency of this cutset is 9.8E-09/RY and accounts for 8.9% of LRF.

(3) SLOCA with reactor trip. EFWS, SIS, and CSS succeed. Therefore, core cooling succeeds. However, containment heat removal by the CS/RHR HX fails. Also, the alternative containment cooling by containment fan cooler system fails to operate and results in containment failure before core damage. The frequency of this cutset is 7.7E-09/RY and accounts for 6.9 % of LRF.

(4) LOCCW with reactor trip. This is the same as (2) until core damage.

The containment isolation, RCS depressurization, and reactor cavity flooding succeeds. However, firewater injection to the spray header fails. Recovery of CCWS fails and therefore results in containment failure. The frequency of this cutset is 6.0E-09/RY and accounts for 5.5% of LRF.

(5) LOCCW with reactor trip. This is the same as (2) until core damage.

The containment isolation and RCS depressurization succeeds. However both firewater injections to the reactor cavity and to the spray header fail. Recovery of CCWS fails and therefore results in containment failure. The frequency of this cutset is 6.0E-09/RY and accounts for 5.5% of LRF.

(6) LOCCW with reactor trip. This is the same as (2) until core damage.

The containment isolation, RCS depressurization, and reactor cavity flooding succeeds. Also firewater injection to the spray header succeeds. However, recovery of CCWS fails and results in containment failure. The frequency of this cutset is 3.6E-09/RY and accounts for 3.3 % of LRF.

(7) LOCCW with reactor trip. This is the same as (2) until core damage.

The containment isolation, RCS depressurization, and reactor cavity flooding succeeds. Also firewater injection to the spray header succeeds, and recovery of CCWS succeeds. However, the containment fails due to some severe accident phenomenon. The frequency of this cutset is 2.9E-09/RY and accounts for 2.6 % of LRF.

(8) SLOCA with reactor trip. EFWS and SIS succeed. Therefore, core cooling succeeds. However, CSS fails. Also, the alternative containment cooling by containment fan cooler system fails to operate and results in containment failure before core damage. The frequency of this cutset is 1.7E-09/RY and accounts for 1.6 % of LRF.

(9) RV rupture. This initiating event is assumed to directly result in core damage. All systems are functional.

The containment isolation and reactor cavity flooding succeeds. Also the containment heat removal succeeds. However, the containment fails due to severe accident phenomena such as steam explosion and hydrogen burning. The frequency of this cutset is 1.2E-09/RY and accounts for 1.1 % of LRF.

(10) MLOCA with reactor trip. This is the same as (3) except for initiating events. The frequency of this cutset is 1.1E-09/RY and accounts for 1.0 % of LRF.

The portion of each initiating event in the LRF is summarized in Table 19.1-40. This information is presented in the chart shown in Figure 19.1-10 with the percentage of total LRF.

Table 19.1-40 shows that five initiating events account for over 90 percent of the total LRF. These events are as follows:

- Loss of component cooling water (LOCCW)
- Loss of offsite power (LOOP)
- Small pipe break LOCA (SLOCA)
- Partial loss of component cooling water (PLOCW)
- Steam generator tube rupture (SGTR)

The first three events account for 34.6%, 29.4%, and 15.2% of the total LRF, respectively. The contribution of the other initiating events is less than 10% of the total LRF.

Importance analyses have been performed to evaluate the following issues:

- Basic event importance
- CCF importance
- Human error importance
- Component importance

The results of Fussell Vesely (FV) importance and risk achievement worth (RAW) for the large release frequency are shown in Table 19.1-41 and Table 19.1-42 respectively.

The top five most significant basic events, based on the FV importance, are as follows:

ACWOO02FS (Fail to supply alternate component cooling water from FSS) – This basic event applies to conditions where loss of CCW has occurred. If operators fail to supply alternate component cooling water to the charging pump cooling line, RCP seal injection function is lost. Eventually, RCP seal LOCA occurs. 32% reduction from the current LRF is anticipated if the probability of this failure is set to 0.0.

ACWOO02CT-DP2 (Fail to supply alternate component cooling water from non-essential chilled water system) – This basic event applies to conditions where loss of CCW has occurred. If operators fail to supply alternate component cooling water to the charging pump cooling line, RCP seal injection function is lost. Eventually, RCP seal LOCA occurs. 31% reduction from the current LRF is anticipated if the probability of this failure is set to 0.0.

OPS----PRBF (Failure of offsite power recovery within 1 hour) – This basic event applies only to condition where total loss of ac power occurs after LOOP. If offsite power does not recover within 1 hour under total loss of ac power condition, RCP seal LOCA is assumed to occur. 21% reduction from the current LRF is anticipated if the probability of this failure is set to 0.0.

OPS---- PRCF (Failure of offsite power recovery within 3 hours) – This basic event applies only to condition where total loss of ac power occurs after LOOP. If offsite power does not recover within 3 hours under total loss of ac power condition, core damage is assumed to occur due to RCP seal LOCA. 21% reduction from the current LRF is anticipated if the probability of this failure is set to 0.0.

OPSRSB (Failure of offsite power recovery after core melt) – This basic event applies only to condition where total loss of ac power occurs after LOOP and ac power does not recover until core damage. If offsite power does not recover by the commencement of MCCI under total loss of ac power condition, containment failure is assumed to occur. 18% reduction from the current LRF is anticipated if the probability of this failure is set to 0.0.

The top five most significant basic events, based on the RAW, are as follows:

SWSCF4PMYR-FF (CCF of ESWS pumps fail to run)

The plant LRF would increase approximately 5.6E+04 times if the probability of this failure were set to 1.0. This significant increase in the LRF is because of the loss of containment heat removal due to loss of cooling chain to ultimate heat sink.

CWSCF4RHPR-FF (CCF of CCWS HXs plug, foul, or external large leak)

The plant LRF would increase approximately 5.1E+04 times if the probability of this failure were set to 1.0. This significant increase in the LRF is because of the loss of containment heat removal due to loss of cooling chain to ultimate heat sink.

CWSCF4PCYR-FF (CCF of CCWS pumps fail to run)

The plant LRF would increase approximately 5.1E+04 times if the probability of this failure were set to 1.0. This significant increase in the LRF is because of the loss of containment heat removal due to loss of cooling chain to ultimate heat sink.

EPSCF4BYFF (CCF of three class 1E batteries fail to operate)

The plant LRF would increase approximately 4.2E+04 times if the probability of this failure were set to 1.0. If this failure occurs after loss of offsite power, three safety buses fail to be isolated from the faulted offsite power. Eventually, three safety buses will lose vital power. One safety bus may be available, but only one SG is supplied feed water because the cross tie-line valves at the emergency feed water pump discharge line cannot open due to loss of dc power. Accordingly, sufficient decay heat cannot be removed from SGs.

RTPBTSWCCF (CCF of support software)

The plant LRF would increase approximately 2.6E+04 times if the probability of this failure were set to 1.0. This significant increase in the LRF is due to loss of all digital instruments that will result in failure of transmitting various signals including plant trip signal and emergency core cooling system actuation signal.

<u>Common cause importance</u>

The top 10 risk-important common cause basic events for a FV importance and for a RAW are given in Table 19.1-43 and Table 19.1-44, respectively.

The most significant CCF basic event based on FV importance is CCF of all 6.9kV income circuit breakers. The second most significant CCF basic event is CCF of CS/RHR HX discharge line motor operated valves.

The most significant CCF basic events based on the RAW are the same as the basic events ranked in top ten most significant basic events based on RAW.

Human error importance

The top 10 risk-important human error basic events for a FV importance and for a RAW are given in Table 19.1-45 and Table 19.1-46, respectively.

The most significant human error basic event based on FV importance is **ACWOO02FS (Fail to supply alternate component cooling water from FSS)**, with a FV importance of 3.2E-01.

The most significant human error basic event based on RAW is **MSROO02533A (Fail to close of main steam isolation valves)**, with a RAW of 2.1E+01. The plant LRF would increase approximately 21 times, if the probability of this failure were set to 1.0.

Component importance

The top 10 risk-important hardware single failure events for a FV importance and for a RAW are given in Table 19.1-47 and Table 19.1-48, respectively.

Three single failure basic events have a FV importance greater than 2.0E-02. The most significant single failure basic events based on FV importance are CFAMVFCFSV2 and CFAMVFCFSV5, which represent the failure of motor operated valves on the firewater injection line to the spray header, with same FV importance of 8.7E-02.

There are top 10 basic events that have a RAW greater than 1.0E+03. The most significant single failure basic event is a rod injection failure. The plant LRF would increase approximately 1.1E+04 times if the probability of this failure were set to 1.0.

The top 10 dominant PDSs are given in Table 19.1-49. This table shows that seven PDSs account for over 90 percent of the total LRF. These PDSs are as follows:

- 3D (Low RCS pressure, cavity flooded before RV failure, igniter functional, CSS not injected, and no containment heat removal)
- 4K (Medium RCS pressure, and containment failure before core damage)
- 4D (Medium RCS pressure, cavity not flooded, igniter functional, CSS not injected, and no containment heat removal)
- 3A (Low RCS pressure, cavity flooded before RV failure, igniter functional, CSS injected, and containment heat removal)
- 4L (SGTR)
- 4H (Medium RCS pressure, cavity not flooded, igniter not functional, CSS not injected, and no containment heat removal)
- 9A (High RCS pressure, cavity flooded before RV failure, igniter functional, CSS injected, and containment heat removal)

The 3D, 4D, and 4H account for 38.0%, 14.9%, and 5.1% of the total LRF, respectively. These PDSs involve loss of containment heat removal. Therefore, containment cannot maintain its integrity.

The 4K accounts for 17.3% of the total LRF. This PDS is containment failure before core damage.

The 3A accounts for 6.3% of the total LRF. This PDS is success of containment isolation, containment heat removal, reactor cavity flooding before vessel melt through and igniters. Also this PDS is low RCS pressure. Therefore, containment fails due to severe accident phenomena such as ex-vessel steam explosion.

The 4L accounts for 5.7% of the total LRF. This PDS is containment bypass.

The 9A accounts for 2.7% of the total LRF. This PDS is success of containment isolation, containment heat removal, reactor cavity flooding before vessel melt through and igniters. Also this PDS is high RCS pressure. Therefore, containment fails due to severe accident phenomena such as temperature-induced SGTR, direct containment heating or rocket-mode reactor vessel failure.

An analysis has been performed to determine the sensitivity of LRF to the following:

Sensitivity analysis of failure fraction is performed to study the impact of the debris coolability on plant LRF for internal initiating events at power.

- Case 01: Failure fraction of the debris coolability is increased to 0.1 from 0.002

  If failure fraction of the debris coolability is 0.1, the LRF is 2.1E-07/RY, which is approximately twice that of the base case.

- Case 02: Failure fraction of the debris coolability is decreased to 0.0 from 0.002

  If failure fraction of the debris coolability is 0.0, the LRF is 1.0E-07/RY, which is almost same as the LRF of the base case.

A PRA study involves many sources and type of uncertainty. Some are quantifiable and can be propagated through the model to generate an uncertainty distribution. Others deal with issues such as the state of knowledge and are difficult to quantify. Key sources of uncertainty and key assumptions made in the development of the PRA model for internal events at power are provided below. They have been identified and assessed for their impact on the results of the PRA.

The assessed areas of uncertainty include parametric uncertainty and modeling uncertainty.

Parametric uncertainty associated with parametric values and is that propagating these through modeling formalisms. Evaluations this uncertainty results in a better understanding of the variability of the mean or expected value of the distribution and the range of possible outcomes. A parametric uncertainty evaluation propagates the uncertainty distribution through the model to produce the mean value of LRF using Monte Carlo simulation.

The results of the parametric uncertainty quantification for the total LRF are summarized in Figure 19.1-11. The mean, median, lower 5th percentile, and upper 95th percentile of the distribution were calculated. The EF was estimated by the square root of the ratio of the 95th percentile to the 5th percentile.

The plant LRF uncertainty range is found to be 3.0E-07/RY – 2.0E-08/RY for the 95% to 5% interval. This indicates that there is 95% confidence that the plant LRF is no greater than 3.0E-07/RY. The EF for the total LRF is 3.9.

Modeling uncertainty consists of key assumptions and key decisions that are made in developing the model. Table 19.1-50 lists key sources of uncertainty and key assumptions made in the development of the PRA models along with a qualitative assessment of the items pertaining to modeling uncertainty.

The insights from PRA results are the following:

- The LRF for operations at power is lower than 1.0E-06/RY. This is due to the fact that the US-APWR containment has high capability to withstand many postulated severe accident phenomena, as described in Subsections 19.2.3 and 19.2.4. This fact is obtained from the examination of PDSs in which severe accident phenomena cause containment failure. These PDSs have low contribution to the LRF.

- Some mitigation systems effectively reduce the LRF. The containment isolation system with the dc-driven containment isolation valves effectively reduces the potential of the containment isolation failure in the SBO condition, which is a major contributor to the CDF. The firewater injection to the spray header reduces the potential for containment failure in the loss of CCW. The alternative containment cooling by containment fan cooler system reduces the potential of the containment failure before core damage in which the CSSs fails by CCF.

- The major initial events of the LRF are loss of CCW and loss of offsite power. Loss of offsite power includes CCF of the CCW pumps restart at the time of emergency power recovery. The reason for the importance of these events is that the containment heat removal systems share CCWS as cooling chain to the ultimate heat sink with the core cooling systems such as SIS and alternate core cooling. Therefore the major PDSs that contribute to the total LRF are the ones related to loss of containment heat removal. Upon such a loss, the containment is likely to fail regardless of severe accident phenomena even if incorporating the potential recovery of CCWS for the containment heat removal.

The insights from the importance, sensitivity, and uncertainty analyses are:

- The CCF basic events are important. This is reasonable for a plant with highly redundant safety systems.
- If the failure fraction of the debris coolability increases, the LRF increases because of one of the key conservative assumptions of Level 2 PRA that RV always fails as the consequence of core damage. If this conservative assumption is not considered, the possibility of succeeding in-vessel core retention may arise and it may be possible to avoid the ex-vessel phenomenon, resulting in a reduced LRF.

19.1.5 Safety Insights from the External Events PRA for Operations at Power

External events considered in the US-APWR PRA are those whose cause is external to all systems associated with normal and emergency operations situations, with the exception of internal fires and floods, which are included here based on historical protocol. Some external events may not pose a significant threat of a severe accident. Some external events are considered at the design stage and have a sufficiently low contribution to CDF or plant risk. Chapter 2 of the COLA Final Safety Analysis Report (FSAR) will provide information concerning the geological, seismological, hydrological, environmental, and meteorological characteristics of the site and vicinity, in conjunction with present and projected population distribution, including land use relative to site activities and controls. Chapter 2 of the COLA FSAR will contain site specific information as compared to the standard design envelope criteria. Assessing the risk of external events necessarily includes site-specific issues. Chapter 2 of the DCD contains generic site parameter requirements necessary to meet the engineering and design needs for safe construction and operation of the US-APWR. Based primarily upon the guidelines provided in Generic Letter 88-20 (Reference 19.1-33) and ANSI/ANS-58.21-2007 (Reference 19.1-8), the following is a list of external events that are included for US-APWR analysis.

1. High winds and tornadoes
2. External flooding
3. Transportation and nearby facility accidents
4. Aircraft crash
5. Seismic
6. Internal fires
7. Internal flooding

The last three events listed above receive detailed evaluation in the following subsection. The first four cannot be properly evaluated until a specific site has been selected. Chapter 2 of this DCD contains bounding site parameter requirements for following events.

- Nearby industrial, transportation, and military facilities

- Meteorology
- Hydrologic engineering
- Geology, seismology, and geotechnical engineering

Evaluation of potential accidents for the nearby industrial, transportation, and military facilities in Chapter2 is a probabilistic and predictive approach that will be followed and documented in the COLA to verify that a 10^{-7} per year occurrence rate has been demonstrated. For low probability events, where data may not be available, a 10^{-6} per year occurrence rate can be utilized when combined with reasonable qualitative arguments. Otherwise, a PRA may need to be performed to comply with the guidance of ANSI/ANS-58.21-2007. The screening criteria of US-APWR for other external events will be determined at COL phase confirming that the screening criteria is below the plant specific risk of US-APWR.

19.1.5.1 Seismic Risk Evaluation

The following subsections describe the seismic risk evaluation including the results of the evaluation.

19.1.5.1.1 Description of the Seismic Risk Evaluation

Risk quantification of the seismic PRA involves the integration of the seismic hazard, fragility, and accident sequence model to evaluate core damage, radiological releases, and offsite risks. The seismic margin methodology has been applied to estimate the plant-level seismic margin and accident sequences. The seismic margin for the US-APWR is evaluated by using PRA-based SMA. This methodology satisfies the recommendation of SECY-93-087 (Reference 19.1-34) approved by the NRC for a seismic risk evaluation. SMA identifies potential vulnerabilities and demonstrates seismic margins beyond the design-level safe-shutdown earthquake (SSE). The capacity of components required to bring the plant to a safe and stable conditions is assessed. The SSCs identified as important to seismic risk are addressed.

The outline associated with the SMA methodology is shown in Figure19.-12. The PRA based SMA consists of following elements.

- Selection of review level earthquake

  The starting point to perform SMA is to select a review level earthquake. SMA demonstrates that sufficient margin in seismic design exists by showing the high confidence of low probability of failures (HCLPFs) of the plant and components are greater than review level earthquake (RLE). The RLE of US-APWR is 0.5g, that is, 1.67 times of the SSE (0.3g).

- Development of seismic equipment list

  The seismic equipment list is provided from the internal event PRA model. Also, earthquake-specific SSCs such as passive components and structures related to a safety function, which are not addressed in the internal event PRA model, are involved for the fragility analysis and system analysis.

- Identification of seismic initiating event category

  Initiating events due to a seismic event are identified from the internal events analysis. However there are some major differences between the seismic and internal events for purpose of identifying initiating event category, which are as follows: (1) seismic events may damage passive plant components and structures (e.g., SGs, reactor building, power source building) that are not explicitly modeled in the internal event PRA; and (2) seismic events may simultaneously damage multiple redundant systems and components at the plant. Identified seismic initiating event categories are modeled as hierarchy structures.

- Development of system models

  The SMA system models are developed from the internal events PRA model to include the important accident sequences. This model also contains random failures and human errors from the internal events PRA. System models are modified to accommodate a seismic event. The model is used to estimate seismic margins and to identify vulnerabilities in the design.

- Fragility analysis

  At the design certification phase, specific design data such as material properties, analysis results, qualification test information, etc. are not available. Therefore, generic fragility data is used for the component fragility of US-APWR components. The generic data used for US-APWR are based on the fragilities provided by the Electric Power Research Institute (EPRI) Utility requirements document (Reference 19.1-35). Seismic fragilities of structures are developed using the methodology in Reference 19.1-36.

- Evaluation for the plant seismic capacity

  There are two acceptable approaches to evaluate the plant seismic margin as described in NUREG/CR-4482 (Reference 19.1-37).

  - "Min-max" method, in which HCLPF is assessed for accident sequences by taking the lower HCLPF value for components operating under OR logic and the highest HCLPF value for components operating under AND logic.

  - "Convolution" method in which probabilities of non-seismic and operator failures are included in the calculation as well as the component fragilities. This is a fully quantitative approach where the importance and contribution of seismic as well as non-seismic failures can be assessed quantitatively.

  The "min-max" method is selected as the appropriate method at the design certification phase since detailed plant-specific data is unavailable. This method is accomplished by calculating HCLPFs for each seismic event tree top event that represents a safety-related system or function. HCLPFs of systems are calculated in conjunction with random and/or human factors.

- Demonstration of seismic margin in the design

  The objective is to demonstrate that there is sufficient seismic margin in the design. If the plant HCLPF is less than the review level earthquake, modification of the design or the model is required.

  A fragility evaluation is performed to obtain the seismic margin of components and structures that could have an effect on safe shutdown of the plant following a seismic event. In this evaluation, the seismic margin values of components and structures modeled in the accident sequences are obtained. The seismic margin is expressed in terms of HCLPF values.

  $HCLPF = A_m * \exp(-1.65*(\beta_R + \beta_U))$

  or

  $HCLPF = A_m * \exp(-2.33*\beta_C)$

  A_m: median capacity

  β_R: logarithmic standard deviation representing the randomness

  β_U: logarithmic standard deviation representing the uncertainty

  β_C: composite logarithmic standard deviation

  The median capacities and HCLPFs are expressed in terms of the peak ground acceleration (PGA). An earthquake of 0.5g PGA is defined as the review level earthquake for the US-APWR.

  a) Components

  As previously noted, at the design certification phase, specific design data of components such as material properties, analysis results, qualification test information, etc. are not available. Therefore, generic fragility data are used to obtain the component fragility of the US-APWR standard design. The generic data used for US-APWR are based on the fragility data presented in Reference 19.1-35. Median capacities are provided for various types of site foundations in Reference 19.1-35, i.e., rock, soil 1, soil 2, soil 3, soil 4, and soil 5. In this evaluation, the HCLPF value of each component is calculated using the most conservative median capacity of these site type values. Components for which generic data are not available or not appropriate are assumed conservative HCLPF values. The assumed HCLPF values are selected conservatively from the seismic Category I components designed to a SSE with 0.3g PGA .

  b) Structures

The containment structure is a freestanding post-tensioned pre-stressed reinforced concrete structure with a hemispherical dome. A three-dimensional lumped mass stick model of the nuclear island buildings that are founded on a common basemat was developed for dynamic seismic response analyses. Seismic fragilities of the structures are developed using the methodology in Reference 19.1-36 and information from the design documents.

The important structural response factors that would influence structure seismic response and variability are as follows:

- Spectral shape factor
- Damping factor
- Modeling factor
- Modal combination factor
- Earthquake components combination factor
- Soil-structure interaction factor
- Ground motion incoherence factor
- Horizontal direction peak response

Also the capacity factors considered in the evaluation are as follows:

- Strength factor
- Inelastic energy absorption factor

Structures for which design information is not available are assumed conservative HCLPF values. The assumed HCLPF values are decided conservatively from the seismic Category I structures designed to a SSE of 0.3g PGA

For SSCs for which generic fragility data is not available or is not appropriate, a HCLPF value of 0.5g PGA is assumed. The seismic design of US-APWR has some conservatism. For example,

- Broadened floor response spectrum is used for seismic response analysis of seismic Category I SSCs.

- Allowable stress of SSCs is provided considering safety margins

SSCs of seismic Category I are designed for SSE of 0.3g PGA with such conservatisms that they have high seismic capacity. Therefore, HCLPF of 0.5g PGA would be reasonably achievable for seismic Category I SSCs. This value is assigned for those SSCs at design certification phase. The fragilities of those SSCs will be confirmed that the HCLPFs of the SSCs are greater than 0.5g PGA at the detailed seismic design phase.

The major assumptions for the SMA model are as follows:

a. It is assumed that the seismic event would result in a LOOP, since offsite power equipment is not seismic Category I. (The insulators on the offsite power feed lines can fail in a seismic event such that a LOOP occurs.)

b. No credit is taken for non-safety-related systems. They are assumed in the model to have failed or to be non-functional due to the seismic event.

c. In the SMA system fault trees, the operator actions in the random failure cutsets from the internal events PRA are assumed as having a failure probability of 1.0. Thus, no credit is taken for the operator actions.

d. As a conservative assumption, if one component fails due to the seismic event, the same type components of the system will fail as well.

e. Failure of the reactor trip signal is not modeled since the control rod motor generator sets would be de-energized following a LOOP due to a seismic event and succeed in the release of control rods into the core even if the reactor trip function fails. However, if the core assembly or the control rod system fails to insert into the core, these equipment failures are addressed in the event, which leads to core damage.

f. It is assumed that piping will fail prior to failure of associated pressure boundary valves. Therefore, valves that are not required to change positions are not included. Also, orifices are not included. Valves that change position, such as motor-operated valves or check valves are assumed to fail the function at the HCLPFs.

g. Failure of the RHRS isolation valves is not included in the analysis, because the pipe sections are assumed to fail before the valves fail and these valves are normally closed. Also, the US-APWR design has provided further protection against interfacing system LOCA by upgrading design pressure. Therefore, interfacing system LOCA is not modeled.

h. Identified pipe segments in the same system are modeled as failing at the same acceleration level at the same time.

i. Failure of buildings that are not seismic Category I (i.e., turbine building, auxiliary building and access building) does not impact SSCs designed to be seismic Category I. Seismic spatial interactions between SSCs design to be seismic Category I and any other buildings will be avoided by proper equipment layout and design. The following seismic Category I buildings and structures are identified as buildings and structures that involve safety-related SSCs to prevent core damage.

- Reactor building
- Safety power source buildings
- Essential service water intake structure
- Essential service water pipe tunnel

j. Relay chatter does not occur or does not affect safety functions during and after seismic event.

Six seismically induced initiating event categories have been identified, and are listed below in order of greatest to least “challenges.”

- Gross structural collapse
- LOCA in excess of ECCS capacity
- Loss of CCW system (includes loss of essential service water system)
- Large LOCA (includes medium LOCA)
- Small LOCA (includes very small LOCA)
- LOOP (includes a “family” of transients)

Cutset calculation of the US-APWR PRA used the RiskSpectrum® PRA code.

19.1.5.1.2 Results from the Seismic Risk Evaluation

The result of the PRA based SMA is the plant HCLPF for core damage. The steps to perform the PRA based SMA include the following.

1. HCLPFs for seismic basic events - The HCLPFs for various US-APWR SSCs were calculated. See Table19.1-51 for HCLPF values of structures and categories of components, and Table19.1-52 for HCLPF values for basic events.

2. Calculation of seismic initiating event HCLPFs - Initiating event HCLPFs are calculated using the min-max method.

3. Calculation of cutsets for the core damage - Cutsets of the core damage sequences are quantified using fault tree linking process. The seismic cutsets contain only seismic failure events. Then, the probability of random failures is set to 0.0, and cutsets are calculated.

4. Calculation of sequence HCLPFs and the plant HCLPF - Sequence HCLPFs are calculated using the min-max method. The plant HCLPF is calculated as the minimum sequence HCLPF, as shown in Table19.1-53.

5. Calculation of core damage mixed-cutsets - The mixed-cutsets contain both seismic failures and random failures. Random failure probabilities are derived from the internal PRA model. The mixed-cutsets are quantified using fault tree linking process.

The dominant sequence HCLPFs are shown below.

Initiating event		Fault tree		Sequence
1. SE_GSTC (0.50 g)				= SE_GSTC-0001 (0.50 g)
2. SE_ELOCA (0.50 g)				= SE_ELOCA-0001 (0.50 g)
3. SE_CCW (0.50 g)				= SE_CCW-0001 (0.50 g)
4. SE_LOOP (0.08 g)	[AND]	SE-OPS (0.50 g)		= SE_LOOP-0027 (0.50 g)

Accident scenario and important contributors to each sequence are described below.

1. SE_GSTC-0001

SE_GSTC-0001 sequence, with HCLPF value 0.50 g, is a gross structural collapse event which lead to core damage. The most important contributors to this event are:

(1) Structural failure of safety power source buildings: 0.50g

(2) Structural failure of the cable trays: 0.53 g

2. SE_ELOCA-0001

SE_ELOCA-0001 sequence, with HCLPF value 0.50 g, is a loss of the RCS inventory that exceeds the ECCS capacity to provide makeup event. This event leads to core damage. The most important contributors to this event are:

(1) Structural failure of the fuel assembly : (reactor internals and core assembly) 0.50 g

(2) Structural failure of the RV : 0.62 g

(3) Structural failure of the reactor coolant pumps (RCPs) : 0.67 g

3. SE_CCW-0001

SE_CCW-0001 sequence, with HCLPF value 0.50 g, is a seismically induced loss of CCW event. This event causes RCP seal LOCA and results in failure of all systems cooled by the CCWS such as the safety injection pumps and the CS/RHRS pumps. This event leads to core damage. The most important contributors to this event are:

(1) Structural failure of the HVAC chillers:	0.50 g
(2) Structural failure of essential service water Intake structure:	0.50 g
(3) Structural failure of essential service water pipe tunnel:	0.50 g
(4) Structural failure of component cooling heat exchangers:	0.58 g
(5) Structural failure of the CCWS surge tank:	0.58 g
(6) Structural failure of the CS/RHR heat exchangers:	0.58 g

4. SE_LOOP-0027

SE_LOOP-0027 sequence, with HCLPF value 0.50 g, is a seismically-induced LOOP event and failure of class 1E gas turbine generators. This event sequence causes RCP seal LOCA and results in failure of all systems cooled by CCWS. The most important cutsets associated with this sequence involve failure of the ceramic insulators (0.08 g) combined with failure of the class 1E gas turbine generators (0.50 g).

The plant HCLPF is calculated by finding the lowest HCLPF sequence shown in Table19.1-53. The plant HCLPF value is 0.50 g. Therefore, an acceptable standard design is realized since the plant HCLPF (0.50 g) is greater than or equal to the review level earthquake PGA (0.50 g).

It is not desirable that conservative SSC HCLPFs control the plant HCLPF. Conservative HCLPFs of 0.50 g are assigned to HVAC chillers (0.50 g), safety power source buildings (0.50 g), essential service water Intake structure (0.50 g), essential service water pipe tunnel (0.50 g), fuel assembly (0.50 g) and class 1E gas turbine generators (0.50 g). When the design activity progresses and specific design data becomes available, these HCLPFs will be updated during the COLA phase to reflect specific design data.

Thus, a sensitivity study is performed by setting the HCLPF capacities for these SSCs to1.0 g. The result of the plant HCLPF increased to 0.53 g.

From the results of the plant HCLPF calculation and sensitivity studies, SSCs that make the largest contribution to seismic risk are as follows:

1. SE-HVACHSFCHLHX (0.50 g) : HVAC chillers (structural failure)
2. SE-GTSBDSFBLDGP (0.50 g) : Safety power source buildings (structural failure)
3. SE-SWSSRSFESWBAS (0.50 g) : Essential service water Intake structure (structural failure)
4. SE-SWSSRSFESWTUN (0.50 g) : Essential service water pipe tunnel (structural failure)
5. SE-ELOSRSFFUEL (0.50 g) : Fuel assembly (structural failure)
6. SE-ELSDLFFGTABCD (0.50 g) : Class 1E gas turbine generators (functional failure)
7. SE-GTSCASFCABLE (0.53 g) : Cable tray (structural failure)
8. SE-CWSTNSFCW1TK (0.58 g) : CCWS surge tank (structural failure)
9. SE-CWSRISFCCWHXABCD(0.58 g) : CCWS heat exchangers(structural failure)
10. SE-RSSRISFRHEXABCD (0.58 g): CS/RHRS heat exchangers(structural failure)

The potential impact of random failures on the vulnerability of the plant is assessed by examining "mixed cutsets" in the results. Dominant mixed-cutsets are defined as the mix-cutsets containing the random failure probability higher than 1.0E-03 in this study. The dominant mixed-cutsets (i.e., the combination of seismic failure and no seismic failures) are organized as follows:

- Combination 1:

  Seismically induced small LOCA initiating event

  [AND] Seismically induced failure of motor driven EFW pumps

  (including supporting system failure)

  [AND] Random failure of one turbine driven EFW pump

  (including supporting system failure)

- Combination 2:

  Seismically induced small LOCA initiating event

  [AND] Seismically induced failure of turbine driven EFW pumps

(including supporting system failure)

[AND] Random failure of one motor driven EFW pump

(including supporting system failure)

- Combination 3:

  Seismically induced loss of offsite power initiating event

  [AND] Seismically induced failure of motor driven EFW pumps

  (including supporting system failure)

  [AND] Random failure of one turbine driven EFW pump

  (including supporting system failure)

- Combination 4:

  Seismically induced loss of offsite power initiating event

  [AND] Seismically induced failure of turbine driven EFW pumps

  (including supporting system failure)

  [AND] Random failure of one motor driven EFW Pump

  (including supporting system failure)

Multiple failures of SSCs are required in order to drive the plant to core damage. The probability of this scenario would be low. From these results, random failures are concluded to not have significant impact on seismic safety.

One of the objectives of a seismic event is to identify vulnerabilities of containment functions. These include containment integrity, containment isolation and prevention of bypass functions. Seismic capacities for these functions are as follows.

- Containment integrity

  - PCCV

- Containment spray and containment cooling System (involved in CS/RHRS)

- Containment isolation
  - Containment isolation valves and associated piping
  - Penetrations
  - Equipment hatches
- Prevention of bypass function
  - Main steam isolation valves

·Containment integrity

HCLPF of PCCV is 1.1g. The seismic capacity for CS/RHRS is identified higher than RLE PGA. Therefore there is a seismic margin for containment integrity.

·Containment isolation function

HCLPF of containment isolation valves are 0.8g. The seismic capacity for safety-related I&C system and power distribution system to actuate containment isolation valves are also higher than RLE PGA. HCLPFs for penetrations and equipment hatches are greater than 0.5g.

·Prevention of containment bypass function

Causes of containment bypass are interfacing LOCA (ISLOCA),and steam generator tube rupture. US-APWR has enhanced the plant design against an ISLOCA by increasing the design pressure. Therefore the frequency of ISLOCA is very low. Also HCLPF of steam generators is 0.67g and higher than RLE PGA. Therefore there is a seismic margin for containment bypass event.

The SMA results identified some risk insights as follows:

1. There are some important safety-related SSCs for which seismically induced failure would lead directly to core damage. In this SMA study, these SSCs have HCLPF values in excess of 0.50 g. If any of these SSCs were built with a HCLPF lower than 0.50g, the plant HCLPF would also be lower than 0.50 g.

2. The plant HCLPF is dominated by HVAC chillers (0.50g), safety power source buildings (0.50g), essential service water Intake structure (0.50 g), essential service water pipe tunnel (0.50g), fuel assembly (0.50g) and class 1E gas turbine generators (0.50g). If those SSCs HCLPF value were to be increased to any value

above 0.53 g, the plant HCLPF would increase to 0.53 g and would be dominated by the cable tray (0.53 g).

3. The analysis did not identify any important sequence containing mixed cutsets. The only sequences containing mixed cutsets which would lower the plant HCLPF to below 0.50 g when random failures occur are LOOP sequences which are initiated by failure of the ceramic insulators (0.08 g). However, the probability of such random failures occurring is low (i.e., less than 1.0E-03). This means that random failures are unlikely to occur in a seismically-initiated accident sequence.

4. No credit is taken for operator actions in this study. The plant HCLPF is dominated by failures of SSCs result in core damage directly, such as the failure of structures.

5. Depending on whether offsite power is available, different scenarios to trip the reactor are considered. In the case offsite power failed (i.e., a LOOP initiating event), the control rod motor generator sets would be de-energized following LOOP and succeed in the release of control rods into the core even if the reactor trip function failed. Only when the control rod system is failed would the reactor trip be failed. This scenario is considered in this study and the HCLPF value for this event is 0.67 g (dominated by the control rod HCLPF). In case offsite power is available, the failure of the reactor trip function should be considered. However, the HCLPF for the reactor trip system would be higher than 0.67 g determined when offsite power is lost. This is because HCLPFs for electrical equipment and sensors/transmitters to trip the reactor are above 0.67 g. Thus, whether offsite power is available or not, the HCLPF value (i.e., seismic capacity) to trip the reactor is higher than the plant HCLPF of 0.50 g.

6. There are no vulnerabilities for containment performance (i.e., containment integrity, containment isolation and prevention of bypass functions) due to a seismic event.

19.1.5.2 Internal Fires Risk Evaluation

The following subsections describe the internal fires risk evaluation and its results.

19.1.5.2.1 Description of the Internal Fires Risk Evaluation

The fire PRA methodology for the US-APWR is based on NUREG/CR-6850 (Reference 19.1-7). This methodology and related data were developed jointly by EPRI and the NRC. NUREG/CR-6850 provides a state-of-the-art methodology for fire PRAs. The fire PRA methodology is composed of 16 tasks, described below.

Step 1: Plant boundary definition and partitioning – The objectives of this task are to define the global plant analysis boundaries relevant to the fire PRA, and to divide the plant into discrete physical analysis units (fire compartments). The fire compartments are the fundamental basis of fire PRA.

Step 2: Fire PRA component selection – This step establishes the link between internal events PRA model (i.e., plant response model) and internal fire PRA. The purpose of this step is to define the components that should be included in the CDF and LRF estimation process. The list of relevant components comes from the internal events analysis and often includes additional components unique to internal fire PRA.

Step 3: Fire PRA cable selection – For the components identified in the preceding step, the associated circuits (including cables) and their locations in terms of the fire compartments of defined in Step 1 are identified.

Step 4: Qualitative screening – Fire compartments that do not contain any fire PRA components or cables are screened from further analysis. Also, if it can be shown that a fire in a compartment cannot lead to a plant trip, those compartments are also screened.

Step 5: Plant fire-induced risk model – The purpose of this step is to create the model that will be used in estimating the fire risk (i.e., the plant response model is put together in this step). The initiating events and internal events model are examined for applicability to fire events. Additional fire induced initiating events that are unlikely to occur by the internal events are identified. Similarly, additional peculiarly fire accident sequences will also be identified.

Step 6: Fire ignition frequency – This is the first step where probability and frequency values are used. Database of fire ignition frequencies for specific ignition sources which is provided in NUREG/CR 6850 are used.

Step 7: Quantitative screening – The fire risk contribution of the compartments selected in the preceding steps are analyzed in this step. Initially, in this step it is assumed that the fire postulated in the fire compartment would fail the equipment and cables within the compartment. This assumption will be later relaxed if necessary and the quantitative screening is repeated for fire scenarios defined in more detail.

Step 8: Scoping fire modeling – This step is used for reducing the level of effort of the detailed analysis (Step 11). This step has been skipped in the US-APWR fire PRA.

Step 9: Detailed circuit failure analysis – For risk-significant fire compartments, more detailed circuit analysis than Step 3 analysis eliminate some of the cables in the compartments. The analysis in this step is typically conducted for components that appear in the dominant plant response sequences of quantitative screening steps.

Step 10: Circuit failure mode likelihood analysis – The failure mode probabilities are estimated for the cables of risk-significant components. The methodology provided in NUREG/CR 6850, which is based on knowledge gained from recent cable fire tests, is used.

Step 11: Detailed fire modeling – In this step initial fire characteristics, fire growth in a fire compartment, detection and suppression, damage from heat and smoke and many other relevant topics are addressed. This step is composed of following three parts: (1) Detailed fire modeling of single fire compartments;

In this analysis, fire scenarios are defined in terms of ignition sources, target sets, fire growth, and propagation pattern and fire detection and suppression features. All fire PRA equipment and cables in the fire compartment in which fire origin are postulated will be assumed to be adversely impacted by the fire.

(2) MCR fire analysis;

This analysis is forcused on the fire frequency and the human error the operation remote shutdown console in the situation for MCR evacuation due to the fire adverse effects.

(3) Multi-compartment fire analysis.

This analysis uses the screening steps to reduce the scope of detailed analysis. The screening criteria includes lack of additional fire PRA equipment in the adjacent fire compartment , low fire load in fire origin compartment which influences the probability of fire propagation, small fire scenario frequency, and finally CDF.

Survived scenarios will be analyzed by the same method as for single compartment case.

Step 12: Post-fire HRA – Operator actions after fire ignition are assumed to be affected by the fire unless it can be clearly shown otherwise. In this step identification, inclusion, and quantification of operator action cases are addressed and their HEPs are estimated.

Step 13: Seismic fire interactions – The main purpose of this step is to identify and correct any weaknesses in the fire protection systems and vulnerabilities in the ignition sources due to seismic events. This is the qualitative evaluation that has been in NUREG/CR 6850 to ensure that the impact of earthquake on fire related issues are addressed. No risk are computed.

Step 14: Fire risk quantification – This is the final step of the analysis process, where the risk values (i.e., CDF and LRF) are computed and risk contributors are identified.

Step 15: Uncertainty and sensitivity analyses – Uncertainty analysis is an integral part of every preceding probabilistic analysis. Through a series of sensitivity analyses, the assumptions that have the largest impact on the fire risk are identified. One purpose of the sensitivity analysis is to demonstrate the importance of some of the assumptions.

Step 16: Fire PRA documentation – Appropriate documentation of the above steps is to be accomplished in this step.

Various assumptions and engineering judgments provide a basis for the internal fire analysis. The assumptions and engineering judgments used in this analysis are as follows:

a. All fire doors provided to the fire barriers between the redundant safety train fire compartments are normally closed, but are opened with the barrier failure probability.

b. For the transient combustibles “three airline trash bags ” has been assumed in each fire compartment

c. There can be only one fire barrier failure and/or one fire damper failure at any given time. Cascading effect will be unimportant because the probability of situation beyond such assumption will be low.

d. It is assumed that, in a fire in MCR, any mitigation systems considered in Level 2 PRA are not available when operators must evacuate from the MCR.

e. It is assumed that, for a Level 2 PRA, firewater pumps can be used as mitigation systems such as reactor cavity direct injection and providing water in containment as spray droplet, even when a fire breaks out.

In first step, fire compartments have been defined through plant partitioning. And, in next step, the internal events PRA model for the US-APWR has been reviewed to identify the accident sequences that should potentially be included in the fire PRA model, and equipment to be included in the fire PRA component list has been identified. Some of the sequences included in the internal events PRA are eliminated from the fire PRA model. The elimination criteria of the sequences are as follows:

- Sequences associated with initiating events involving a passive/mechanical failure that can generally be assumed not to occur as a direct result of a fire. Therefore, initiating events that are caused by primary or secondary side pipe breaks, vessel failure, and SGTRs can be eliminated from the PRA model.

- Sequences associated with events that, while it is possible that fire could cause the events, a low-frequency of occurrence argument could be justified. For example, the anticipated transient without scram sequence has not been treated in the fire PRA because fire-induced failures will almost certainly remove power from the control rods (resulting in a trip), rather than cause a “failure-to-scram” condition. Additionally, fire frequencies multiplied by the independent failure-to-scram probability can be seen as small contributors to fire risk.

Table 19.1-54 provides a listing of the initiating events that were included and excluded in the fire PRA.

As a result, the following accident sequences have been eliminated from the fire PRA model.

- LOCAs (pipe break)
- RVR
- SGTR
- Feed water line break
- Anticipated transient without scram

Furthermore, cables associated with fire PRA components have been identified in each fire compartment.

In qualitative screening step, screening of fire scenarios have been performed. A fire scenario is classified into three types: (a) single-compartment fire scenario, (b) multi-compartment fire scenario, and (c) MCR fire scenario. In this step, singe compartment fire scenarios have been studied, and following compartments have been screened. :

- The compartment which does not contain any fire PRA components or cables, and
- The compartment of which fires will not lead to:
  - An automatic reactor trip
  - A manual reactor trip as specified in fire procedure, EOPs, or plant technical specification

  However, such information as being contained in fire procedures and EOPs does not exist for the US-APWR at the present stage. Therefore, it has been assumed that every compartment within the reactor building, power source building, and turbine building (T/B) might contain cables which would require manual reactor trip-operation in a fire scenario. And, access control building have been screened from further analysis because those buildings do not contain safety equipment.

In next step, fire ignition frequency has been estimated. plant ignition sources have been classified in the ignition source specified in Table 6-1 of NUREG/CR 6850. The frequencies are based on fire event experience in the U.S. nuclear power plants prior to December 2000, the same frequencies are used in US-APWR fire PRA. NUREG/CR 6850 also presents the modeling method in which self ignition fire of cables should be postulated in "unqualified cables". Therefore, self ignition fire of cable runs has been excluded from the ignition sources bins because "qualified cables" will be adopted in US-APWR.

19.1.5.2.2 Results from the Internal Fires Risk Evaluation

Quantitative screening has been performed to screen some fire compartments from further analysis.

In this step, three types of fire scenarios of (a) single-compartment fire scenario, (b) multi-compartment fire scenario, and (c) MCR fire scenario have been addressed separately. In type (a) and (c) fire scenario, it has been postulated that the heat and smoke generated by the fire may affect the function of all PRA equipment and cables installed in the fire compartment. In type (b) fire scenario, fire propagation to adjacent fire compartment has been postulated with the failure probability of one fire barrier.

"RiskSpectrum"®PRA code has been used to quantify CDF of US-APWR. Any fire suppression system has been not credited. Damage probability of cable system has been estimated through Circuit Failure Mode Likely Analysis. HEP has been estimated by using ASEP.

Screening has been performed based on the criteria specified in NUREG/CR-6850 (Reference 19.1-7) which provides two screening criteria.

The first criteria is given in Table 7-2 of NUREG/CR-6850 as:

- CDF < 1.0E-07/year
- LERF < 1.0E-08/year

The second criteria is given in Table 7-3 of NUREG/CR-6850 as:

- Sum of CDFs for all screened out fire compartments< 0.1*Internal event CDF
- Sum of LRFs for all screened out fire compartments< 0.1*Internal event LERF

Practically the value for CDF screening analysis is conservatively established as 9.0E-09/RY, in order to satisfy the second screening criterion, As a results, CDF of all screened out sequences has been within 10% of internal event CDF.

Also, practically the value for LRF screening analysis is conservatively established as 1.0E-09/RY, in order to satisfy the second screening criterion, As a results, LRF of all screened out sequences has been within 10% of total internal event LRF.

In detailed fire modeling following three situations have been addressed:

A. Single compartment fire scenario

B. Fire scenario in the MCR

C. Fire scenario impacting multiple compartments

After having screened single compartment scenarios based on the second criteria, 16 fire compartments scenarios have remained. These are shown in Table19.1-55. For these 16 scenarios, the necessity of detailed fire modeling has been evaluated by comparing CDF contribution of each scenario with 1.0E-07/year. Consequently, the necessity of detailed fire modeling has been identified for the following fire compartments.

- Yard (Switchyard)
- FA6-101-01 (Turbine building other floor)

However, detailed fire modeling has not been performed because the detailed design information on the Swicthyard and T/B has not yet been sufficient at this stage, and the risk of these compartments has not been so high. Hence, detailed fire modeling has not been performed for any single compartment.

In some severe fire scenario for the MCR, it has been assumed that operators will abandon the MCR and evacuate to the remote shutdown panel room.

The following are included in the analysis:

- The damage of digital control systems including control boards in the MCR due to fire will cause open circuits in equipment control systems (resulting in fail as-is conditions). This meas MCR fire will not affect the automatic start function of safety related equipment like ECCS;

- MCR evacuation scenario is modeled as a transient without the main FWS.

Quantitative screening analysis has been performed to determine if detailed analysis is required for any multiple compartment scenarios. This screening has evaluated (1) qualitative factors (e.g., do the exposed compartment(s) contain any fire PRA components or cables); (2) frequency of occurrence; and (3) CDF. The results of these screenings are shown in Table19.1-56. Four multiple compartments fire scenarios have been remained from the screening analysis, and, as can be seen in the table, the CDF of every fire scenarios have been less than the 1.0E-07/year screening criterion. Therefore, detailed analysis for those scenarios has not been performed.

In addition to the above, inside C/V fire has been simulated by CFAST code (Reference 19.1-38), and fire effect in the fire origin compartment and adjacent fire compartment has been analyzed. In this analysis, the following condition has been set:

- Fire origin compartment is FA1-101-18 (A- Accumulator area);

- Adjacent fire compartments are FA1-101-15 (B- Accumulator area) and FA1-101-17 (D- Accumulator area);

- Fire ignition source is transient combustibles whose total heat release is equal to 93,000 BTU (refer to NUREG/CR-6850 (Reference 19.1-7), "Appendix G table-7 LBL-Von Volkinburg, Rubbish Bag" Test results);

- Heat release rate given in Chapter-11 of NUREG/CR-6850 is used;

- Damage temperature of thermoplastic cable shown in Appendix H of NUREG/CR-6850 is applied.

The result of the CFAST simulation has shown that the temperature of each compartment does not reach to the damage temperature of thermoplastic cable. This means that the fire influence due to the transient combustible fire will be negligible. Therefore, a multiple compartment fire scenario has not been developed in the inside C/V fire scenario analysis.

Using the results of previous tasks, the fire induced CDF and LRF for the US-APWR have been estimated as follows:

Total CDF

Single compartment fire scenario = 1.7E-06/RY

MCR fire scenario = 1.0E-08/RY

Multi compartments fire scenario = 1.0E-07/RY

Total = 1.8E-06/RY

Total LRF

Single compartment fire scenario = 1.5E-07/RY

MCR fire scenario = 4.9E-09/RY

Multi compartments fire scenario = 7.4E-08/RY

Total = 2.3E-07/RY

Dominant Scenarios (CDF)

Yard (Switchyard) = 1.2E-06/RY

FA6-101-01 (T/B other floor) = 1.0E-07/RY

FA6-101-04 (FA6-101-04 zone) = 8.4E-08/RY

FA4-101 (Auxiliary building) = 4.6E-08/RY

FA2-205(D class 1E electrical room) = 4.6E-08/RY

FA2-202(A class 1E electrical room) = 4.4E-08/RY

FA3-104(A-class 1E GTG room) = 3.7E-08/RY

FA2-205- M-05(Multi Fire Scenario from FA2-205 to FA2-206)= 3.7E-08/RY

Dominant Scenarios (LRF)

Yard (Switchyard) = 5.7E-08/RY

FA1-101-17 (C/V 3F northwestern part floor zone)= 1.6E-08/RY

FA2-205- M-05(Multi fire scenario from FA2-205 to FA2-206)= 1.5E-08/RY

FA2-205(D class 1E electrical room) = 1.3E-08/RY

Dominant fire scenarios for CDF and LRF are described below. Dominant fire scenarios for CDF account for about 90 percent of total CDF. Each dominant fire scenario for LRF accounts for over 5 percent of total LRF.

Yard Fire (Switchyard)

This area contains main transformer and reserve auxiliary transformer. Fire ignition source postulated in Switchyard are catastrophic fire, non-catastrophic fire and other fires of transformer (it has been referred to NUREG/CR-6850, attachment C, table 6-1, item 27, 28 and 29), whose fire ignition frequency is 2.0E-02/year.

The fire in this switchyard may cause LOOP (loss of offsite power), and it also may make the recovery of all power sources. CCDP of this fire scenario has been estimated to 6.0E-05/RY.

Fire scenario postulated is as follows:

- Fire may cause LOOP because main transformer and reserve auxiliary transformer located in switchyard may be damaged by the fire.
- Offsite power cannot be recovered because the fire may damage both of main transformer and reserve auxiliary transformer.
- All four class 1E gas turbine generators could not be operated by the random failure.
- Operator may fail to connect the emergency power bus to auxiliary alternative current by the human error.
- Reactor has the potential to cause the loss of all power supplies of safety systems

The core damage frequency of this fire scenario is 1.2E-06/RY and account for 67.0% of total CDF. LRF scenario frequency is 5.7E-08/RY and accounts for 25.2% of total LRF.

Remarks: Switchyard does not contain any fire PRA component except main transformer and reserve auxiliary transformer. The dominant factor in this fire scenario risk is CCF of all four class 1E gas turbine generators, whose failure probability of starting and running was estimated to approximately 1.4E-03.

FA6-101-01 (T/B other floor) fire

FA6-101-01 consists of many compartments in T/B and occupies large floor area, and many fire ignition sources are contained in this fire compartment. Fire ignition frequency of this fire compartment is 5.6E-02/year.

This fire compartment contains turbine bypass valves whose spurious operation due to fire leads to reactor transient, but any mitigation system such as EFW and ECCS are not damaged by this fire. Therefore, CCDP of this fire scenario is low, and has been estimated to 1.9E-06.

The core damage frequency of this scenario is 1.0E-07/RY and account for 5.6% of total CDF. LRF scenario frequency is 3.1E-09/RY and accounts for 1.4% of total LRF.

FA6-101-04 (FA6-101-04 zone) fire

FA6-101-04 has the potential of transient combustibles fire and cable fire caused by welding or cutting and so forth, whose fire ignition frequency is 1.4E-03/year.

This area also contains all four train cables to safety bus ducts from offsite power sources. Therefore, the fire in this area may cause LOOP, and it may make the recovery of every power sources impossible. And, CCDP of this fire scenario has been estimated to 6.0E-05/RY.

Fire scenario is as follows:

- Fire may cause LOOP because it may damage all four train cables to safety bus ducts from offsite power located in FA6-101-04.
- Offsite power cannot be recovered because fire may damage all four train of safety bus duct cable from offsite power sources.
- All four class 1E gas turbine generators could not be operated by the random failure.
- Operator may fail to connect the emergency power bus to auxiliary alternative current by the human error.
- Reactor has the potential to cause the core damage by causing the loss of all power supplies of safety systems.

Core damage frequency of this scenario is 8.4E-08/RY and account for 4.7% of total CDF. LRF scenario frequency is 4.0E-09/RY and accounts for 1.8% of total LRF.

Remarks: FA6-101-04 has not contained any fire PRA component except all four train cables to safety bus ducts. The dominant factor in this fire scenario risk is CCF of all four class 1E gas turbine generators, whose failure probability of starting and running was estimated to approximately 1.4E-03.

<u>FA4-101(Auxiliary building) fire</u>

FA4-101 consists of all compartments in A/B, and many fire ignition sources are contained in this area. Fire ignition frequency of this area is 2.5E-02/year.

FA4-101 contains turbine bypass valves whose spurious operation due to fire leads to SLBO (Steam Line Break), but does not contain mitigation systems (and their associated cable) like EFWS and ECCS. Therefore, CCDP of this fire scenario is low; and has been estimated to 1.9E-06.

In this fire scenario, human error of following operator actions has been postulated.

- Isolation of safety injection system by containment isolation valve (MOV-001A (B, C, D))
- Isolation of RWSP discharge line of CS/RHR by Isolation valve(MOV-001A (B, C, D))
- Isolation of CCW tie-line by manual valve

The frequency of this scenario is 4.6E-08/RY and account for 2.6% of total CDF. LRF scenario frequency is 1.8E-09/RY and accounts for 0.8% of total LRF.

FA2-205 (D class 1E electrical room) fire

FA2-205 contains D-train class 1E electrical cabinets of mitigation system and their cables, and those have the potential of fire ignition sources in this fire area. Fire ignition frequency of FA2-205 is 2.3E-03/year.

A fire in FA2-205 has the potential to cause the spurious operation of turbine bypass valve due to the control cable damage, and it may result in SLBO. Fire also have the potential to damage D-train mitigation system function of metal clad switch gear and control center. In addition, feedwater isolation valves to steam generator-C and D have the potential of spurious closure due to their control cables damaged and it results in loss of emergency feed water supply to 2 steam generators. CCDP of this fire scenario is low; and has been estimated to 2.0E-05.

Postulated fire scenario is as follows.

- Spurious opening of turbine bypass valves results in SLBO..
- Closing of main steam line isolation valve may fail by the random failure, and it may result in loss of Secondary system cooling.
- Moreover, if feed and bleed becomes unavailable by the operator error or the failure of safety depressurization valve, reactor has the potential to cause core damage and large release.

The frequency of this scenario is 4.6E-08/RY and account for 2.6% of total CDF. LRF scenario frequency is 1.3E-08/RY and accounts for 5.7% of total LRF.

FA2-202 (A class 1E electrical room) fire

FA2-202 contains A-train class 1E electrical cabinets of mitigation system and their cables, and those have the potential of fire ignition sources in this fire area. Fire ignition frequency of FA2-202 is 2.3E-03/year.

A fire in FA2-202 has the potential to cause the spurious operation of turbine bypass valve due to the control cable damage, and it may result in SLBO. Fire also have the potential to damage A-train mitigation system function of metal clad switch gear and control center. In addition, feedwater isolation valves to steam generator-A and B have the potential of spurious closure due to their control cables damaged and it results in loss of emergency feed water supply to 2 steam generators. CCDP of this fire scenario is low; and has been estimated to 1.9E-05.

Postulated fire scenario is as follows.

- Spurious opening of turbine bypass valve results in SLBO.
- Closing of main steam line isolation valve may fail by the random failure, and it may result in loss of secondary system cooling.
- Moreover, if feed and bleed becomes unavailable by the operator error or the failure of safety depressurization valve, reactor has the potential to cause core damage and large release.

The frequency of this scenario is 4.4E-08/RY and account for 2.5% of total CDF. LRF scenario frequency is 1.0E-08/RY and accounts for 4.5% of total LRF.

FA3-104 (A class 1E gas turbine room) fire

FA3-104 contains A-train gas turbine generator, emergency generator control board and fuel oil drain tank, and those have the potential of fire ignition sources in this fire area. Fire ignition frequency of FA3-104 is 5.4E-03/year.

It has been postulated that a fire in FA3-104 has the potential to cause the reactor transient. Fire has the potential to damage mitigation system function of A-train gas turbine generator, dc control center and their cables. CCDP of this fire scenario is low; and has been estimated to 6.9E-06.

Postulated fire scenario is as follows.

- It is assumed that the fire may cause reactor transient.
- Emergency feedwater line-B may fail by the random failure or the failure of support system like ESWS.
- Operator may fail to connect emergency feedwater system to EFW pit, and it may result in the loss of secondary system cooling.
- Moreover, if feed and bleed becomes unavailable by the operator error or the failure of safety depressurization valve, reactor has the potential to cause core damage and large release.

The frequency of this scenario is 3.7E-08/RY and account for 2.1% of total CDF. LRF scenario frequency is 7.2E-09/RY and accounts for 3.2% of total LRF.

FA2-205-M-05 (Propagation from FA2-205 to FA2-206) fire

This is the fire scenario which the fire in FA2-205 propagates to FA2-206. FA2-205 contains D-train class 1E electrical cabinets of mitigation system and their cables, and those have the potential of fire ignition sources in this fire area. Fire ignition frequency of FA2-205 is 2.3E-03/year.

FA2-205 contains the cables of safety depressurization valve, and FA2-206 contains safety depressurization valve isolation valve. This fire has the potential to cause the spurious opening of both valves due to the control cable damage, and it may result in SLOCA. Fire also has the potential to damage D-train mitigation system function of metal clad switch gear, control center and dc control center, and it results in C and D-trains mitigation functions. The fire also damages the control cables of accumulator outlet valves or nitrogen line isolation valves of every accumulators, and it may result in loss of accumulator function. CCDP of this fire scenario is low; and has been estimated to 2.2E-05.

Postulated fire scenario is as follows.

- Spurious opening of safety depressurization valve and safety depressurization valve isolation valve, and it may result in SLOCA.
- Moreover, if safety Injection system becomes unavailable by the random failure or the failure of support system like ESW and so forth, reactor has the potential to cause core damage and large release.

The frequency of this scenario is 3.7E-08/RY and account for 2.1% of total CDF. LRF scenario frequency is 1.5E-08/RY and accounts for 6.7% of total LRF.

FA1-101-17 (C/V 3F northwestern part floor zone) fire

FA1-101-17 contains some valves and transformers in the C/V, and those have the potential of fire ignition sources in this fire area. Fire ignition frequency of FA1-101-17 is 7.8E-04/year.

It has been postulated that a fire in FA1-101-17 has the potential to cause the reactor transient. The fire also damages SDVs and their power cables. CCDP of this fire scenario is low; and has been estimated to 2.9E-05.

Postulated fire scenario is as follows.

- It is assumed that the fire may cause reactor transient.
- Moreover if EFWS become unavailable by the random failure or the failure of support system like ESWS, reactor has the potential to cause core damage and large release.

The frequency of this scenario is 2.3E-08/RY and account for 1.3% of total CDF. LRF scenario frequency is 1.6E-08/RY and accounts for 7.1% of total LRF.

The top 10 cutsets of CDF including the above sequences are shown in Table 19.1-57. Sum of other event sequences is approximately 10% of the total CDF. The top 10 cutsets of LRF including the above four dominant sequences are shown in Table 19.1-58.

Importance analysis for CDF has been performed to determine the following:

- All basic event importance
- CCF importance
- Human error importance
- Component importance

The importance for CDF is Fussell Vesely (FV) and risk achievement worth (RAW). For all basic events, events for FV >0.005 and events for RAW>2.0 are shown in Table

19.1-59 and 60. For other events, top 10 importances organized by FV importance and RAW are shown in Table 19.1-66 from Table 19.1-61.

The most significant basic events, based on the FV importance, is as follows:

RCP----SEAL (RCP SEAL LOCA) – This basic event applies only to condition where total loss of ac power occurs after LOOP without offsite power recovery, and its probability has set to 1.0. If offsite power could not be recovered within 1 hour, RCP seal LOCA will be postulated to occur. The plant CDF is decreased by a factor of 74% if the probability of this failure is set to 0.0.

The most significant basic event, based on the RAW importance, is as follows:

EPSCF4BYFF-124 (CCF of class 1E battery A, B, D fail to operate) – The plant CDF would increases approximately 1.3E+04 times if the probability of this failure were set to 1.0. If this failure occurs after loss of offsite power, 3 safety buses fail to be isolated from the faulted offsite power. Eventually, three safety buses will lose vital power. One safety bus may be available, but only one SG is supplied feed water because the cross tie-line valves at the emergency feed-water pump discharge line cannot open due to loss of dc power. Accordingly, sufficient decay heat cannot be removed from SGs.

The most significant common cause basic event, based on the FV importance, is as follows:

EPSCF4DLLRDG-ALL (CCF of class 1E gas turbine generator A, B, C, D fails to run after 1hr running) – This basic event applies to conditions after LOOP. If all four class 1E gas turbine generators failed to operation due to CCF, total loss of ac power occurs. The plant CDF is decreased by a factor of 31% if the probability of this failure is set to 0.0.

The most significant common cause basic event, based on the RAW importance, is as follows:

EPSCF4BYFF-124 (CCF of class 1E battery A, B, D fail to operate) – The plant CDF would increases approximately 1.3E+04 times if the probability of this failure is set to 1.0. If this failure occurs after loss of offsite power, 3 safety buses fail to be isolated from the faulted offsite power. Eventually, three safety buses will lose vital power. One safety bus may be available, but only one SG is supplied feed water because the cross tie-line valves at the emergency feed-water pump discharge line cannot open due to loss of dc power. Accordingly, sufficient decay heat cannot be removed from SGs.

The most significant human error basic event, based on the FV importance, is as follows:

EPSOO02RDG (Operator fails to connect alternative gas turbine generator to safety bus (HE)) – This basic event applies only to LOOP conditions where the class 1E gas turbine generators have failed to supply power. If the operator fails to connect alternative ac power to safety buses, total loss of ac power occurs. The plant CDF is decreased by a factor of 39% if the probability of this failure is set to 0.0.

The most significant human error basic event, based on the RAW importance, is as follows:

HPIOO02FWBD-S (Operator fails to open relief valves for bleed and feed (HE)) – The plant CDF would increase approximately 4.3E+01 times if the probability of this failure were set to 1.0. If the operator fails to operate this action where secondary side cooling failed, core damage occurs.

The most significant hardware single failure event, based on the FV importance, is as follows:

RCP----SEAL (RCP SEAL LOCA) – This basic event applies only to condition where total loss of ac power occurs after LOOP without offsite power recovery, and its probability has set to 1.0. If offsite power could not be recovered within 1 hour, RCP seal LOCA will be postulated to occur. The plant CDF is decreased by a factor of 74% if the probability of this failure is set to 0.0.

The most significant hardware single failure event, based on the RAW importance, is as follows:

EFWXVELPW2A (2B) (Secondary demineralizer water tank discharge line X/V VLV-006A (B) large leak) – The plant CDF would increase approximately 8.9E+02 times if the probability of this failure were set to 1.0. If this failure occurs, EFWS cannot function because of water from emergency feed water pit-A (B) leaks due to failure of VLV-006A (B) and it cannot connect to emergency feed water pit B (A) and Secondary demineralized Water Tank.

From the dominant scenarios and their dominant cutsets of LOOP in LRF scenarios, CCF of gas turbine generators, failure of opening of 6.9kV ac bus circuit breaker, and failure of operator action of connecting alternative GTG to safety bus have been identified as the significant functions and operator actions.

And in transient scenario, turbine driven EFW pump, operator actions of opening the valve of EFW pit discharge cross tie-line and operator action of FAB have been identified as the significant functions and operator actions.

In Level 1 analysis, sensitivity analysis has been performed for fire suppression system. In this analysis any fire suppression system has not been credited. However, fires occurring in existing plants are generally extinguished by automatic suppression system or manual action before the fire grow and cause the functional damage of safety components. A sensitivity analysis has, therefore, been performed using success probability 0.1 to evaluate the effects of fire suppression system. Credit of fire suppression for inside C/V fire scenarios, however, has not been taken. The result of this sensitivity analysis, using a failure probability of 0.1 for fire suppression system, CDF has been reduced to 10 percent.

A sensitivity analysis has also been done for gas turbine fire. However, the increase of CDF is negligible because any equipment that might cause important initiating event and fire scenario has not been installed in this area.

In Level 2 analysis, it has been assumed that the firewater pumps cannot be used because the fire pumps are expected to feed the fire water to reactor cavity flooding system and spray header after core melt due to fire having occurred, it is considered that this feature is required to maintain containment integrity. As a result, if the firewater pump can be used, LRF will decrease by about 40% comparing with the case that it cannot be used.

Uncertainty analysis for CDF has been completed based on the followings:

- In fire frequency analysis, lognormal distribution with the mean and standard deviation from Table C.3 of NUREG/CR 6850 has been used
- Uncertainty of conditional core damage probability has been derived from the internal events uncertainty

Uncertainties in the evaluation of different fire scenarios are evaluated using a Monte Carlo process. The plant CDF uncertainty range is found to be 5.6E-06/RY-2.4E-07/RY for the 95% to 5% interval.

- 95th percentile 5.6E-06/RY
- Mean 1.8E-06/RY
- Median 8.5E-07/RY
- 5th percentile 2.4E-07/RY

The plant LRF uncertainty has been examined, and the results of those are as follows. This uncertainty calculation is considered about 90% contribute scenarios of LRF.

- 95th percentile 5.1E-07/RY
- Mean 2.1E-07/RY
- Median 1.4E-07/RY
- 5th percentile 5.3E-08/RY

19.1.5.3 Internal Flooding Risk Evaluation

The following subsections describe the internal flooding risk evaluation and its results.

19.1.5.3.1 Description of the Internal Flooding Risk Evaluation

Internal flooding risk was evaluated using qualitative and quantitative methods, as discussed below. The internal flooding analysis was performed to identify, analyze, and quantify the core damage risk contribution as a result of internal flooding. The internal flooding analysis models potential flood vulnerabilities in conjunction with random failures modeled as part of the internal events PRA. Through this process, flood vulnerabilities that could jeopardize core integrity have been identified.

The internal flooding PRA is organized into three phases. In the first phase of the internal flooding PRA, qualitative evaluation, the information that is needed for the IFPRA is collected and the initial qualitative analysis steps are performed. The four key steps are (1) identification of flood areas and SSCs; (2) identification of flood sources and flooding mechanisms; (3) performance of plant walk downs (alternatively, perform tabletop examination at design certification stage and COL phase); and (4) perform qualitative screening by considering flood source and mode, and flood propagation pathways; and screen out areas free of flood sources, critical equipment, and propagation potential. The major outputs of the first phase include screening of plant flood areas based on criteria associated with flood sources, identifying flood propagation pathways, identifying potential impacts of floods on SSCs, and selecting flood areas for quantitative evaluation.

The second phase is the quantitative evaluation. Quantitative evaluations of plant locations that have not been screened out are addressed in six separate steps. These steps are organized around the key steps in defining flood scenarios and quantifying their impacts in the PRA model in terms of their contributions to CDF and LRF, and entail (1) flood scenario characterization; (2) flood initiating events analysis; (3) flood consequence analysis; (4) flood mitigation evaluation; (5) PRA modeling of flood scenarios; and (6) PRA quantification. These steps include the definition of flood scenarios in terms of flood initiating events, the consequences of the flood on SSCs, and the interfacing of the flood scenario with the PRA event tree and fault tree logic. Once the scenarios have been properly characterized, this phase also addresses the quantification of the flood initiating event frequency, CDF, and LRF. The last phase, which is the documentation phase, is an ongoing effort that is being performed along with each of the steps noted above for the qualitative evaluation and quantitative evaluation phases.

The scope of the internal flooding risk evaluation is during normal power operations as well as low power or shutdown operations. Reviews of operating experience data show that on the order of one-third of recorded significant internal flooding events have occurred during shutdown operations.

The internal flooding analysis does not include an evaluation of flooding inside the containment structure. During routine power operation the containment is closed and independent of other buildings from a flooding standpoint. The equipment inside this structure is qualified for a post-accident environment, which includes the effects of CSS actuation. Any adverse effects of water accumulation due to loss of primary coolant are considered in the LOCA models. Therefore, flooding is not a unique threat to the operability of equipment in the containment, and the structure is not included in internal flooding PRA.

It is noted that high-energy line breaks (HELB) is evaluated in Chapter 3, Section 3.6, and “Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping.”

Various assumptions and engineering judgments provide a basis for the internal flooding analysis. The key assumptions used in this analysis are as follows:

a. Flooding resulting from pipe and tank ruptures is considered. However, concurrent spray or flooding from different sources are not considered

b. The loss of functions of electric equipment such as motors, electrical cabinets, solenoid valves and terminal boxes by spraying or flooding is assumed

c. Components such as check valves, pipes and tanks are not vulnerable to effects of flooding

d. The components that are environmentally qualified are considered impregnable to spraying or submerge effects. Also component failure by flooding will not result in the loss of an electrical bus

e. Same models used for internal PRA models are used for internal flooding PRA, such as event trees, fault trees of mitigating systems to prevent core damage

f. It is assumed that the operators in the control room can not mitigate flood outside of the control room during the flood

g. Flooding inside of containment is not included in the internal flooding PRA because inside of containment vessel are designed and evaluated for LOCA events

h. Walls are assumed to remain intact against flooding events since they are designed to withstand anticipated maximum flood loading. Flood propagation from the flood areas which enclosed by water tight doors are considered if the flood water is much and high water level in the area

i. Fire protection doors are considered as flood propagation paths, but the propagation through penetrations is not considered since fire protection seals are provided for walls, floors and ceilings, which compose the fire area boundaries

j. Penetrations within the boundaries between the restricted area and non-restricted area are sealed and doors or dikes are provided for openings. Therefore, flood propagation, except for major flood events is not considered

k. East side and west side of reactor building (R/B) are physically separated by flood propagation preventive equipments such as water tight doors. Therefore, flood propagation between east side and west side in the reactor building is not considered

l. Drain systems are designed to compensate with flood having flow rate below 100 gpm. Flood with flow rate below 100 gpm will not propagate to other areas due to the drain systems

m. The first floor of the electrical equipment room of T/B is designed to be water proof and the first floor of T/B is equipped with relief panels so that these measures prevent the occurrence of loss of offsite power due to flood in the T/B

n. Watertight doors are provided for the boundaries between R/B and A/B in the bottom floor and between R/B and T/B in flood area 1F so that this measure prevents flood propagation from non-safety building to R/B

o. Flooding of ESWS can to be isolated within 15 minutes and flooding of fire protection system can be isolated within 30 minutes

p. Four trains of ESWS have physical separations and flooding in one train does not propagate to other trains

Flood areas are provided in the same way as fire areas because of the following characteristics of the US-APWR.

- Fire areas are divided in fire zones which are divided by walls. Boundaries of fire areas consist of fire walls which maintain integrity for three hours. The walls are also effective to mitigate the effects of sprays.

- Fire protection seals for penetrations or fire protection doors are effective to mitigate the impact of flood.

Large circulating water system leaks due to pipe failures are indicated in the control room by a loss of vacuum in the condenser shell and water level in the sump. Water from a system rupture will run out of the building through a relief panel in the T/B wall before the level can raise high enough to cause damage. Site grading will carry the water away from safety-related buildings.

The SSCs in the flood areas are identified from internal events PRA models. Equipment location is gathered from several sources: general arrangement drawings, US-APWR internal and fire PRA databases, and clarification discussions with design engineers. SSCs, such as manual valves, check valves, safety valves, orifices, and tanks have been excluded because those SSCs would not be affected by flooding.

Performing a flood hazard evaluation is a key to achieving a realistic, plant-specific internal flooding PRA model. At each level of the flood hazard evaluation different types of passive component pressure boundary failures are considered including the following categories of loss-of-fluid events:

- Sprays - Spray events result in no accumulation of water on a building floor. An underlying assumption is that a spill rate from a pressure boundary through-wall flaw is within the capacity of a floor drain system. The equipment in each flood zone is identified and the range of a potential spray zone and the effectiveness of spray shields considering local spray impacts determined. A detailed evaluation of potential spray impacts includes identification of the type of spray source. An engineering calculation of estimated spray range may be performed if required. The resulting leak or spill rate is defined as less than 100 gpm. The upper bound flow rate is based on engineering judgment and insights accumulated in the review of service data and licensing basis flood level calculations. This upper bound flow rate of 100 gpm also corresponds to be typical capacity of a floor drain system. Hence, if the consequences of a flood event are limited to spray impact, the submergence of equipment in the area need not be considered. A spray event should therefore be assumed to fall in the range of less than 100 gpm unless the results of a site-specific design basis evaluation indicate otherwise.

- Floods - Flood events are characterized as pressure boundary failures involving large through-wall flow rates and resulting in accumulation of water on a building floor. In the flood hazard evaluation the upper bound for a resulting spill rate is chosen in such a way that it remains within the plant-specific flood design basis as defined in NUREG-0800, Standard Review Plan (SRP) Subsection 3.4.1 (Reference 19.1-39). The spill rate resulting from this type of pressure boundary failure may or may not challenge the capacity of a floor drain system depending on the drain design. The resulting spill rate is defined as in excess of 100 gpm but no larger than 2000 gpm. This spill rate range is typically within the flood design basis in safety related structures.

- Major Floods - Major flood events are characterized as pressure boundary structural failures with a resulting spill rate beyond the flood design basis. A resulting spill rate is likely to exceed the capacity of a floor drain system. The result of a major structural failure is a rapid release of a large volume of water with a spill rate in excess of 2000 gpm.

- HELB - HELB is characterized by a large through wall flow rate caused by a major structural failure in a high-energy line. A piping system is defined as high-energy if the maximum operating temperature exceeds 200ºF or the maximum operating pressure exceeds 275 psig. By contrast, a piping system is defined as moderate energy if the maximum operating temperature is less than 200 ºF or the maximum operating pressure is less than 275 psig. Consequential effects of HELB as well as moderate-energy line break (MELB) events are considered in the internal flooding PRA.

Flood frequencies have been calculated using Reference 19.1-40. This report provided the failure rates per reactor operating year - linear foot for each system. Therefore, flood frequencies in the flood areas are calculated considering the plant specific piping lengths of the systems which involved in the areas. Flood scenarios have been screened out qualitatively if there are no flood sources in the flood area or there are no SSCs in the area of flood propagation.

Plant CDF quantification of the US-APWR PRA used the RiskSpectrum® PRA code.

19.1.5.3.2 Results from the Internal Flooding Risk Evaluation

The total CDF due to the internal flooding is 1.4E-06/RY. The “spray” contribution is 1.9E-07/RY, the “flood” contribution is 4.3E-07/RY, and the “major flood” contribution is 7.4E-07/RY.

The total LRF due to the internal flooding is 2.8E-07/RY. The “spray” contribution is 1.8E-08/RY, the “flood” contribution is 1.2E-07/RY, and the “major flood” contribution is 1.4E-07/RY.

Dominant flooding scenarios are as follows:

<u>Dominant scenarios of CDF are following 20 scenarios that contribute 90% of CDF.</u>

- FA2-102-01 (Major flood at reactor building B1F A-EFW pump room) 1.7E-07/RY

- FA2-108-01 (Flood at reactor building B1F D-EFW pump room) 1.7E-07/RY
- FA2-102-01 (Flood at reactor building B1F A-EFW pump room) 1.5E-07/RY
- FA2-108-01 (Major flood at reactor building B1F D-EFW pump room) 1.5E-07/RY
- FA2-414-01 (Major flood at reactor building 3F east main steam piping room) 1.4E-07/RY
- FA2-415-01 (Major flood at reactor building 3F west main steam piping room) 1.3E-07/RY
- FA2-414-01 (Spray at reactor building 3F east main steam piping room) 7.3E-08/RY
- FA2-501-03 (Flood at reactor building 4F main feedwater piping room) 3.7E-08/RY
- FA2-501-01 (Flood at reactor building 4F west corridor) 3.7E-08/RY
- FA2-415-01 (Spray at reactor building 3F west main steam piping room) 3.3E-08/RY
- FA2-102-01 (Spray at reactor building B1F A-EFW pump room) 3.1E-08/RY
- FA2-108-01 (Spray at reactor building B1F D-EFW pump room) 1.3E-08/RY
- FA2-112-01 (Major flood at reactor building B1F west corridor) 1.3E-08/RY
- FA2-501-11 (Flood at reactor building 4F west corridor) 1.3E-08/RY
- FA2-206-02 (Major flood at reactor building 2F west corridor) 1.2E-08/RY
- FA2-407-04 (Flood at reactor building 3F east corridor) 1.2E-08/RY
- FA2-501-11 (Major flood at reactor building 4F west corridor) 1.1E-08/RY
- FA2-407-04 (Major flood at reactor building 3F east corridor) 1.1E-08/RY
- FA2-201-02 (Major flood at reactor building 2F east corridor) 1.1E-08/RY
- FA2-407-01 (Major flood at reactor building 3F west corridor) 1.0E-08/RY

Dominant scenarios of LRF are following 25 scenarios that contribute 90% of LRF.

- FA2-108-01 (Flood at reactor building B1F D-EFW pump room) 3.8E-08/RY
- FA2-108-01 (Major flood at reactor building B1F D-EFW pump room) 3.4E-08/RY

- FA2-102-01 (Major flood at reactor building B1F A-EFW pump room) 2.6E-08/RY
- FA2-102-01 (Flood at reactor building B1F A-EFW pump room) 2.3E-08/RY
- FA2-501-03 (Flood at reactor building 4F main feedwater piping room) 2.0E-08/RY
- FA2-501-01 (Flood at reactor building 4F west corridor) 1.9E-08/RY
- FA2-112-01 (Major flood at reactor building B1F west corridor) 8.2E-09/RY
- FA2-501-11 (Flood at reactor building 4F west corridor) 8.1E-09/RY
- FA2-206-02 (Major flood at reactor building 2F west corridor) 7.6E-09/RY
- FA2-501-11 (Major flood at reactor building 4F west corridor) 7.1E-09/RY
- FA2-407-01 (Major flood at reactor building 3F west corridor) 6.5E-09/RY
- FA2-407-04 (Flood at reactor building 3F east corridor) 6.4E-09/RY
- FA2-407-04 (Major flood at reactor building 3F east corridor) 5.9E-09/RY
- FA2-201-02 (Major flood at reactor building 2F east corridor) 5.8E-09/RY
- FA2-206-01 (Major flood at reactor building 1MF west corridor) 5.1E-09/RY
- FA2-111-01 (Major flood at reactor building B1F east corridor) 5.1E-09/RY
- FA2-501-01 (Major flood at reactor building 4F west corridor) 4.7E-09/RY
- FA2-201-01 (Major flood at reactor building 1F east corridor) 4.1E-09/RY
- FA2-414-01 (Major flood at reactor building 3F east corridor) 3.3E-09/RY
- FA2-501-08 (Major flood at reactor building 4F B-EFW pit) 3.2E-09/RY
- FA2-415-01 (Major flood at reactor building 3F west main steam piping room) 3.1E-09/RY
- FA2-109-01 (Major flood at reactor building B1F C-EFW pump room) 2.5E-09/RY
- FA2-414-01 (Spray at reactor building 3F east corridor) 2.2E-09/RY
- FA2-501-02 (Major flood at reactor building 4F A-EFW pit) 1.9E-09/RY
- FA2-103-01 (Major flood at reactor building B1F B-EFW pump room) 1.7E-09/RY

The key scenarios of internal floods for both CDF and LRF are as followings.

[FA2-102-01]

Major flood due to the rupture of piping in the A-EFW pump (T/D) room on the B1F of R/B causes loss of function of both A and B trains of component cooling water pumps, essential chiller pumps, and batteries by the effect of flooding propagation. Also A and B EFW pumps lose the function. This scenario causes partial loss of component cooling water systems. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (1.7E-07/RY) and LRF (2.6E-08/RY).

[FA2-108-01]

Flood due to the rupture of piping in the D-EFW Pump (T/D) room on the B1F of R/B causes loss of function of both C and D trains of component cooling water pumps, essential chiller pumps, and batteries by the effect of flooding propagation. Also C and D EFW Pumps lose the function. This scenario causes partial loss of component cooling water systems. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (1.7E-07/RY) and LRF (3.8E-08/RY).

[FA2-102-01]

Flood due to the rupture of piping in the A-EFW pump (T/D) room on the B1F of R/B causes loss of function of both A and B trains of component cooling water pumps, essential chiller pumps, and batteries by the effect of flooding propagation. Also A and B EFW pumps lose the function. This scenario causes partial loss of component cooling water systems. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (1.5E-07/RY) and LRF (2.3E-08/RY).

[FA2-108-01]

Major flood due to the rupture of piping in the D-EFW pump (T/D) room on the B1F of R/B causes loss of function of both C and D trains of component cooling water pumps, essential chiller pumps, and batteries by the effect of flooding propagation. Also C and D EFW pumps lose the function. This scenario causes partial loss of component cooling water systems. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (1.5E-07/RY) and LRF (3.4E-08/RY).

[FA2-414-01]

Major flood due to the rupture of piping in the east side main steam line piping room on the 3F of R/B causes secondary line break. Secondary cooling by A and B steam generators are also not available. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (1.4E-07/RY) and LRF (3.3E-09/RY).

[FA2-415-01]

Major flood due to the rupture of piping in the west side main steam line piping room on the 3F of R/B causes secondary line break. Secondary cooling by C and D steam generators are also not available. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (1.3E-07/RY) and LRF (3.1E-09/RY).

[FA2-414-01]

Spray due to the leak from piping in the east side main steam line piping room on the 3F of R/B causes secondary line break. This scenario assumed plant shutdown by operators. Simultaneously operators fail to open the valve of EFW pit discharge cross tie line. Also operators fail to feed and bleed operation. This scenario is dominant contributor of CDF (7.3E-08/RY).

[FA2-501-03]

Flood due to the rupture of piping on the 4F of R/B east side steam generator blowdown water radiation monitor room causes loss of function of both A and B trains of component cooling water pumps, essential chillers, and batteries, by the effect of flood propagation. Also B-EFW pump (M/D) loses function. This scenario causes partial loss of component cooling water systems. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line, random failure of one EFW pump and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (3.7E-08/RY) and LRF (2.0E-08/RY).

[FA2-501-01]

Flood due to the rupture of piping on the 4F of R/B east side corridor causes loss of function of both A and B trains of component cooling water pumps, essential chillers, and batteries, by the effect of flood propagation. Also B-EFW pump (M/D) loses function. This scenario causes partial loss of component cooling water systems. Simultaneous operator failure to open the valve of EFW pit discharge cross tie line, random failure of one EFW pump and operator failure for feed and bleed operation result in core damage. This scenario is dominant contributor of CDF (3.7E-08/RY) and LRF (1.9E-08/RY).

[FA2-415-01]

Spray due to the leak from piping in the west side main steam line piping room on the 3F of R/B causes secondary line break. This scenario assumed plant shutdown by operators. Simultaneously operators fail to open the valve of EFW pit discharge cross tie line. Also operators fail to feed and bleed operation. This scenario is dominant contributor of CDF (3.3E-08/RY).

Risk significant scenarios involve major flooding due to the ruptures of piping at R/B west side or east side non restricted areas. R/B contains safety related components. Major flood causes partial (east side or west side) failures of many components, such as CCW pumps and EFW pumps, due to submerge rapidly. Dominant cutsets are shown in Table 19.1-67. Fussell-Vesely importance and risk achievement worth are shown in Table 19.1-68 and Table 19.1-69 respectively. Importance of common cause failures, human errors and hardware failure are shown in Table 19.1-70 through Table 19.1-75. Significant SSCs are EFWS, feed & bleed operation using high head injection system and SDVs. Key initiating events are partial loss of CCWS. CCW pumps are located in B1F and are affected by major floods. Key SSCs for internal flood are CCWS and mitigation systems for the partial loss of CCWS such as EFWS and feed and bleed operations.

US-APWR designs to prevent electrical equipment rooms from the flooding and fire such as separation of the electrical rooms on the first floor and the second floor of the T/B. Those reduced risk from loss of offsite power caused by flood in the T/B. If the measures against the flooding for electrical room of T/B have not been done, it is difficult to switchover to alternate gas turbine generators for power supply to class 1E buses when all emergency gas turbine generators failed. As a sensitivity study, a loss of offsite power due to the flooding in the T/B is assumed. If these measures have not done and a loss of offsite power with all four class 1E gas turbine generators failure occurred, the CDF and LRF of this scenario are 1.1E-06/RY and 3.1E-08/RY, respectively. These measures are effective to reduce flooding risk.

US-APWR sets several water tight doors to prevent the propagation of floods. As a bounding sensitivity study, assumed all water barrier doors except the controlled barriers such as R/B separations between east side and west side and high energy compartments are invalid. The CDF and LRF of this bounding study are 2.6E-06/RY and 6.1E-07/RY, respectively. Although the several local watertight doors opened, the increasing of risk is not significant.

Assessment of uncertainties of the internal flood PRA model accounts for uncertainty in initiating events. Table A-13 through Table A-52 of EPRI 1013141 [Reference 19.1-40] addresses uncertainties in pipe failure rates. Uncertainties in the evaluation of different flood isolation strategies implicitly involve accounting for uncertainties in spill rate distributions, and the time to reach a critical flood volume. Uncertainty is calculated using a Monte Carlo process.

The plant CDF uncertainty range is found to be 4.1E-06/RY - 2.3E-07/RY for the 95% to 5% interval. This uncertainty calculation is considered 95% contribute scenarios of CDF.

- 95th percentile 4.1E-06/RY

- Mean 1.3E-06/RY
- Median 8.1E-07/RY
- 5th percentile 2.3E-07/RY

The plant LRF uncertainty range is found to be 6.4E-07/RY - 5.2E-08/RY for the 95% to 5% interval. This uncertainty calculation is considered about 90% contribute scenarios of LRF.

- 95th percentile 6.4E-07/RY
- Mean 2.4E-07/RY
- Median 1.8E-07/RY
- 5th percentile 5.2E-08/RY

Based on these risk insights, safety-related equipment is separated as following, so that the risk due to internal flooding is significantly reduced.

- East side and west side of reactor building are physically separated by flood propagation preventive equipment and the connections are kept closed and locked.
- Areas between the reactor building and the turbine building are physically separated by flood prevention equipment.

19.1.6 Safety Insights from the PRA for Other Modes of Operation

A description of the LPSD state including the results of the analysis is provided in the following subsections.

19.1.6.1 Description of the Low-Power and Shutdown Operations PRA

LPSD operating states may involve one or more of the following three outage types.

- Type A: Shutdown for maintenance and restart without reducing RCS inventory and refueling. RCS is closed and coolant inventory in the pressurizer is retained. Although a single SG may be unavailable either for the forced outage or for the planned maintenance outage, the other SGs are available for heat removal.
- Type B: Shutdown for maintenance with below normal RCS inventory and restart without refueling. In contrast to type A, the RCS inventory is reduced and/or the RCS boundary is opened. During the period when the RCS is open, SGs are not used for heat removal. Alternate heat removal function would be provided and planned.

- Type C: Refueling shutdown, which includes both type A and B conditions. In contrast to type A and B, there may be times a large amount of additional water over the fuel during refueling, and the fuel may be unloaded from the RV to the SFP during the major maintenance activities. Reduced inventory condition states (mid-loop) may exist for periods before or after refueling.

- Low power: There may be periods when the plant operates at power levels below full power either due to failed or degraded equipment, equipment under repair, or other demands for lower than full power operation. These states may involve many configurations and are usually bounded by the full power case. They are not explicitly analyzed herein at this stage.

The outage types are clarified for modeling the complex configuration at LPSD and summarized as below.

Outage type	Plant shutdown	Early reduced inventory state	Refuel activity	Late reduced inventory state	Plant startup
A	×	N/A	N/A	N/A	×
B	×	×	N/A	N/A	×
C	×	×	×	×	×

The LPSD PRA has estimated that an outage type C "Refueling shutdown" is a representative outage type.

The LPSD operation modes are characterized in 13 plant operation states (POS). These POSs are identified considering plant configuration, potential of initiating events, and plant responses. The followings are identified POSs for LPSD PRA.

- POS 1: Low power operation

  POS 1 is a low power operation state. Normal plant shutdown is gradually decreasing a reactor power. The control mode of control rods is switched from automatic operation mode to manual operation mode. The turbine bypass control is also switched from T_{avg} control mode to steam pressure control mode, and the main feed water control is switched to the bypass control mode. When the turbine output decreases to 5% lower, the turbine is tripped and the control rods are inserted in the reactor fully. The end of POS 1 is defined as the time at which a control rod insertion into the core to shift to a hot standby state.

- POS 2: SG cooling without the RHR cooling

  POS 2 is a hot standby state transitioning to hot shutdown with core cooling by use of the SGs. Using the turbine bypass valves (and/or the main steam release valve), the RCS is cooled down and de-pressurized from hot standby to hot shutdown. If the RCS is below a pressure of 400psig and a temperature of 350ºF, The RHRS can be used as the RCS cooling system. Therefore, the end of POS 2 is defined as the time of RCS temperature reaching 350ºF.

- POS 3: RHR cooling (RCS is filled with coolant)

  POS 3 is a hot shutdown and a cold shutdown state with cooling provided by the RHRS. When the RCS is below a pressure of 400 psig and a temperature of 350ºF, the RHRS starts and cools the RCS. The end of POS 3 is defined as the timing of initiation of a draindown of the RCS because the change of RCS inventories level is the important factor for LPSD PRA.

- POS 4: RHR cooling (mid-loop operation)

  POS 4 is a mid-loop operation state with cooling by the RHRS before refueling. To perform the aeration of the RCS and the eddy current test on the SGs, the SG nozzle lids are installed and the upper lid on the RV is removed. The RCS water level is decreased to near the center of the reactor nozzle. Because the RCS inventory is decreasing, the possibility of the RHR pump failure due to the pump cavitations is considered. Also, the time required for loss of inventory and subsequent fuel damage is less than for other states in the event of loss of decay heat removal.

  POS 4 or a mid-loop operation is further divided according to the plant states. The subdivided POSs are shown in Table 19.1-76 and Figure 19.1-13 to Figure 19.1-15.

- POS 5: Refueling cavity is filled with water (refueling)

  POS 5 is period when the refueling cavity is filled with water. To offload fuel from the reactor, the refueling cavity is filled with water. If a loss of decay heat removal were to occur, there is considerable time before the reactor core is exposed due to the boil down of coolant. Therefore, the state in which the refueling cavity is filled with water is identified as one of the states of the plant. The end of POS 5 is defined as the time at which the reactor core is empty.

- POS 6: No fuel in the core

  POS 6 is the state at which there is no fuel in the reactor core. For refueling and examination of fuel, fuel is transported from the RV to the SFP during this POS. This state is excluded from the analysis because there is no fuel in the reactor. The end of POS 6 is defined as the time at which fuel is loading into the reactor core.

- POS 7: Refueling cavity is filled with water (refueling)

  POS 7 is the state at which the refueling cavity is filled with water. To load new fuel in the reactor, the refueling cavity is filled with water which defines this POS. If a loss of decay heat removal were to occur, there would be considerable time before the reactor core is exposed by the boiling of coolant. Therefore, the state in which the refueling cavity is filled with water is one of the states of the plant. The end of POS 7 is defined as the time at which the RCS is drained. The change of RCS inventory level is an important factor for LPSD PRA.

- POS 8: RHR cooling (mid-loop operation after refueling)

  POS 8 is a mid-loop state with cooling by the RHRS after refueling. In order to install the upper lid on the RV, and to remove the SG nozzle lids, the RCS water level is decreased to near the center of the reactor nozzle. Because the RCS inventory is decreased, there is a possibility of the RHR pump failure by cavitation and this is considered. Also the time to act to avoid reactor core damage in this state is less than in other states because the RCS inventory is decreased.

  POS 8 or a mid-loop operation is further divided according to a plant states. The subdivided POSs are shown in Table 19.1-77 and Figure 19.1-13 to Figure 19.1-15.

- POS 9: Cold shutdown with RHR cooling (RCS is filled with water)

  POS 9 is cold shutdown state with cooling by the RHRS. Before performing the leakage tests of the RCS, the RCS is filled with water.

- POS 10: RCS leakage test (RHRS isolated from RCS)

  POS 10 is the RCS leakage test state. Before the plant start-up, the leakage test of the RCS is performed. Since the RCS pressure becomes high during the RCS leakage test, the RHRS is isolated from the RCS. After the leakage test, the RCS is returned to use of RHR cooling. The end of POS 10 is defined at the time of the end of the RCS leakage test and initiation of cooling by the RHRS.

- POS 11: RHR cooling (RCS is filled with water, after leakage test.)

  POS 11 is a cold shutdown and a hot shutdown state with cooling by the RHRS. After returning to RHR cooling, the temperature and pressure are increased before start-up of the plant. The RHRS is operated under the condition that the RCS temperature is less than 350º F. The end of POS 11 is defined as the time at which the RCS temperature approaches 350°F and isolation the RHRS has occurred.

- POS 12: Hot standby condition after RHR isolation

  POS 12 is a hot standby state. When the RCS temperature approaches 350º F, the RHRS is isolated. The RCS temperature and pressure are raised to a hot standby state while using the release valves of the main steam system. The end of POS 12 is defined as the time at which the reactor enters a critical state (at power).

- POS 13: Low power operation

POS 13 is a low power operation. This is grouped as one of the plant states from hot shutdown to start-up. If a LOCA were to occur, the ECCS starts automatically and the integrity of fuels would be assured.

Several of these POSs were excluded from modeling based on the reasons given in Table 19.1-78. Table 19.1-79 provides the assumed duration of the various POSs. Table 19.1-80 is a planned maintenance schedule created supposing the actual outage.

POS8-1 is a bounding POS of LPSD PRA in terms of the RCS water level, the duration time of POS, and the diversity of a mitigation system. For example, the RCS water level is lower than the other POSs because POS 8-1 is a mid-loop operation state, the duration time of POS 8-1, 55.5 hours, is the longest of all the POSs, the decay heat removal from SGs are not available because the SGs are separated from the RCS by the SG nozzle lid, and furthermore, the gravitational injection is not available because the RCS is not under atmospheric pressure. For these reasons, CDF of POS 8-1 would be predicted to be greater than the other POSs.

During shutdown, control rods are inserted in the core, and decay heat is removed by heat removal systems or other backup system. The causes of fuel damage or release activities are loss of decay heat removable from RCS, loss of RCS inventory, loss of supporting systems such as electric power systems, and component cooling systems, reactivity insertion, and loss of SFP cooling. The likelihood of initiating events (IE) is dependent on plant configuration and the maintenance procedures. In order to select and grouping the IEs at LPSD, FMEA are performed.

IEs for the LPSD PRA are listed below.

- LOCA: all POSs
- Loss of RHR due to over-drain: POS 4-1 and 8-1 (During transition to the RCS full to mid-loop)
- Loss of RHR caused by failing to maintain water level: POS 4-2, 4-3, 8-2, and 8-3. (During mid-loop operation)
- Loss of RHR caused by other failures: all POSs
- Loss of CCW/ essential service water: all POSs
- Loss of offsite power : all POSs

Also there may be other two initiating events. One is the reactivity insertion and another is the loss of SFP cooling. Reactivity insertion event will progress phenomena very slowly by boron dilution and long grace periods so that this event has enough time to recovery. Loss of SFP cooling is also progress the phenomena and has sufficient time to recovery because of large coolant inventory in the pool. Furthermore, both events have not been risk significant in previous PRA studies. Therefore, both events are excluded as an initiating event for LPSD PRA.

Freeze plug may not use for US-APWR because the isolation valves are installed considering maintenance and CCWS has been separated individual trains. Therefore, the freeze plug failure is excluded from the potential initiator.

The methods for data analysis and common cause analysis are the same as for Level 1 internal events PRA at power. The details of data analysis and CCF analysis are given in Subsection 19.1.4.1.1.

Mitigating functions during LPSD can be categorized into two groups: decay heat removal function and RCS inventory make up function. Systems that provide these functions are listed below. It is postulated that if these systems fail following an initiating event, bulk boiling and core damage will occur.

- Decay heat removal functions
  - RHR system

    If RHR pumps are available, the RCS is cooled by the RHR system through RHR suction line.

  - SG and secondary side system

    When the RHRS cooling is unavailable, decay heat is removed from the RCS via the SGs.

- RCS inventory make-up Functions
  - CVCS

    If the RHRS and the SGs heat removal are unavailable, coolant to the RCS is injected by the CVCS in order to prevent bulk boiling and to maintain the RCS inventory.

  - High head injection system

    If the CVCS fails to operate, safety injection pumps are utilized to inject coolant to the RCS in order to maintain coolant inventory.

  - Gravitational injection system

    If the other mitigation functions fail, the gravitational injection line is opened manually and coolant drain into the RCS by gravity from the SFP which is located on a higher elevation than the RCS. This function is only available when the RCS pressure is at atmospheric pressure.

The following describes the event trees for the analyzed LPSD IEs.

Loss of coolant accident (LOCA)

During shutdown, the RCS is under low or atmospheric pressure. LOCA caused by pipe rupture are unlikely to occur. Only LOCA events that occur by operator error are considered in the PRA of LPSD - an event that would result from the inadvertent transfer of reactor coolant out of the RCS. In this evaluation, inadvertent transfer to the RWSP from the RHR is assumed. This diversion can happen if a motor-driven valve is opened. This event is defined as a loss of all RHR trains.

The frequency of LOCA is evaluated as follow:

- Frequency of plant shutdown is 1 shutdown / 2 years = 0.5 events per RY because a refueling shutdown is assumed to be scheduled every 2 years.
- The frequency is evaluated for human error. The assumed human errors are either an omission error or a commission error. The failure probability of an omission error, obtained using THERP methodology, is 1.9E-04. The failure probability of a commission error using THERP methodology is 1.3E-05.

Therefore, the frequency of a LOCA during POS 8-1 is:

[0.5 x (1.9E-04 + 1.3E-05)] = 1.0E-4/RY.

The event tree (ET) for the LOCA is shown in Figure 19.1-16. Each top event of this ET is described as follows:

- LOA: Isolation of CS/RHR hot leg suction valves

  Following a LOCA, isolation of CS/RHR pump hot leg suction by motor-operated valves is expected. Two normally closed motor-operated valves are aligned in series in each of four RHR train suction lines between the RCS and the CS/RHR pump. The failure of this event tree heading is a failure of isolation by manual operation at the MCR.

- MC: RCS makeup by charging pump

  This mitigation measure represents the RCS inventory makeup by using the charging pumps. Only a small amount of makeup is needed to raise the level enough to allow operation of the standby RHR pump. The borated water in the RWSAT is injected into the RCS by the charging pumps. It is assumed that loss of this function occurs through failure of the required manual operation.

- RH: Decay heat removed from the RCS by RHR on standby

  Following a loss of operating RHR, decay heat removal by standby RHR is possible. The failure of this event tree heading is a result of failure of the standby RHR to start or to run during its mission time.

- SG: Decay heat removed from the RCS via SGs

  If heat removal by RHR fails, decay heat would be removed using secondary system cooling via the SGs. It is assumed that loss of this function occurs when the EFWS fails to start manually or fails to run fro the allocated mission time, or the main steam relief valves fail to open manually. Meanwhile, this function is unavailable if there is a large breach in the RCS or if there is a cap set on the SG nozzle.

- CV: Injection by the CVCS

  If decay heat removal using the RHRS and the SGs fails, in order to avoid loss of coolant and prevent the boiling of coolant, the boric water in the RWSAT is injected into the RCS using the charging pumps. It is assumed that loss of this function occurs by failure to inject to the RCS using the make-up pumps, or failure to provide make-up to the RWSAT. Make-up to the RWSAT is required as the RWSAT does not have sufficient capacity for the injection over the required mission time. Make-up is achieved via the in-containment RWSP water being pumped by the refueling water recirculation pumps to the RWSAT.

- SI: High head Injection

  If injection using the CVCS fails, the borated water in the RWSP is injected into the RCS using the SI pumps to maintain the RCS inventory. It is assumed that loss of this function occurs if the SI pumps fail to start manually or fail to run for the mission time. The SI pumps have to be started manually because the safety injection signal is blocked during shutdown.

- GI: Gravitational injection

  Gravity injection from the SFP to the RCS is expected if the other mitigation systems fail. The RCS must be at atmospheric pressure. In order for gravity injection to be initiated, it is necessary to operate valves in the injection line and to supply RWSP water to SFP using the refueling water recirculation pumps.

Loss of RHR due to over-drain (OVDR)

This category is loss of RHR operation during mid-loop operation caused by loss of coolant inventory. Two sub-categories are considered. One is OVDR and another is failure to maintain water level (FLML).

The over-drain occurs if the operator fails to stop the drain down process while the RCS is being drained to mid-loop level. It occurs at the beginning of the mid-loop operation POS (POS 4-1 and POS 8-1). This event is defined as loss of all RHR trains.

For the US-APWR, low-pressure letdown line isolation valves are installed. One normally closed air-operated valve is installed in each of two low-pressure letdown lines that are connected to two of four RHR trains. During normal plant cooldown operation, these valves are opened to divert part of the normal RCS flow to the CVCS for purification and the RCS inventory control.

These valves are automatically closed and the CVCS is isolated from the RHRS by the RCS loop low-level signal to prevent loss of RCS inventory at mid-loop operation during plant shutdown.

The initiating frequency of loss of RHR due to OVDR is evaluated as follow:

- Frequency of plant shutdown is 1 shutdown / 2 years = 0.5 events per RY because a refueling shutdown is assumed to be scheduled every 2 years.
- The human error rate for OVDR is evaluated by THERP methodology. The failure probability is 4.2E-03.
- The automatic isolation failure of the low-pressure letdown line is estimated by fault tree (FT) analysis. Two failures are taken into consideration for automatic isolation failure. One is failure of the RCS loop low-level signal, and the other is failure of an air-operated valve to close. The failure probability obtained by quantifying this FT is 2.5E-03.

Therefore, the frequency of loss of RHR due to OVDR during POS 8-1 is:

[0.5 x 4.2E-03 × 2.5E-03] = 5.3E-06/RY.

The ET for the OVDR is shown in Figure 19.1-17. Each top event of this ET is described as follows:

- LOB: Isolation of letdown line

  Following an OVDR event, manual isolation of the letdown line by an air-operated valve is expected. The top event is failure of manual isolation.

The other top events are the same as described previously for the LOCA.

<u>Loss of RHR caused by failing to maintain water level (FLML)</u>

This sequence does not apply to POS 8-1.

<u>Loss of RHR caused by other failures (LORH)</u>

Failures of RHR such as RHR pump failure or premature closure of RHR isolation valves cause loss of decay heat removal function. This event is defined as loss of all RHR trains. The frequency is calculated by FT analysis.

The initiating frequency of loss of RHR caused by other failures is evaluated as follows:

- Frequency of plant shutdown is 1 shutdown / 2 years = 0.5 events per RY because a refueling shutdown is assumed to be scheduled every 24 months.
- Loss of RHR caused by other failures during POS 8-1 is evaluated in the RHR FT. The failure probability obtained from quantifying this fault tree is 1.2E-05.

Therefore, the frequency of loss of RHR caused by other failures during POS 8-1 is:

[0.5 x 1.2E-05] = 6.0E-06/RY.

The ET for the LORH is shown in Figure 19.1-18. The ET top events are the same as described previously for a LOCA.

Loss of CCW/Essential service water (LOCS)

Failure of CCW or essential service water would result in loss of decay heat removal function. Failure of the CCW or the essential service water of operating trains is assumed and the occurrence frequency is calculated by FT analysis. Loss of CCW/essential service water is evaluated as follow:

The initiating frequency of loss of CCW/essential service water is evaluated as follows:

- Frequency of plant shutdown is 1 shutdown / 2 years = 0.5 events per RY because a refueling shutdown is assumed to be scheduled every 2 years.
- Loss of CCW/essential service water during POS 8-1 is evaluated in the CCW/essential service water FT. The failure probability obtained from quantifying this FT is 5.2E-07.

Therefore, the frequency of loss of CCW/essential service water during POS 8-1 is:

[0.5 x 5.2E-07] = 2.6E-07/RY.

This ET for the LOCS is shown in Figure 19.1-19. The ET top events are described as follows:

- SC: Injection by CVCS using alternate component cooling water system

  Upon loss of CCW/essential service water, the CVCS is the only mitigating system except for gravitational injection. The FSS can be connected to the cooling water line for the charging pumps by remote operation from the MCR. Reactor core cooling is preserved by starting a charging pump which is cooled by the alternate component cooling water system.

The other top events are the same as described previously for a LOCA.

Loss of offsite power (LOOP)

This event is defined as the failure of RHR initiated by a LOOP during shutdown condition. The LOOP is initiated by the failure of the power grid or the failure of the station power supply equipment. Following the LOOP, gas turbines, or alternative ac power attempt to start up and supply ac power. If the gas turbines or alternative ac power fail to start or run for the required mission, decay heat removal is lost.

- The frequency of a LOOP is estimated as 4.0E-02/RY. This is the frequency of the LOOP per reactor year as described in Reference19.1-41. This approach is similar to the full power operation because the configuration of off site power in the shut down PRA is considered the same as for the full power operations PRA.

- Based on a POS 8-1 duration of 56 hours (Table 19.1-79), the probability of a LOOP during POS 8-1 is:

  4.0E-02 / 8760 × 56 = 2.5E-04

- The frequency of plant shutdown is 1 shutdown / 2 years = 0.5 events per RY because a refueling shutdown is assumed to be scheduled every 2 years.

Therefore, the frequency of a LOOP during POS 8-1 is:

2.5E-04 x 0.5 = 1.3E-04/RY

The ET for the LOOP is shown in Figure 19.1-20. The ET top events are described as follows:

- GT: Power supply by the gas turbine generators

  The automatic start up of the gas turbine generators is initiated with blackout sequence after the LOOP, and the gas-turbine generators supply electricity to components important for RHR operation.

- SP: Power supply by the gas turbines or alternative ac power

  If operation of the gas turbine generators fails, alternative power supply can supply the emergency power. The operation time of the alternative power supply is longer than 24 hours. If this function succeeds, it is assumed that sufficient time has elapsed for offsite power to be recovered.

- AC: Offsite power recovery

  The recovery of the LOOP within an allowable time is considered. The allowable time is assumed to be 1 hour. The probability that the LOOP duration exceeds 1 hour is taken as 0.53 from Reference 19.1-41.

- PR: CCW pumps / essential service water pumps restart

  Following blackout sequence, CCW pumps and essential service water pumps automatically start (or re-start) up after power supply to the safety bus is re-established. If this function fails, the mitigation systems to require CCWS are unavailable.

The other top events are the same as described previously for a LOCA or LOCS.

The process of FT analysis is same as for the Level 1 internal events PRA at power (see Subsection 19.1.4.1.1).

In general, the success criteria for the LPSD PRA are the same as for the Level 1 internal events PRA at power (see Subsection 19.1.4.1.1).

The assumptions of success criteria specific to the LPSD PRA are as follows:

- For manual operation, 1 hour is conservatively assumed to be the allowable time until the exposure of reactor core from previous PRA studies and experience which mid-loop operation.

- When the RCS is under atmospheric pressure, it is assumed that the gravitational injection from SFP is effective. The gravitational injection from SFP is established by opening the injection flow path from SFP to RCS cold legs, and the water supply path from the RWSP to SFP. The validity of this function is determined by engineering judgment based on the previous PRA studies.

- When the RCS is in mid-loop operation, it is assumed that the reflux cooling with the SGs is effective. The validity of this function is determined by engineering judgment based on previous PRA studies.

- The success criteria for the LPSD system are based on the success criteria of the Level 1 internal events PRA at power. The success criteria for the LPSD PRA are determined for each POS and each system. As an example, the success criteria for each system during POS 8-1 are given in Table 19.1-81.

The method for human error analysis is the same as for the Level 1 internal events PRA at power (see Subsection 19.1.4.1.1). Detailed analysis by THERP method was performed for human errors associated with a LOCA and a loss of RHR due to OVDR event.

The system fault trees are quantified and the results of the quantification are fault tree cutsets and system unavailability. The fault trees are quantified using the same methods that were followed in quantifying the Level 1 internal events PRA at power (see Subsection 19.1.4.1.1).

The LPSD PRA CDF is quantified using the initiating event frequencies, and systems and operator failure models. The core damage accident sequences defined in the event trees are quantified by using the FT linking method using Risk Spectrum® code to obtain the following results:

- Plant CDF for LPSD initiating events

- Frequency of each core damage accident sequence

- Dominant component level cutsets leading to core damage

The inputs to the core damage model include the following:

- Initiating event frequencies

- Event sequences (as shown on the event tree diagrams) for the initiating event categories
- Either a FT model for each event tree top event heading or an HEP
- US-APWR PRA master data base

The truncation frequency used to solve the LPSD PRA is 1.0E-15/RY.

For the LPSD Level 2 PRA, quantification of LRF is performed on the conservative assumption that LRF equals CDF because the containment may be open to the environment or mitigation systems may be out of service during shutdown states.

The key assumptions for LPSD are summarized below;

Key assumptions for IE of LPSD

a. Loss of the SFP cooling function and boric acid dilution events are excluded from initiating events of LPSD since these events are not risk significant.

b. During shutdown, a LOCA caused by pipe rupture is unlikely to occur because the reactor coolant system is at low or atmospheric pressure. Only LOCA events that occur by operator error are considered in LPSD PRA.

Key assumptions for system models of LPSD

a. In the case of loss of CCW/essential service water, operator will perform alternate charging pump cooling in order to maintain RCS injection by establishing the injection flow path from FSS tank to charging pump and from charging pump to the FSS tank, and starting the FSS pump.

b. In case a LOCA occurs in the RHR line, operator will perform the isolation of the RHR hot legs suction isolation valves.

c. In case the RCS water level decreases during mid-loop operation and the failure of automatic low-pressure letdown isolation valve occurs, operator will perform the manual isolation of low-pressure letdown line.

d. For manual operation, one hour is conservatively assumed to be the allowable time until the exposure of reactor core. This allowable time is determined from previous PRA studies and experience which mid-loop operation.

e. When the RCS is under atmospheric pressure, gravity injection from SFP is effective. Operator will perform the gravity injection by opening the injection flow path from SFP to RCS cold legs, and supplying water from RWSP to SFP. The validity of this function is determined from previous PRA studies.

f. When the RCS is mid-loop operation, it is assumed that the reflux cooling with the SGs is effective. The validity of this function is determined from the previous PRA studies.

g. The success criteria of LPSD system are determined based on the success criteria of the Level 1 internal events PRA at power. The success criteria of the LPSD PRA are determined for each POS and each system.

h. Various equipments will be possible temporary in the containment during LPSD operation for maintenance. However, there are few possibilities that these materials fall into the sump because the debris interceptor is installed on the sump of US-APWR. (see Chapter 6, Subsection 6.2.2) Therefore, potential plugging of the suction strainers due to debris is excluded from the PRA modeling.

19.1.6.2 Results from the Low-Power and Shutdown Operations PRA

Table 19.1-82 shows a summary of system unavailability of frontline systems. Table 19.1-83 shows a summary of system unavailability of support systems. LPSD initiating event frequencies are shown in Table 19.1-84.

Detailed accident sequence quantification was performed only for POS 8-1 and the results are shown in Table 19.1-85. The LPSD CDF for POS 8-1 is 4.8E-08/RY. The dominant accident sequences for POS 8-1 are given in Table 19.1-86. The top 50 component level failure combinations (cutsets) associated with these sequences is shown in Table 19.1-87.

The top six accident sequences contribute 92 percent toward the Level 1 LPSD CDF in POS 8-1. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 30 percent of the CDF
- LOOP initiating event, with success of the power supplying by the class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 17 percent of the CDF
- LOCS initiating event, with failure of injection to RCS using alternate component cooling, which contributes 17 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 12 percent of the CDF
- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 11 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 5 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA with success of isolation and failure of RCS makeup

  This is sequence #11 of the LOCA ET. In this sequence, a LOCA event occurs in POS 8-1. The isolation of the source of the LOCA is successful. Since the RCS makeup fails and the SG nozzle lids are closed in POS 8-1, the RHRS and the SGs as the mitigation system are unavailable. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, the gravitational injection is unavailable either. Consequently, failures of injection to the RCS by charging pump and SI pump lead to core damage. The major contributor to CDF is a combination of:

  - Operator fails to actuate CVCS (basic event ID: CHIOO02CV21)
  - Operator fails to actuate SI pump (basic event ID: HPIOO02S-DP2)

- LOOP with success of the power supplying by the class 1E gas turbine generators and failure of mitigation systems

  This is sequence #6 of the LOOP ET. This sequence is that the power supply by the class 1E gas turbine generators succeeds to start and run automatically following the initiating event. The decay heat removal by the SGs and the gravitational injection are unavailable for the same reason as sequence #11 of LOCA ET. Consequently, failures of decay heat removal by the RHRS and injection to the RCS by charging pump and SI pump lead to core damage in POS 8-1. The major contributor to CDF is a combination of:

  - Operator fails to actuate RHRS (Basic event ID: RSSOO02RHR2)
  - Operator fails to actuate SI pump (basic event ID: HPIOO02S-DP2)
  - Operator fails to actuate CVCS (basic event ID: CHIOO02CV212-DP3)

- LOCS initiating event, with failure of the alternate component cooling

  This is sequence #3 of the LOCS ET. This sequence has a loss of CCW/essential service water initiator. The mitigation systems such as RHRS, SG, CVCS, and High head injection that are supported by CCW/essential service water are unavailable for this initiating event. (the SG is required for HVAC that is supported by the essential service water) Moreover, the gravitational injection is unavailable for the same reason described above. Consequently, failure of injection by charging pump using the alternate component cooling water system leads to core damage. The major contributors to CDF due to loss of CCW/essential service water are:

  - Common cause failure of CCW/essential service water pumps (initiating event frequency contributors)
  - Common cause failure of CCW heat exchangers (initiating event frequency contributors)

- Operator fails to perform alternate component cooling actuation (basic event ID: ACWOO02SC)

- LOCA with success of isolation and RCS makeup

  This is sequence #6 of the LOCA ET. In this sequence, the LOCA event occurs in POS 8-1. The isolation of the source of the LOCA and the RCS makeup are successful. The decay heat removal by the SGs and the gravitational injection are unavailable for the same reason described above. Consequently, failure of the decay heat removal by the RHRS, and failures of injection to the RCS by charging pump and SI pump lead to core damage. The major contributor to CDF is a combination of:

  - Operator fails to actuate RHRS (Basic event ID: RSSOO02RHR2)
  - Operator fails to actuate SI pump (basic event ID: HPIOO02S-DP2)
  - Operator fails to actuate CVCS (basic event ID: CHIOO02CV2-DP3)

- LOOP with failure of the power supplying by all of ac power

  This is sequence #28 of the LOOP ET. This is station blackout sequence. class 1E gas turbine generators and alternative gas turbine generators fail following the Initiating event. The recovery of offsite power is not successful either. It is assumed that any mitigation systems which are supported by ac power are unavailable. The major contributor to core damage frequency is a combination of:

  - Common cause failure of class 1E gas turbine generators (basic event ID: EPSCF3DLLRDG-AL)
  - Operator fails to actuate spare gas turbine generator equipment (basic event ID: EPSOO02RDG)
  - Recovery of offsite power fails (Basic event ID: AC2-F)

- LOCA [loss-of-coolant accident] with failure of isolation and RCS makeup

  This is sequence #15 of the LOCA ET. This sequence is that isolation of source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SG and the RHRS are unavailable because coolant continues to out of flow the RCS. The gravitational injection cannot be used for the same reason described above. Consequently, failure of injection to the RCS by charging pump and SI pump leads to core damage in POS 8-1. The major contributor to CDF is a combination of:

  - Operator fails to isolate the source of LOCA (basic event ID: LOAOO02LC)
  - Operator fails to actuate SI pump (basic event ID: HPIOO02S-DP2)
  - Operator fails to actuate CVCS (basic event ID: CHIOO02CV212-DP3)

As described above, first, the detailed analysis of POS 8-1 was carried out. Since almost all of mitigation systems of LPSD need operator action, quantitative analysis results are greatly influenced by the dependability between tasks of human error. Table19.1-87 shows that the dominant cutsets of CDF are human error, especially dependence between tasks. This result indicated that the effect of human errors dependency between tasks is greater than contribute of hardware failure. Based on this insight, CDF of POSs other than POS 8-1 were evaluated conservatively using the values of the human errors in consideration of the dependability between tasks.

Although the plant states of other POSs differ from POS 8-1, the mitigation system of other POSs are equivalent to that of POS 8-1, or the decay heat removal via SGs or the gravitational injection can be additionally taken credit compared to POS 8-1. The conditional core damage probability of each sequence in other POSs decreases as a result of increase in mitigation systems and were represented by human error probability caused by dependency between tasks. For the frequency evaluation of initial events (IEs), such as loss of CCW, contribution of human error is relatively small, so the frequency of IEs were quantified by detailed analysis for each POSs. The CDF value of POSs other than POS 8-1 were evaluated by the three values shown below;

- The frequency of IEs evaluated for each POS
- conditional core damage probability of POS 8-1
- The reduction factor of conditional core damage probability of POS 8-1 based on number of effective mitigation systems and human error dependency

CDF for other POSs than POS 8-1 were evaluated using the following equation for each core damage sequences.

$$CDF_{POSX,\ SequenceY} = IE_{POSX} \times CCDP_{POS8\text{-}1,\ SequenceY} \times factor_{POSX,\ SequenceY}$$

$CDF_{POSX,\ SequenceY}$: CDF of the sequence Y in POS X

IE_{POSX} : IE frequency of POS X

$CCDP_{POS8\text{-}1,\ SequenceY}$: CCDP of the sequence Y in POS 8-1

$factor_{POSX,\ SequenceY}$: Reduction factor of the sequence Y in POS X

CDFs of other POSs are given in Table 19.1-85. The overall estimate of CDF for all LPSD POSs is 2.0E-07/RY.

LOCA initiating event is significant for all POSs during low power and shutdown. For all POSs, LOCA is conservatively assumed to occur by opening of a single valve. Its frequency is higher than other initiating events that are caused by mechanical failures, hence largely contributes to the CDF. The LOCA frequencies do not vary with duration of each POSs because it is determined by human error probability. Since other initiating event frequencies vary with duration of its POS, LOCA frequencies tend to become relatively higher than other initiating events in POSs with short duration.

Significant core damage sequences for each POSs other than POS 8-1 are shown below.

(POS 3)

The top three accident sequences contribute 94 percent of the Level 1 shutdown core damage frequency of POS 3. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 55 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 22 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 18 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

  Isolation of the source of LOCA is successful. Since the RCS makeup fails, the RHRS as the mitigation system is unavailable. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, the gravitational injection is also unavailable. Failure of heat removal by SGs and injection to the RCS by charging pumps and SI pumps occurs and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  Isolation of the source of LOCA and RCS makeup are successful. The gravitational injection is unavailable for the same reason described above. Failure of the decay heat removal by the RHRS and SGs, and failure of injection to the RCS by charging pumps and SI pumps occurs and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of the source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SGs and the RHRS are unavailable because coolant continues to flow out of the RCS. The gravitational injection is unavailable for the same reason described above. Failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

(POS 4-1)

The top six accident sequences contribute 95 percent of the Level 1 shutdown core damage frequency of POS 4-1. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 28 percent of the CDF

- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling, which contributes 22 percent of the CDF
- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 14 percent of the CDF
- LOOP initiating event, with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 11 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 11 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 9 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

  Isolation of the source of the LOCA is successful. RCS makeup fails, and the RHRS as the mitigation system is unavailable. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, the gravitational injection is unavailable either. Failure of heat removal by SGs and failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling

  This sequence is initiated by loss of CCW/essential service water. The mitigation systems such as RHRS, SG, CVCS, and high head injection that are supported by CCW/essential service water are unavailable under this initiating event. (The SGs require HVAC of EFW system that is supported by essential service water). Moreover, the gravitational injection is unavailable during this POS. Failure of RCS makeup by charging pumps using the alternate component cooling system occur and the reactor core is damaged.

- LOOP with failure of the power supplying by all of ac power

  This is station blackout sequence. class 1E gas turbine generators and alternative gas turbine generators fail following the initiating event. Offsite power does not recover and all mitigation systems supported by ac power are unavailable. Therefore, this sequence results in reactor core damage.

- LOOP with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems

  Power supply by class 1E gas turbine generators succeeds to start and run automatically following the LOOP initiating event. The gravitational injection is unavailable during this POS. Failure of decay heat removal by RHRS and SGs, and failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  Isolation of the source of LOCA and the RCS makeup are successful. The gravitational injection is unavailable during this POS. Failure of the decay heat removal by the RHRS and SGs, and failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SG and the RHRS are unavailable because coolant continues to flow out from the RCS. The gravitational injection is unavailable during this POS. Failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

(POS 4-2)

The top six accident sequences contribute 95 percent of the Level 1 shutdown core damage frequency of POS 4-2. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 50 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 20 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 8 percent of the CDF
- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 8 percent of the CDF
- LOOP initiating event, with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 6 percent of the CDF
- FLML initiating event, with success of the isolation and failure of the injection to the RCS by the SI pump, which contributes 3 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

  Isolation of the source of LOCA is successful. Since the RCS makeup fails, the RHRS as the mitigation system is unavailable. Since POS 4-2 is the mid-loop operation and the SG manhole lid is open, the heat removal by SGs is unavailable either. Failure of injection to the RCS by charging pumps, SI pumps and the gravitational injection occur and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  Isolation of the source of LOCA and the RCS makeup are successful. The heat removal by SGs is unavailable for the same reason described above. Failure of the decay heat removal by the RHRS, and failure of injection to the RCS by charging pumps, SI pumps and gravitational injection occur and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of the source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SG and the RHRS are unavailable because coolant continues to flow out from the RCS. Failure of injection to the RCS by charging pumps, SI pumps and gravitational injection occur and the reactor core is damaged.

- LOOP with failure of the power supplying by all of ac power

  This is station blackout sequence. class 1E gas turbine generators and alternative gas turbine generators fail following the initiating event. Offsite power does not recover. Since mitigation systems supported by ac power are unavailable, this sequence results in reactor core damage.

- LOOP with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems

  Power supply by class 1E gas turbine generators succeed following the initiating event. The heat removal by SGs is unavailable for the same reason described above. Failure of decay heat removal by RHRS, and failure of injection to the RCS by charging pumps, SI pumps and the gravitational injection occur and the reactor core is damaged.

- FLML initiating event, with success of the isolation and failure of the injection to the RCS by the SI pump

  Isolation of the source of the FLML is successful. Since this initiating event is assumed to be caused by failure of the CVCS, the RCS makeup and the injection to the RCS by charging pump which use the CVCS system is unavailable during this event. The heat removal by SGs is unavailable for the same reason described above. Failure of injection to the RCS by the SI pumps and gravitational injection occur and the reactor core is damaged.

(POS4-3)

The top five accident sequences contribute 95 percent of the Level 1 shutdown core damage frequency of POS 4-3. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 47 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 19 percent of the CDF
- FLML initiating event, with success of the isolation and failure of the injection to the RCS by the SI pump, which contributes 16 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 8 percent of the CDF
- LOOP initiating event, with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 3 percent of the CDF
- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling, which contributes 3 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

  Isolation of the source of LOCA is successful. Since the RCS makeup fails and the SGs nozzle lids are closed in POS 4-3, the RHRS and the SGs as the mitigation system are unavailable. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, the gravitational injection is unavailable either. Failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  Isolation of the source of LOCA and the RCS makeup are successful. The heat removal by SGs and the gravitational injection are unavailable for the same reason described above. Failure of the decay heat removal by the RHRS, and failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- FLML initiating event, with success of the isolation and failure of the injection to the RCS by the SI pump

  Isolation of the source of FLML is successful. Since this initiating event is assumed to be caused by failure of the CVCS, the RCS makeup and the injection to the RCS by charging pump which use the CVCS system are unavailable during this event. The heat removal by SGs and the gravitational injection are unavailable for the same reason described above. Failure of the injection to the RCS by the SI pumps occur and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the RHRS is unavailable because coolant continues to flow out of the RCS. The heat removal by SGs and the gravitational injection are unavailable for the same reason described above. Failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOOP with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems

  Power supply by class 1E gas turbine generators succeeds following the initiating event. Heat removal by SGs and the gravitational injection are unavailable for the same reason described above. Failures of decay heat removal by RHRS, and injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling

  This sequence is initiated by CCW/essential service water. The mitigation systems such as RHRS, SG, CVCS, and high head injection that are supported by CCW/essential service water are unavailable for this initiating event. Moreover, the gravitational injection is unavailable for the same reason described above. Failure of injection by charging pump using the alternate component cooling system occur and the reactor core is damaged.

(POS 8-2)

The top five accident sequences contribute 96 percent of the Level 1 shutdown core damage frequency of POS 8-2. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 52 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 21 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 8 percent of the CDF
- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 8 percent of the CDF
- LOOP initiating event, with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 7 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

  Isolation of the source of the LOCA is successful. Since the RCS makeup fails, the RHRS as the mitigation system is unavailable. Since POS 8-2 is the mid-loop operation and the SG manhole lid is open, the heat removal by SGs is unavailable either. Failure of the injection to the RCS by charging pumps, SI pumps and the gravitational injection occur and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  Isolation of the source of the LOCA and the RCS makeup are successful. Heat removal by SGs is unavailable for the same reason described above. Failure of the decay heat removal by the RHRS, and failure of injection to the RCS by charging pumps, SI pumps and gravitational injection occur and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SG and the RHRS are unavailable because coolant continues to flow out from the RCS. Failure of injection to the RCS by charging pumps, SI pumps and gravitational injection occur and the reactor core is damaged.

- LOOP with failure of the power supplying by all of ac power

  This is station blackout sequence. class 1E gas turbine generators and alternative gas turbine generators fail following the initiating event. The offsite power does not recover. All mitigation systems supported by ac power are unavailable. Therefore, this sequence results in reactor core damage.

- LOOP with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems

  Power supply by class 1E gas turbine generators succeeds following the initiating event. The heat removal by SGs is unavailable for the same reason described above. Failures of decay heat removal by RHRS, and failure of injection to the RCS by charging pumps, SI pumps and the gravitational injection occur and the reactor core is damaged.

(POS 8-3)

The top six accident sequences contribute 95 percent of the Level 1 shutdown core damage frequency of POS 8-3. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 47 percent of the CDF

- LOCA initiating event, with success of isolation and RCS makeup, which contributes 19 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 15 percent of the CDF
- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 7 percent of the CDF
- LOOP initiating event, with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 5 percent of the CDF
- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling, which contributes 4 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

  Isolation of the source of the LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system is unavailable. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, the gravitational injection is unavailable either. Failure of heat removal by SGs and failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  Isolation of the source of the LOCA and RCS makeup are successful. The gravitational injection is unavailable for the same reason described above. Failure of the decay heat removal by the RHRS and SGs, and failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SG and the RHRS are unavailable because coolant continues to flow out of from the RCS. The gravitational injection is unavailable for the same reason described above. Failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOOP with failure of the power supplying by all of ac power

  This is station blackout sequence. class 1E gas turbine generators and alternative gas turbine generators fail following the Initiating event. Offsite power is does not recover. All mitigation systems which supported by ac power are unavailable. Therefore, this sequence results in reactor core damage.

- LOOP with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems

  Power supply by class 1E gas turbine generators succeeds following the initiating event. The gravitational injection is unavailable for the same reason described above. Failures of decay heat removal by RHRS and SGs, and injection to the RCS by charging pump and SI pump occur and the reactor core is damaged.

- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling

  This sequence is initiated by loss of CCW/essential service water. The mitigation systems such as RHRS, SG, CVCS, and high head injection that are supported by CCW/essential service water are unavailable for this initiating event. Moreover, the gravitational injection is unavailable for the same reason described above. Failure of injection by charging pump using the alternate component cooling system occur and the reactor core is damaged.

(POS 9)

The top five accident sequences contribute 95 percent of the Level 1 shutdown core damage frequency of POS 9. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 48 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 20 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 16 percent of the CDF
- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 6 percent of the CDF
- LOOP initiating event, with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 5 percent of the CDF
- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling, which contributes 4 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

Isolation of the source of the LOCA is successful. RCS makeup fails, and the RHRS as the mitigation system is unavailable. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, the gravitational injection is unavailable either. Failures of heat removal by SGs and the injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  Isolation of the source of the LOCA and the RCS makeup are successful. The gravitational injection is unavailable for the same reason described above. Failure of decay heat removal by the RHRS and SGs, and failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SG and the RHRS are unavailable because coolant continues to flow out from the RCS. The gravitational injection is unavailable for the same reason described above. Failure of injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

- LOOP with failure of the power supplying by all of ac power

  This is station blackout sequence. class 1E gas turbine generators and alternative gas turbine generators fail following the Initiating event. Offsite power does not recover. All mitigation systems which are supported by ac power are unavailable. Therefore, this sequence results in reactor core damage.

- LOOP with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems

  Power supply by class 1E gas turbine generators succeeds following the initiating event. The gravitational injection is unavailable for the same reason described above. Failures of decay heat removal by RHRS and SGs, and injection to the RCS by charging pumps and SI pumps occur and the reactor core is damaged.

(POS 11)

The top six accident sequences contribute 97 percent of the Level 1 shutdown core damage frequency of POS 11. These dominant sequences are as follows:

- LOCA initiating event, with success of isolation and failure of RCS make-up, which contributes 27 percent of the CDF
- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling, which contributes 23 percent of the CDF

- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 15 percent of the CDF
- LOOP initiating event, with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems such as RHRS, which contributes 12 percent of the CDF
- LOCA initiating event, with success of isolation and RCS makeup, which contributes 11 percent of the CDF
- LOCA initiating event, with failure of isolation, which contributes 9 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of isolation and failure of RCS make-up

  Isolation of the source of the LOCA is successful. The RCS makeup fails, and the RHRS as the mitigation system is unavailable. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, the gravitational injection is unavailable either. Failures of heat removal by SGs and the injection to the RCS by charging pump and SI pump occur and the reactor core is damaged.

- LOCS initiating event, with failure of the injection to the RCS using alternate component cooling

  This sequence is initiated by loss of CCW/essential service water. Mitigation systems such as RHRS, SG, CVCS, and high head injection that are supported by CCW/essential service water are unavailable for this initiating event. Moreover, the gravitational injection is unavailable for the same reason described above. Failure of injection by charging pump using the alternate component cooling system occur and the reactor core is damaged.

- LOOP with failure of the power supplying by all of ac power

  This is station blackout sequence. class 1E gas turbine generators and alternative gas turbine generators fail following the Initiating event. Offsite power does not recover. All mitigation systems supported by ac power are unavailable. Therefore, this sequence results in reactor core damage.

- LOOP with success of the power supplying by class 1E gas turbine generators and failure of mitigation systems

  Power supply by class 1E gas turbine generators succeeds following the initiating event. Gravitational injection is unavailable for the same reason described above. Failures of decay heat removal by RHRS and SGs, and injection to the RCS by charging pump and SI pump occur and the reactor core is damaged.

- LOCA with success of isolation and RCS makeup

  The isolation of the source of the LOCA and the RCS makeup are successful. The gravitational injection is unavailable for the same reason described above. Failure of the decay heat removal by the RHRS and SGs, and failures of injection to the RCS by charging pump and SI pump occur and the reactor core is damaged.

- LOCA with failure of isolation

  Isolation of source of LOCA fails following a LOCA initiated by inadvertent opening of motor-driven valve. If the isolation fails after the LOCA occurs, decay heat removal by the SG and the RHRS are unavailable because coolant continues to flow out from the RCS. The gravitational injection is unavailable for the same reason described above. Failure of injection to the RCS by charging pump and SI pump occur and the reactor core is damaged.

Sensitivity studies have been performed to find additional insights for LPSD PRA results. The following are presented as sensitivity analysis:

- Case 01: Sensitivity to gas turbine generator failure rate

  This sensitivity study evaluates the impact of failure rate of the gas turbine generator on the CDF. For the base case study, the failure rate of the gas turbine generator is set to the failure rate of diesel generators described in NUREG/CR-6928 (Reference 19.1-16). In this sensitivity study, that failure rate is set to data of gas turbine generator described in NUREG/CR-6928.

  The sensitivity case produces a CDF of 2.2E-07/RY, which is an increase of 10 percent in the base case CDF of 2.0E-07/RY. Although a failure rate of gas turbine generator is ten times as high as one of diesel generator, it is indicated that the impact of failure rate of the gas turbine generator is small during plant shutdown conditions.

- Case 02: Sensitivity to the frequency of LOOP

  For this sensitivity case, in order to confirm how the CDF of LOOP is sensitive to total CDF, the frequency of the LOOP is set to be three times higher than the base case.

  The sensitivity case produces a CDF of 2.8E-07/RY, which is an increase of 40 percent in the base case CDF. For this reason, it is indicated that the LOOP in LPSD PRA has a small impact on total CDF.

- Case 03: Sensitivity to the planned maintenance during the LPSD

  In the base case, some components or systems are unavailable due to the planned maintenance during the LPSD. The assumption of their planned maintenance used in the base case is documented in Table 19.1-80.

This sensitivity study evaluates the impact not allowing the planned maintenance during the LPSD. In this sensitivity, unavailability due to the planned maintenance is not modeled for any component and system in the event trees. The schedule not allowing the planned maintenance for this sensitivity study is described in Table19.1-88. This sensitivity is designed to assess the impact on the base case CDF, if some components and systems are not unavailable due to the planned maintenance.

This sensitivity produces a CDF of 1.8E-07/RY, which is a decrease of 10 percent in the base case CDF. This result indicates that the assumption of the planned maintenance is not risk-important.

- Case 04: Sensitivity to human error probabilities set to 0.0

  This sensitivity study evaluates the impact of having perfect operators (i.e., setting all human error probabilities to 0.0 in the baseline shutdown core damage quantification).

  This sensitivity produces a CDF of 1.1E-08/RY, which is approximately one divided by twenty of the base CDF. This indicates that the operator actions are risk important at the level of plant risk obtained from the base case study.

- Case 05: Sensitivity to dependency of human error to CD(complete dependency)

  This sensitivity study evaluates the impact of setting dependency level of human error to CD. That is, the sensitivity case most conservatively assumes that operator actions have a complete dependency on a previously failed action.

  This sensitivity produces a CDF of 1.3E-05/RY, which is approximately 65 times of the base CDF. This indicates that assumption of dependency of human error provide significant impact to result of PRA during shutdown, and the operators play a significant role in maintaining a very low CDF during shutdown conditions.

- Case 06: Sensitivity to dependency of human error to ZD (zero dependency)

  This sensitivity study evaluates the impact of setting dependency level of human error to ZD. That is, the sensitivity case most non-conservatively assumes that operator actions are independent absolutely between prior mitigation system and post mitigation system.

  This sensitivity produces a CDF of 5.4E-08/RY, which is approximately one divided by four of the base CDF. This indicates that assumption on dependency of human error provide meaningful sensitivity to result of PRA during shutdown.

Importance assessment has been performed only in POS 8-1 because detailed analysis of CDF was limited to POS 8-1 for the LPSD PRA. These analyses have been performed to determine the following:

- Basic event importance
- Common cause failure importance
- Human error importance
- Component importance

Basic event importance

In this subsection, importance of basic event except initiating events is documented.

The results of basic event importance are organized by the FV importance and the RAW. The FV importance that value is greater than 0.5% is shown in Table19.1-89 and the RAW that value is greater than 2 is shown in Table19.1-90.

The top five most significant basic events, based on the FV importance, are as follows:

HPIOO02S-DP2 (Operator fails to start standby SI pump under the condition of failing their previous task (HE)) – This basic event applies to conditions where loss of decay heat removal from RHRS and via the SGs has occurred. If the operator fails to start standby SI pump, the high head injection function is lost. The CDF of POS 8-1 is decreased by a factor of 63% if the probability of this failure is set to 0.0.

CHIOO02CV21 (Operator fails to start standby charging pump (HE)) – This basic event applies to conditions where the loss of RCS inventory due to LOCA or over-drain, and the loss of decay heat removal functions from RHRS, SGs and SI pumps have occurred. If the operator fails to start standby charging pump, the RCS injection function by charging pump is lost. The CDF of POS 8-1 is decreased by a factor of 31% if the probability of this failure is set to 0.0.

RSSOO02RHR2 (Operator fails to start standby RHR pump(HE)) – This basic event applies to condition where the initiating event has occurred. If the operator fails to start standby RHR pump, the decay heat removal function from RHRS is lost. The CDF of POS 8-1 is decreased by a factor of 28% if the probability of this failure is set to 0.0.

CHIOO02CV212-DP3 (Operator fails to establish charging injection (start standby charging pump and connect the RWSAT makeup line) under the condition of failing their previous two tasks (HE)) – This basic event applies to condition where the loss of decay heat removal functions from RHRS, SGs and SI pumps have occurred. If the operator fails to establish charging injection, the decay heat removal function by charging pump is lost. The CDF of POS 8-1 is decreased by a factor of 20% if the probability of this failure is set to 0.0.

ACWOO02SC (Operator fails to establish the alternate component cooling water using the FSS (HE)) – This basic event applies to condition where the loss of CCW/essential service water has occurred. If the operator fails to establish the alternate component cooling water using the FSS, the decay heat removal functions supported by CCW is lost. The CDF of POS 8-1 is decreased by a factor of 18% if the probability of this failure is set to 0.0.

The top five most significant basic events, based on the RAW, are as follows:

SWSCF3PMYRSWPABC-ALL (CCF of essential service water pumps A, B and C to run) – The CDF of POS 8-1 would increase approximately 5.0E+03 times if the probability of this failure were set to 1.0. If this failure occurs, all effective trains of essential service water will be lost, and since the CCW train D is unavailable due to the planned maintenance, this basic event leads to the total loss of component cooling water.

CWSCF3PCYRCWPABC-ALL (CCF of CCW pump A, B and C to run) – The CDF of POS 8-1 would increase approximately 5.0E+03 times if the probability of this failure were set to 1.0. If this failure occurs, since the CCW train D is unavailable due to the planned maintenance, all trains of CCW will be lost.

CWSCF3RHPRHXABC1-ALL (CCF of CCW heat exchanger A, B and C plug) – The CDF of POS 8-1 would increase approximately 5.0E+03 times if the probability of this failure were set to 1.0. If this failure occurs, since the CCW train D is unavailable due to the planned maintenance, all trains of CCW will be lost.

EPSBTSWCCF (CCF of emergency electric power supply software) – The CDF of POS 8-1 would increase approximately 1.5E+03 times if the probability of this failure were set to 1.0. If this failure occurs after LOOP, all train of blackout signal will be lost.

EPSCF4CBTD6H-ALL (CCF of all 6.9KV incoming circuit breaker to open) – The CDF of POS 8-1 would increase approximately 1.4E+03 times if the probability of this failure set to 1.0. If this failure occurs after LOOP, safety buses cannot be supplied power since they are not isolated from the faulted offsite power. Accordingly, loss of total ac power will occur.

<u>Common-cause importance</u>

It is useful to separate above basic event importance into several groups of basic events (i.e., hardware events and human error), in order to review the most important within each group.

In this subsection, importance of common cause basic events is documented.

The top 10 FV importance of CCF basic events is shown in Table19.1-91 and the top 10 RAW is shown in Table19.1-92.

The most significant CCF basic event based on FV importance is CCF of all emergency power generators. The second most significant CCF basic event is CCF of all 6.9kV incoming circuit breakers.

The top six most significant CCF basic events based on the RAW are the same as the basic events ranked in top ten most significant basic events based on RAW.

Human error importance

In this subsection, “operator actions” basic event are documented.

The top 10 FV importance of human error basic events is shown in Table 19.1-93 and the top 10 RAW is shown in Table 19.1-94.

The most significant human error basic event based on FV importance is **HPIOO02S-DP2 (Operator fails to start standby SI pump under the condition of failing their previous task (HE))**, with a FV importance of 6.3E-01.

Ten human error basic events have a RAW larger than 2.0E+00. The most significant human error basic event based on RAW is **CHIOO02CV21 (Operator fails to start standby charging pump (HE))**, with a RAW of 1.2E+02. The CDF of POS 8-1 would increase approximately 120 times, if the probability of this failure were set to 1.0.

Component importance

In this subsection, component (single failure of hardware) importance is documented.

The top 10 FV importance of component basic events is shown in Table 19.1-95 and the top 10 RAW is shown in Table 19.1-96.

No single failure basic events have a FV importance greater than 1.0E-02. The most significant single failure basic event based on FV importance is EPSDLLRDGA-CG3, which represents the failure of emergency power generator to run, with a FV importance of 7.8E-03.

There are more than 40 basic events that have a RAW which value is 1.2E+02. The most significant single failure of basic event is large external leak of various components and piping. The CDF of POS 8-1 would increase approximately 1.2E+02 times if the probability of this failure were set to 1.0.

The important SSCs and operator actions of other POS are qualitatively extracted based on the mitigation system which is available for each POS. For example, the decay heat removal by RHR operation is available not only in POS 8-1 evaluated quantitatively but also in other POS. Since the result that this operator action is important in POS 8-1 is obtained, it is assumed to be important in other POS similarly. Moreover, main active components which are installed in available mitigation system for each POS are assumed to be important SSCs. Passive components are excluded from important SSCs because generally the failure rate of passive mode is lower than active mode. The important operator action of POS 8-1 and other POSs are shown in Table19.1-97 to Table19.1-105. And the important SSCs of POS 8-1 and other POSs are shown in Table19.1-106 to Table19.1-114.

The uncertainty of the CDF for POS 8-1 has been calculated and is summarized in Figure 19.1-21. The mean value, median, 5th percentile and 95th percentile of the distribution are calculated. The EF was estimated by the square root of the ratio of the 95th percentile to the 5th percentile.

The uncertainty range for the POS 8-1 CDF is found to be 5.8E-09/RY - 1.6E-07/RY for the 5% to 95% interval. This indicates that there is 95% confidence that the POS 8-1 CDF is no greater than 1.6E-07/RY. The EF for the POS 8-1 CDF is 5.2. The point estimate CDF for POS 8-1 is 4.8E-08/RY.

In the LPSD Level 2 PRA, the release probability under the condition that core damage occurs is assumed to be 1.0. Therefore, the LRF, which equals the CDF, is 2.0E-07/RY. The most significant containment release sequence is included in POS 8-1 and the most significant initiating event resulting in subsequent containment release is loss of CCW/essential service water.

19.1.6.3 Other Risk of the Low-Power and Shutdown Operations PRA

Risk of other external events at LPSD has been discussed under several conservative assumptions.

19.1.6.3.1 Seismic at LPSD

For seismic, SSCs for LPSD has been involved in Subsection “19.1.5.1 Seismic Risk Evaluation” and confirmed that the HCLPFs are greater than or equal to RLE.

19.1.6.3.2 Internal Fire at LPSD

The scope of the internal fire PRA for LPSD at design certification phase focused on mid-loop operations since during these states the plant would be most vulnerable fire such as maintenance-induced fire. POS 8-1(mid-loop operation) is risk significant for the internal event LPSD PRA. For internal fires, risk significant POS 8-1 of LPSD has been estimated using the same methodology at power though the transient fire due to welding and cutting works and access for maintenance works have been specially reflected. The primary focus of the fire scenario development is the potential of fire damage to Yard transformers, RHRS, CVCS and its support system. Possible initiating events by internal fire at LPSD are as follows:

- LOCA
- OVDR (Loss of RHR due to over drain)
- LOOP (Loss of offsite power)

Standby states of mitigation systems for those initiators are shown in Table19.1-80. The states of out of services of POS 8-1 are similar to other POSs so that there are not more severe other POSs than POS 8-1 related to conditions of available mitigation systems. Therefore POS 8-1 is selected for internal fire at LPSD PRA.

LOCA and LOOP initiating events are potentially significant for all POSs. On the other hand, OVDR and FLWL are initiating events only considered in POSs representing mid-loop operation. Accordingly, LOCA and LOOP are significant in POSs where the RCS is full, while for POS of mid-loop operation, OVDR and/or FLWL are significant event other than LOCA and LOOP. In internal fire PRA for at-power operation, fire in the compartments (e.g. switchyard) that cause LOOP are significant fire scenarios. Similar events are considerably significant during low power and shutdown (Internal events).

Fire risk at LPSD has been evaluated following conservative assumptions.

- Assumed most risk dominant POS; POS 8-1 (mid-loop operation, 55.5 hours).
- In low power and shutdown period, fire door provided to the opening between the fire origin compartment and the adjacent fire compartment in which some maintenance works are held are assumed to be left open.
- The impacts to LPSD mitigation systems are assumed the worst scenario.

The results of CDF of POS 8-1 are 1.9E-8/RY. Risk by internal fire at shutdown has been very small in spite of conservative assumptions.

19.1.6.3.3 Internal Flood at LPSD

The scope of the internal flood PRA for LPSD at design certification phase focused on mid-loop operations since during these states the plant would be most vulnerable to flooding such as maintenance-induced flooding. POS 8-1(mid-loop operation) is risk significant for the internal event LPSD PRA. The primary focus of the flood scenario development is the potential of flood damage to the RHR system and its support systems. Possible initiating events by internal flood at LPSD are as follows.

- LOCA (Flood at CVCS letdown line)
- Loss of RHR (Flood at CSS/RHRS line)
- Loss of CCWS/ESWS (Flood at CCWS/ESWS line)

Standby states of mitigation systems for those initiators are shown in Table19.1-80. The states of out of services of POS 8-1 are similar to other POSs so that there are not more severe other POSs than POS 8-1 related to conditions of available mitigation systems. Therefore POS 8-1 is selected for internal flood at LPSD PRA.

Loss of CCW/ESW initiating event is significant for all POSs during low power and shutdown. As can be seen by at-power operation internal flooding PRA, the probability of consequential loss of CCW/ESW event caused by flooding is much higher than loss of other functions. In POSs where redundancy of CCW/ESW is degraded, the conditional core damage probability will increase. These features are common to all POSs and accordingly, loss of CCW/ESW is considered to be a significant initiating event.

The qualitative and quantitative steps of internal flood PRA as described in subsection 19.1.5.3 is also applied to the low power and shutdown modes.

The frequencies of internal flooding at power are also applied to the frequencies at LPSD. This assumption may be more conservative because the pressure conditions of LPSD operation are low and it may be expected that the possibility of rupture of pipe will be less.

During shutdown operations, temporary piping pressure boundaries and operator errors during maintenance may be possible initiators of internal flooding. However, the internal flood by the effect of those temporary isolation valves, such as freeze seals, are not considered from the potential initiators because the isolation valves are installed considering maintenance and CCWS has been separated individual trains.

Also flood risk at LPSD has been evaluated following conservative assumptions.

- Assumed most risk dominant POS: POS 8-1 (mid-loop operation, 55.5 hours).
- Initiating event frequencies for LPSD flood initiating events are assumed as the total flood frequencies of each flood mode (spray, flood, and major flood) at power.
- The impacts to LPSD mitigation systems are estimated assuming the worst scenario (boundary conditions of event trees).
- The flood barriers that separated the reactor building between the east side and the west are effective.
- Assumed available safety injection pumps are A and C pumps and outage safety injection pumps are B and D from the insights of flooding risk.

The CDF of the flooding risk at POS 8-1 of LPSD was 1.8E-08/RY. Important SSCs for internal flood at LPSD are RHR, CCWS and supporting power supply systems. Risk from internal flood at LPSD will be very small though it has been estimated using conservative assumptions.

19.1.7 PRA-Related Input to Other Programs and Processes

The following subsections describe PRA-related input to various programs and processes.

19.1.7.1 PRA Input to Design Programs and Processes

The US-APWR PRA is an integral part of the design process and has been used to optimize the plant design with respect to safety. The PRA models and results have influenced the selection of design alternatives such as four train core cooling systems, an in-containment RWSP, full digital I&C systems, etc.

The US-APWR is expected to perform better than current operating plants in the area of severe accident safety performance since prevention and mitigation of severe accidents, as shown in Table19.1-1, have been addressed during the design stage, taking advantage of PRA results and severe accident analysis. The PRA results indicate that the US-APWR design results in a low level of risk and meets the CDF, LRF, and containment performance goals for new generation PWRs. Key assumptions are summarized in Table19.1-115.

19.1.7.2 PRA Input to the Maintenance Rule Implementation

PRA input is provided as required to develop the Maintenance Rule, discussed in Chapter 17 Section 17.6.

19.1.7.3 PRA Input to the Reactor Oversight Process

Ultimately, the PRA models and results will be utilized to support elements of the reactor oversight process including the mitigating systems performance index and the significance determination process. PRA input is provided as required to evaluate the mitigating systems performance indicators as part of the reactor oversight process.

19.1.7.4 PRA Input to the Reliability Assurance Program

Risk significant SSCs are identified for the RAP (Chapter 17, Section 17.4). Key risk significant SSCs are organized by a FV importance greater than 0.005 and RAW greater than 2 in accordance with Reference 19.1-42. These thresholds are consistent with Reference 19.1-43. In addition, risk significant information based on LPSD PRA and external PRA, SSCs related Initiating events, and key assumptions are identified. PRA input is provided as required to develop the RAP, discussed in Chapter 17 Section 17.4.

19.1.7.5 PRA Input to the Regulatory Treatment of Non-Safety-Related Systems Program

PRA information for the RAP includes non-safety risk significant SSCs.

19.1.7.6 PRA Input to the Technical Specification

At the design stage, PRA results have been used as input in the development of the technical specifications (Chapter 16). PRA insights are utilized to develop risk-managed technical specifications (RMTS) and surveillance frequency control program (SFCP).

At operation stage, PRA is used to implement RMTS and SFCP. The RMTS relies on configuration risk management program (CRMP) which is described in 5.5.18 of the technical specification described in chapter 16. The requirement of RMTS is described in NEI 06-09. Section 2 of the NEI 06-09 guideline describes the requirements for the program including adequacy of the PRA. Concerning the SFPC, NEI 04-10 (Reference 19.1-44) provides the guidance to establish licensee control of surveillance test frequencies for the majority of Technical Specifications surveillances. Section 4 of the NEI 04-10 describes the detailed SFCP process including adequacy of the PRA.

In the RMTS, the PRA will be used to calculate risk management action time (RMAT) and risk-informed completion time (RICT). The calculations are performed in accordance with the NEI guideline including, but not limited to following rules:

- RMAT and RICT risk levels are referenced to CDF and LERF associated with the plant “zero maintenance” configuration,
- Compensatory risk management actions may only be credited in the calculations to the extent they are modeled in the PRA and are proceduralized,
- The probability of repair of inoperable SSCs within the scope of the CRMP cannot be credited in the RMAT and RICT program,
- The impact of fire risks shall be included in RMAT and RICT calculations.

In the SFCP, the PRA will be used to determine the risk impact of the surveillance test frequencies.

PRA for the design phase satisfies the requirements specified in the NEI 06-09 and 04-10 that are associated with PRA technical adequacy, such as scope of PRA, level of detail to provide plant configuration specific impacts and operating modes. However, technical elements that require site specific information are not implemented in the design phase PRA.

The COL applicant is responsible for preparation of a PRA model to meet the technical adequacy requirement of NEI 06-09 and 04-10.

19.1.8 Conclusions and Findings

The US-APWR PRA, as demonstrated through the preceding subsections, has been used to achieve the following:

- To identify and address potential design and operational vulnerabilities (i.e., failures or combinations of failures that are significant risk contributors that could drive the risk to unacceptable levels with respect to NRC goals: Subsection 19.1.4, 19.1.5, 19.1.6
- To reduce or eliminate known weaknesses of existing operating plants that are applicable to the new design, by introducing appropriate features and requirements: Subsection 19.1.3
- To select among alternative features, operational strategies, and design options: Subsection 19.1.3
- To develop an in-depth understanding of the design's robustness and tolerance of severe accidents initiated by either internal or external events: Subsections 19.1.4, 19.1.5, 19.1.6
- To examine the risk-significance of specific human errors associated with the design, and characterize the significant human errors in preparation for better training and more refined procedures: Subsections 19.1.4, 19.1.5, 19.1.6
- To determine how the risk associated with the design compares against the NRC goals of less than 1E-4/year for core damage frequency (CDF) and less than 1E-6/year for large release frequency (LRF): Subsections 19.1.4, 19.1.5, 19.1.6
- To determine containment performance against the NRC containment performance goal, which includes a deterministic goal that containment integrity be maintained for approximately 24 hours following the onset of core damage for the more likely severe accident challenges and a probabilistic goal that the conditional containment failure probability (CCFP) be less than approximately 0.1 for the composite of core damage sequences assessed in the PRA: Section 19.2
- To assess the balance of preventive and mitigate features of the design, including consistency with guidance in SECY-93-087 (Reference 19.1-45) and the associated staff requirements memoranda: Section 19.2
- To demonstrate that the plant design represents a reduction in risk compared to existing operating plants: Subsection 19.1.3
- To demonstrate that the design addresses known issues related to the reliability of core and containment heat removal systems at some operating plants: Subsection 19.1.3, Section 19.2
- To support regulatory oversight processes and programs that will be associated with plant operations (e.g., technical specifications, reliability assurance, human factors, maintenance rule, RTNSS): Subsection 19.1.7

- To identify and support the development of design requirements, such as inspection, tests, analysis, and acceptance criteria (ITAAC), reliability assurance program (RAP), technical specification, and Combined License (COL) action items and interface requirements: Subsection 19.1.7, Section 19.3

The results of the US-APWR plant core damage quantification indicate the following CDFs:

- Internal events at power: 1.2 E-06/RY
- Internal fire: 1.8 E-06/RY
- Internal flood: 1.4 E-06/RY
- LPSD: 2.0 E-07/RY

Based on SMA, the plant HCLPF value is 0.50 g.

LRFs were determined as follows:

- Internal events at power: 1.0E-07/RY
- Internal fire: 2.3E-07/RY
- Internal flood: 2.8E-07/RY
- LPSD: 2.0E-07/RY

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Table19.1-1 Uses of PRA in the Design Process (Sheet 1 of 6)

Cause of core damage or large release		Features and requirements to reduce or eliminate weaknesses in current reactor design
1	Loss of ECCS function	Redundancy ・ Highly redundant safety injection system design with four advanced accumulators and independent four train HHIS enhances the reliability of safety injection function. In addition, feed and bleed operation is available with one of four HHIS. Diversity ・ Alternate core cooling/injection utilizing CSS/RHRS is available in case all safety injection fail.
2	Loss of ECCS recirculation function	Simplicity ・ In-containment RWSP is incorporated which results in elimination of switchover to recirculation operation. Reliability of core cooling is enhanced due to simplified operation mode.
3	Loss of containment cooling	Redundancy ・ Independent four train design adapted to the CSS/RHRS enhances reliability of containment spray and RHR function. Diversity ・ Alternate containment cooling operation utilizing containment fan cooler unit and CCWS enhances the reliability of containment cooling function.
4	Loss of secondary side cooling	Redundancy ・ Highly redundant EFWS design with two turbine driven EFW pumps and two motor driven EFW pumps enhances the reliability of secondary side cooling.

Table19.1-1 Uses of PRA in the Design Process (Sheet 2 of 6)

Cause of core damage or large release		Features and requirements to reduce or eliminate weaknesses in current reactor design
5	Loss of support system function	Redundancy ・ Four train CCWS/ESWS design enhances the reliability of CCWS. Furthermore, CCWS is physically separated into two subsystems to minimize dependency between trains. ・ Independent four train electrical system design with four gas turbine emergency generators provides emergency power to each dedicated safety systems. High redundancy and independency enhances the reliability of power supply to safety systems. Diversity ・ Alternate component cooling water utilizing fire suppression system or the non-essential chilled water system enables to maintain CCW supply to charging pump during loss of CCW events. Thus RCP seal injection function is available under loss of CCW and occurrence of RCP seal LOCA is reduced. ・ Alternate ac power supported by two non-Class 1E GTGs is incorporated as a countermeasure against SBO. Alternate ac power can supply power to any two of the four safety buses in case class 1E GTGs fail during loss of offsite power.
6	Failure of reactor trip	Redundancy ・ Independent four train design of reactor protection systems enhances reliability of plant trip. Four redundant measurements using sensors from the four separate trains are made for each variable used for reactor trip. Diversity ・ The DAS, which has functions to prevent ATWS, is installed as a countermeasure to CCF of the digital I&C systems.

Notes: Fire protection water supply system is called “fire suppression system” in the tables and figures shown in this chapter.

Table19.1-1 Uses of PRA in the Design Process (Sheet 3 of 6)

Cause of core damage or large release		Features and requirements to reduce or eliminate weaknesses in current reactor design
7	Interfacing systems LOCA	Prevention ・ Higher rated piping of residual heat removal systems reduces the occurrence of interfacing systems LOCA. Even if residual heat removal system isolation valves open due to malfunction during normal operation, reactor coolant from main coolant pipe would flow to refueling water storage pit without pipe break outside containment.
8	Loss of RHR function during plant shutdown	Redundancy ・ Independent four train design of RHRS is adapted to enhance reliability of RHR function. Diversity ・ As a countermeasure for loss of RHR, RCS makeup by gravity injection from spent fuel pit is available when the RCS in atmospheric pressure. Prevention ・ To prevent over-drain during mid-loop operation, a loop water level gage and an interlock (actuated by the detection of water level decrease), is provided to isolate water extraction.
9	Internal fire	Physical separation ・ Safety related SSCs are physical separated into four independent divisions and thus fire propagation through trains is minimized. ・ Divide the electrical room of T/B into two fire compartments
10	Internal flood	Physical separation ・ R/B is divided to two divisions (e.g. east side and west side) and thus flood propagation to all four trains is prevented.

Table19.1-1 Uses of PRA in the Design Process (Sheet 4 of 6)

Cause of core damage or large release		Features and requirements to reduce or eliminate weaknesses in current reactor design
11	Hydrogen combustion	<u>High reliability</u> ・ Reliability of combustible gas control is enhanced by providing Igniters that automatically start with the safety injection signal. Power supply from two non-Class 1E buses with alternative ac generators also enhances reliability of combustible gas control. <u>Inherent margin of safety</u> ・ Large volume containment provides combustible gas mixing and protection against hydrogen burns.
12	Steam explosion	<u>Inherent margin of safety</u> ・ There are no mitigation features against in- and ex-vessel steam explosions. However, robust structure of the containment vessel reduces the possibility of containment failure following steam explosions.
13	High pressure melt ejection	<u>High reliability</u> ・ A series of depressurization valves which is independent of safety depressurization valves enhances reliability of RCS pressure reduction and reduces possibility of high pressure melt ejection. <u>Defense in depth</u> ・ Even if high pressure melt ejection occurs, mitigation features against the challenges to containment failure are provided. <u>Diversity</u> ・ For direct containment heating, core debris trap enhances capturing of ejected molten core in the reactor cavity. Debris entrainment is also prevented by reactor cavity flooding systems such as drain line injection from SG compartment and firewater injection.

Table19.1-1 Uses of PRA in the Design Process (Sheet 5 of 6)

Cause of core damage or large release		Features and requirements to reduce or eliminate weaknesses in current reactor design
13	High pressure melt ejection (cont.)	Inherent margin of safety ・ There are no mitigation features against containment failure accompanied by rocket-mode reactor vessel failure. However, robust structure of the containment vessel reduces the possibility of containment failure following steam explosions.
14	Temperature-induced SGTR	High reliability ・ A series of depressurization valves which is independent of safety depressurization valves enhances reliability of RCS pressure reduction and reduces possibility of temperature-induced SGTR.
15	MCCI	High reliability ・ Diverse cavity flooding system enhances heat removal from molten core ejected into the reactor cavity where sufficient floor area and appropriate depth ensure spreading debris bed for better coolability. Reactor cavity floor concrete is also provided to protect against challenge to liner plate melt through. Diversity ・ Diverse cavity flooding system consists of drain line injection from SG compartment and firewater injection. Inherent margin of safety ・ Basemat concrete protects against fission products release to the environment.

Table19.1-1 Uses of PRA in the Design Process (Sheet 6 of 6)

Cause of core damage or large release		Features and requirements to reduce or eliminate weaknesses in current reactor design
16	Long-term containment overpressure	Diversity ・ Containment spray mitigates overpressure in the containment. Alternate containment cooling also removes decay heat accumulated in the steam. Firewater injection to spray header, which dose not have a function of heat removal, delays containment failure and ensure the time to recovery of containment spray. Inherent margin of safety ・ Large volume containment provides sufficient capability to withstand overpressure.
17	Containment isolation failure	High reliability ・ Main penetrations are isolated automatically even when SBO occurs and alternative ac generators are not available. Diversity ・ Manual closure of isolation valves is available using DAS even when automatic isolation fails due to software common cause failure.

Table 19.1-2 Initiating Events for the US-APWR

	IE	Event Description	Frequency	Reference
1	LLOCA	Large Pipe Break LOCA	1.2E-06	NUREG/CR-6928 (Reference19.1-16)
2	MLOCA	Medium Pipe Break LOCA	5.0E-04	NUREG/CR-6928
3	SLOCA	Small Pipe Break LOCA	3.6E-03	NUREG/CR-6928
4	VSLOCA	Very Small Pipe Break LOCA	1.5E-03	NUREG/CR-6928
5	SGTR	Steam Generator Tube Rupture	4.0E-03	NUREG/CR-6928
6	RVR	Reactor Vessel Rupture	1.0E-07	WASH-1400 (Reference19.1-22)
7	SLBO	Steam Line Break/Leak (Downstream MSIV : Turbine side)	1.0E-02	NUREG/CR-5750 (Reference19.1-46)
8	SLBI	Steam Line Break/Leak (Upstream MSIV : CV side)	1.0E-03	NUREG/CR-5750
9	FWLB	Feed-water Line Break	3.4E-03	NUREG/CR-5750
10	TRANS	General Transient	0.8	NUREG/CR-6928
11	LOFF	Loss of Feed-water Flow	1.9E-01	NUREG/CR-6928
12	LOCCW	Loss of Component Cooling Water	2.3E-5	Fault tree Analysis
13	PLOCW	Partial Loss of Component Cooling Water	1.2E-3	NUREG/CR-6928
14	LOOP	Loss of Offsite Power	4.0E-2	NUREG/CR-6928
15	LOAC	Loss of Vital ac Bus	9.0E-3	NUREG/CR-6928
16	LODC	Loss of Vital DC Bus	1.2E-3	NUREG/CR-6928

Table 19.1-3 Frontline Systems Shared Systems and Components

Frontline & Shared systems / Frontline Systems (FSs)	Frontline & Shared systems		
	Refueling Water Storage Pit	Containment Spray / Residual Heat Removal System Heat Exchanger	Containment Spray / Residual Heat Removal Pump
Safety Injection System	X		
Containment Spray / Residual Heat Removal System (Spray Injection)	X	X	X
Containment Spray / Residual Heat Removal System (Alternate Core Cooling)	X	X	X

[Note]
X : failure of frontline & shared systems impact to FSs systems

Table 19.1-4 Dependencies Between Frontline Systems and Supporting Systems

Frontline Systems (FSs) \ Supporting Systems (SSs)			Essential Service Water System				Component Cooling Water System				Safety Chilled Water System (Safety-related)				Emergency Station Power Supply System (Safety-related)															
			ESWS				CCWS				CWS(S)				Class 1E GTG/ AC6.9kv				AC480V				DC125V				AC120V			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Emergency Core Cooling System	Accumulator Injection System	A																	NA											
		B																		NA										
		C																			NA									
		D																				NA								
	Safety Injection System	A					X								X				X				X				X			
		B						X								X				X				X				X		
		C							X								X				X				X				X	
		D								X								X				X				X				X
	Containment Spray / Residual Heat Removal System	A					X								X				X				X				X			
		B						X								X				X				X				X		
		C							X								X				X				X				X	
		D								X								X				X				X				X
	Containment Natural Convection Cooling System	A					X												X											
		B					X													X										
		C					X														X									
		D					X															X								
Chemical and Volume Control System	Charging Injection System	A					X	X							X				2		2		X				X			
		B							X	X								X	2		2					X				X
Main Steam / Feed water System	Emergency Feed water System	A																					X	X			X			
		B														X							X	X				X		
		C															X								X	X			X	
		D																							X	X				X
	Main Steam line Isolation System	A																					X							
		B																					X							
		C																								X				
		D																								X				
	Main Steam Pressure Control System	A																	2				X							
		B																	2				X	X						
		C																			2				X	X				
		D																			2					X				
Reactor Coolant System	Pressurizer Pressure Control System	A																	2											
		B																			2									
Reactor Trip System & ESF System		I																									X			
		II																										X		
		III																											X	
		IV																												X

Frontline Systems (FSs) \ Supporting Systems (SSs)			Emergency Station Power Supply System (Non-safety)				Heating, Ventilating & Air Condition System																				Instrument Air		Engineered Safety Features Actuation Signal							
			AC6.9 kV		AC480 V		Safeguard Component Area				Emergency Power Supply Area				Class 1E Electrical Room				Emergency Feedwater Motor-driven Pump Area		Emergency Feedwater Turbine-driven Pump Area		Non-Safety		IA		ECCS Signal				CS Signal			
			P1	P2	P1	P2	A	B	C	D	A	B	C	D	A	B	C	D	A	B	A	B	A	B	A	B	A	B	C	D	A	B	C	D
Emergency Core Cooling System	Accumulator Injection System	A																									1							
		B																										1						
		C																											1					
		D																												1				
	Safety Injection System	A					†																				X							
		B						†																				X						
		C							†																				X					
		D								†																				X				
	Containment Spray / Residual Heat Removal System	A					†																								X			
		B						†																								X		
		C							†																								X	
		D								†																								X
	Containment Natural Convection Cooling System	A																																
		B																																
		C																																
		D																																
Chemical and Volume Control System	Charging Injection System	A					†	†																	NA									
		B							†	†																NA								
Main Steam / Feed water System	Emergency Feed water System	A																			NA						X							
		B																	X									X						
		C																		X									X					
		D																				NA								X				
	Main Steam line Isolation System	A																																
		B																																
		C																																
		D																																
	Main Steam Pressure Control System	A																							NA	NA								
		B																							NA	NA								
		C																							NA	NA								
		D																							NA	NA								
Reactor Coolant System	Pressurizer Pressure Control System	A																																
		B																																
Reactor Trip System & ESF System		I																																
		II																																
		III																																
		IV																																

X : failure of SSs impact to FSs
NA : FSs have dependency with SSs, but failure of SSs do not impact to function of FSs
†: assumed failure of SSs impact late to FSs due to high room temperature
2:Switchover

Table 19.1-5 System Dependencies between Supporting Systems and Supporting Systems (ESW, CCW, CWS[S], Power Supply)

Supporting Systems (SSs) / Supporting System (SSs)			Essential Service Water System				Component Cooling Water System				Safety Chiller Water System (Safety)				Emergency Station Power Supply System (Safety)																Heating, Ventilating & Air Condition System																Engineered Safety Features Actuation Signal							
			ESW				CCW				CWS(S)				EGT/AC6.9kV				AC480V				DC125V				AC120V				Safeguard Component Area				Emergency Power Supply Area				Class 1E Electrical Room				Emergency Feed water Motor-driven Pump Area		Emergency Feed water Turbine-driven Pump Area		SI Signal				P Signal			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	A	B	A	B	C	D	A	B	C	D
Essential Service Water System	ESW	A													X								X																								X							
		B														X								X																								X						
		C															X								X																								X					
		D																X								X																								X				
Component Cooling Water System	CCW	A	X												X				X				X																								X				X			
		B		X												X				X				X																								X				X		
		C			X												X				X				X																								X				X	
		D				X												X				X				X																								X				X
Safety Chilled Water System	CWS(S)	A	X																X				X																								X							
		B		X																X				X																								X						
		C			X																X				X																								X					
		D				X																X				X																								X				
Emergency Station Power Supply System	EGT/ AC6.9kV	A	X																				X				X								†				†								X							
		B		X																				X				X								†				†								X						
		C			X																				X				X								†				†								X					
		D				X																				X				X								†				†								X				
	AC480V	A													X																								†															
		B														X																								†														
		C															X																								†													
		D																X																								†												
	DC125V	A																	X																				†															
		B																		X																				†														
		C																			X																				†													
		D																				X																				†												
	AC120V	A																					X																†															
		B																						X																†														
		C																							X																†													
		D																								X																†												

[Notes]

X : failure of upper column SSs impact to left column SSs

NA : failure of upper column SSs do not impact to left column SSs even though have dependency with upper column SSs

†: assumed failure of upper column SSs impact late to left column SSs due to high room temperature

Table 19.1-6 System Dependencies between Supporting Systems and Supporting Systems (HVAC, Signal)

Supporting Systems (SSs) / Supporting Systems (SSs)			Essential Service Water System				Component Cooling Water System				Safety Chilled Water System (Safety)				Emergency Station Power Supply System (Safety)																Heating, Ventilating & Air Condition System																Engineered Safety Features Actuation Signal							
			ESW				CCW				CWS(S)				EGT/AC6.9kv				AC480V				DC125V				AC120V				Safeguard Component Area				Emergency Power Supply Area				Class 1E Electrical Room				Emergency Feed water Motor-driven Pump Area		Emergency Feed water Turbine-driven Pump Area		SI Signal				P Signal			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	A	B	A	B	C	D	A	B	C	D
Heating, Ventilating & Air Condition System	Safeguard Component Area	A									X								X				NA				X																				X							
		B										X								X				NA				X																				X						
		C											X								X				NA				X																				X					
		D												X								X				NA				X																				X				
	EGT Area	A									X								X				NA				X																				X							
		B										X								X				NA				X																				X						
		C											X								X				NA				X																				X					
		D												X								X				NA				X																				X				
	Class 1E Electrical Room	A									X								X								X																				X							
		B										X								X								X																				X						
		C											X								X								X																				X					
		D												X								X								X																				X				
	Emergency Feedwater Motor-driven Pump Area	B										X								X								X																				X						
		C											X								X								X																				X					
	Emergency Feedwater Turbin-driven Pump Area	A									X								X								X																				X							
		D												X								X								X																				X				
Engineered Safety Features Actuation Signal	SI Signal	A																					X				X																											
		B																						X				X																										
		C																							X				X																									
		D																								X				X																								
	P Signal	A																					X				X																											
		B																						X				X																										
		C																							X				X																									
		D																								X				X																								

[Notes]

X : failure of upper column SSs impact to left column SSs

NA : failure of upper column SSs do not impact to left column SSs even though have dependency with upper column SSs

Table19.1-7 Definition of Accident Classes for US-APWR

No	ACL	Initiating Event and Primary System Pressure		C/V intact or failed at core damage*1	Loss of Support System initiating events	Accident Progression in Containment		
						C/V Spray	C/V Heat Removal	Availability of Reactor Cavity Flooding
1	AED	LB/MLOCA	Low	Intact at CD	No	-	-	-
2	AEF	LB/MLOCA	Low	Intact at CD	No	-	X	-
3	AEW	LB/MLOCA	Low	Intact at CD	No	-	-	X
4	AES	LB/MLOCA	Low	Intact at CD	No	X*1	-	X
5	AEHF	LB/MLOCA	Low	Intact at CD	No	-	X	X
6	AEHS	LB/MLOCA	Low	Intact at CD	No	X*1	X	X
7	AEI	LB/MLOCA	Low	Intact at CD	No	X	X	X
8	ALC	LB/MLOCA	Low	Before CD	No	-	-	X
9	SED	SLOCA	Med	Intact at CD	No	-	-	-
10	SED'	SLOCA	Med	Intact at CD	Power	-	-	-
11	SED’’	SLOCA	Med	Intact at CD	CCW	-	-	-
12	SEF	SLOCA	Med	Intact at CD	No	-	X	-
13	SEW	SLOCA	Med	Intact at CD	No	-	-	X*3
14	SES	SLOCA	Med	Intact at CD	No	X*2	-	X
15	SEHF	SLOCA	Med	Intact at CD	No	-	X	X*3
16	SEHS	SLOCA	Med	Intact at CD	No	X*2	X	X
17	SEI	SLOCA	Med	Intact at CD	No	X	X	X
18	SLC	SLOCA	Med	Before CD	No	-	-	X
19	TED	Transient	High	Intact at CD	No	-	-	-
20	TED'	Transient	High	Intact at CD	Power	-	-	-
21	TED’’	Transient	High	Intact at CD	CCW	-	-	-
22	TEF	Transient	High	Intact at CD	No	-	X	-
23	TEW	Transient	High	Intact at CD	No	-	-	X*3
24	TES	Transient	High	Intact at CD	No	X	-	X
25	TEHF	Transient	High	Intact at CD	No	-	X	X*3
26	TEHS	Transient	High	Intact at CD	No	X*2	X	X
27	TEI	Transient	High	Intact at CD	No	X	X	X
28	G	SGTR	Med	- *4				

*1: Containment Isolation failure is not considered.

*2: Failure of CSS heat exchanger

*3: SIS or alternate core cooling after RV failure

*4: Containment bypass event

X: Available

-: Not Available

Table 19.1-8 Systems Included in Systems Analysis for Internal Events

Systems name (Front line systems)	I.D.
High head injection system	HPI
Accumulator injection system	ACC
Emergency feedwater system	EFW
Containment spray injection / Residual heat removal system	RSS
Main steam pressure control system, main steam safety valve	MSP
Pressurizer pressure control system, Pressurizer safety valve	PZR
Main steam isolation system	MSR
Charging injection system	CHI

System name (Supporting systems)	I.D.
Emergency station power system	EPS
Reactor control protection system	RTP
Component cooling water system	CWS
Essential service water system	SWS
Protections and safety monitoring system	SGN
Heating, ventilating and air conditioning system	HVA

System name (Other systems and functions)	I.D.
Offsite power system	OPS
RCP seal LOCA	RCP
HHIS injection control	HIT
Alternate component cooling water system	ACW
Safety chilled water system	VCW
Fail to recover main feed water system	MFW

System name (Common equipments)	I.D.
RWSP and water intake line rupture	RWS
Alternate containment cooling by recirculation unit	NCC
Injection line	INJ

Table 19.1-9 The Relation of Plant Safety Functions and Initiating Events

Initiating Events	Plant Safety Functions				
	Reactivity Control	RCS Pressure Control	RCS Inventory Control	Decay Heat Removal Function	Containment Heat Removal and CI
Large LOCA	-- (Note 1)	--	X	X	X
Medium LOCA	X	--	X	X	X
Small LOCA	X	--	X	X	X
Very Small LOCA	X	--	X	X	--
Reactor Vessel Rupture	--	--	--	--	--
Steam Generator Tube Rupture	X	X (Fail ISO) (Note2)	X (Fail ISO)	X	--
Steam Line Break (downstream of MSIV)	X	--	--	X	--
Steam Line Break (upstream of MSIV, inside C/V)	X	--	--	X	--
Feed Line Break	X	--	--	X	--
General Transient	X	--	--	X	--
Loss of Main Feedwater	X	--	--	X	--
Total Loss of Component Cooling	X	--	X (LOCA) (Note3)	X	X (LOCA))
Partial Loss of Component Cooling	X	--	X (LOCA)	X	X (LOCA))
Loss of Offsite Power	X	--	X (LOCA)	X	X (LOCA))
Loss of Vital ac Bus	X	--	--	X	--
Loss of Vital DC Bus	X	--	--	X	--
Anticipated transient without scram	X	X	--	X	--

Note 1; even if this safety function is not available, core damage may not occur.
Note 2; If failed SG cannot be isolated, primary coolant leak would be continue
Note 3; LOCA means RCP seal LOCA or Pressurizer Safety Valve stuck open
X; It means that this safety function is required to prevent core damage.
--; It means that this safety function is not required or not effective.

Table 19.1-10 Safety Functions and Mitigating Systems

Initiating Events	Plant Safety Functions				
	Reactivity Control	RCS Pressure Control	RCS Inventory Control	Decay Heat Removal Function	Containment Heat Removal and CI
Large LOCA	--	--	ACC+HHIS	HHIS	CS/RHRS
Medium LOCA	RPS	--	ACC+HHIS	HHIS	CS/RHRS
Small LOCA	RPS		HHIS	EFWS	CS/RHRS
Very Small LOCA	RPS		CVCS	EFWS	--
Reactor Vessel Rupture	--	--	--	--	--
Steam Generator Tube Rupture	RPS	MSRV or SDV	ISO or HHIS	EFWS	--
Steam Line Break (downstream of MSIV)	RPS	--	--	EFWS and ISO	--
Steam Line Break (upstream of MSIV, inside C/V)	RPS	--	--	EFWS and ISO	--
Feed Line Break	RPS	--	--	EFWS and ISO	--
General Transient	RPS	--	--	EFWS	--
Loss of Main Feedwater	RPS	--	--	EFWS	--
Total Loss of Component Cooling	RPS	--	HHIS	EFWS	CS/RHRS
Partial Loss of Component Cooling	RPS	--	HHIS	EFWS	CS/RHRS
Loss of Offsite Power	RPS	--	HHIS	EFWS	CS/RHRS
Loss of Vital ac Bus	RPS	--	--	EFWS	--
Loss of Vital DC Bus	RPS	--	--	EFWS	--
Anticipated transient without scram	RPS or DAS	PRSV	--	EFWS and Turbine Trip	--

Table 19.1-11 Safety Functions and Alternative Operator Actions

Alternative Operator Actions	Plant Safety Functions				
	Reactivity Control	**RCS Pressure Control**	**RCS Inventory Control**	**Decay Heat Removal Function**	**Containment Heat Removal and CI**
Feed and bleed	--	SDV	HHIS	HHIS and SDV	CS/RHRS
Alternate core injection by CS/RHRS	--	MSRV and EFWS	CS/RHR cold leg injection	CS/RHR cold leg injection	CS/RHRS or CS/RHR cold leg injection

Table 19.1-12 Typical Results of Thermal/Hydraulic Analysis

Accident Sequence Designator	Computer Code	Results	Note
Hot leg 8 inches break, 2 High head safety injection, 2 Accumulators	MAAP	PCT < 1400° F	
Cold leg 4 inches break, 1 High head safety injection, 2 Accumulators	MAAP	PCT < 1400° F	
Cold leg 2 inches break, 1 High head safety injection, 2 Accumulators, No emergency feedwater	MAAP	PCT < 1400° F	
Hot leg double ended guillotine break, All high head safety injection, All Accumulators, All Emergency feedwater, 1 Containment spray injection	MAAP	CV pressure < ultimate pressure	
Loss of main feedwater, 1 Emergency feedwater pump to 1 SG	MAAP	PCT < 1400° F	Success criteria: 1 pump to 2SG.
Loss of main feedwater, 1 Emergency feedwater pump to 3 SG (open cross-tie)	MAAP	PCT < 1400° F	
Total loss of feedwater, 1 Safety depressurization valve open, 1 high head safety injection start at SG dryout	MAAP	PCT < 1400° F	
Hot leg 2 inches break, No high head safety injection, All accumulators, 3 Main steam relief valves open at 30 minutes, All emergency feedwater, 1 Low pressure injection	MAAP	PCT < 1400° F	

Table 19.1-13 Results of Thermal/Hydraulic Analysis and Success Criteria

Initiating Events/ Alternative Operator Actions	Plant Safety Functions				
	Reactivity Control	**RCS Pressure Control**	**RCS Inventory Control**	**Decay Heat Removal Function**	**Containment Heat Removal and CI**
Large LOCA	--	--	2ACC＋2HHIS	2HHIS	1CS/RHRS
Medium LOCA	RPS	--	2ACC＋1HHIS	1HHIS	1CS/RHRS
Small LOCA (and other LOCA)	RPS		1HHIS	2EFWS or 1EFWP to 2 SG	1CS/RHRS
Loss of Main Feedwater (and other transient)	RPS	--	--	2EFWS or 1EFWP to 2 SG	--
Feed and bleed	--	1SDV	1HHIS	1HHIS and 1SDV	1CS/RHRS
Alternate core injection by CS/RHRS	--	3MSRV and EFWS	1CS/RHR cold leg injection	1CS/RHR cold leg injection	1CS/RHRS or 1CS/RHR cold leg injection

Table 19.1-14 Component Random Failure Database for US-APWR (Mechanical) (Sheet 1 of 3)

ID	Description	Dist. Type	Mean		α	β	Data Source	Boundary
AVCD	Air-Operated Valve Fail to Close	β	1.2E-03	(/d)	1.0	8.3E+02	NUREG/CR-6928 Table 5-1	the valve, the valve operator (including the associated solenoid operated valves), local circuit breaker, and local instrumentation and control circuitry.
AVOM AVCM	Air-Operated Valve Spurious Operation	γ	2.0E-07	(/h)	0.3	1.5E+06	NUREG/CR-6928 Table 5-1	
AVEL	Air-Operated Valve External Leak Large	γ	9.0E-10	(/h)	0.3	3.3E+08	NUREG/CR-6928 Table 5-1	
AVIL	Air-Operated Valve Internal Leak Large	γ	5.0E-09	(/h)	0.3	6.0E+07	NUREG/CR-6928 Table 5-1	
CVCD	Check Valve Fail to Close	β	1.0E-04	(/d)	0.5	5.0E+03	NUREG/CR-6928 Table 5-1	the valve and no other supporting components
CVOD	Check Valve Fail to Open	β	1.2E-05	(/d)	0.5	4.2E+04	NUREG/CR-6928 Table 5-1	
CVEL	Check Valve External Leak Large	γ	2.0E-09	(/h)	0.3	1.5E+08	NUREG/CR-6928 Table 5-1	
CVIL	Check Valve Internal Leak Large	γ	3.0E-08	(/h)	0.3	1.0E+07	NUREG/CR-6928 Table 5-1	
CVPR	Check Valve Plug	γ	1.0E-07	(/h)	0.3	3.0E+06	NUREG/CR-3226 Table E-1	
MVFC	Motor-Operated Valve Fail to Control	γ	3.0E-06	(/h)	0.3	1.0E+05	NUREG/CR-6928 Table 5-1	the valve, the valve operator, local circuit breaker, and local instrumentation and control circuitry
MVOD MVCD	Motor-Operated Valve Fail to Open or Close	β	1.0E-03	(/d)	1.2	1.2E+03	NUREG/CR-6928 Table 5-1	
MVOM MVCM	Motor-Operated Valve Spurious Operation	γ	4.0E-08	(/h)	0.5	1.3E+07	NUREG/CR-6928 Table 5-1	
MVEL	Motor-Operated Valve External Leak Large	γ	1.0E-09	(/h)	0.3	3.0E+08	NUREG/CR-6928 Table 5-1	
MVIL	Motor-Operated Valve Internal Leak Large	γ	3.0E-09	(/h)	0.3	1.0E+08	NUREG/CR-6928 Table 5-1	
MVPR	Motor-Operated Valve Plug	γ	1.0E-07	(/h)	0.3	3.0E+06	NUREG/CR-3226 Table E-1	
RVCD	Power-Operated Relief Valve Fail to Close	β	1.0E-03	(/d)	0.5	5.0E+02	NUREG/CR-6928 Table 5-1	the valve, the valve operator, local circuit breaker, and local instrumentation and control circuitry
RVOD	Power-Operated Relief Valve Fail to Open	β	7.0E-03	(/d)	0.4	5.7E+01	NUREG/CR-6928 Table 5-1	
SVCD	Safety Valve Fail to Close	β	7.0E-05	(/d)	0.5	7.1E+03	NUREG/CR-6928 Table 5-1	the valve and the valve operator
SVOM	Safety Valve Spurious Operation (Open)	γ	2.0E-07	(/h)	0.3	1.5E+06	NUREG/CR-6928 Table 5-1	
XVOD XVCD	Manual Valve Fail to Open or Close	β	7.0E-04	(/d)	0.5	7.1E+02	NUREG/CR-6928 Table 5-1	the valve and valve operator
XVPR	Manual Valve Plug	γ	1.0E-07	(/h)	0.3	3.0E+06	NUREG/CR-3226 Table E-1	
XVEL	Manual Valve External Leak Large	γ	3.0E-09	(/h)	0.3	1.0E+08	NUREG/CR-6928 Table 5-1	
XVIL	Manual Valve Internal Leak Large	γ	1.2E-09	(/h)	0.3	2.5E+08	NUREG/CR-6928 Table 5-1	
TNEL	Tank Unpressurized External Leak Large	γ	2.0E-09	(/h)	0.3	1.5E+08	NUREG/CR-6928 Table 5-1	the tank
TKEL	Tank Pressurized External Leak Large	γ	3.0E-09	(/h)	0.3	1.0E+08	NUREG/CR-6928 Table 5-1	the tank
RHPR	Heat Exchanger Plug/Foul (RHR)	γ	6.0E-07	(/h)	1.5	2.5E+06	NUREG/CR-6928 Table 5-1	the heat exchanger shell and tubes
RHPF	Heat Exchanger (Plate Type) Plug/Foul (CCW)	γ	6.0E-08	(/h)	0.3	5.0E+06	One order of magnitude lower than for RHPR	
RXEL	Heat Exchanger Shell External Leak Large	γ	4.0E-09	(/h)	0.3	7.5E+07	NUREG/CR-6928 Table 5-1	
RIEL	Heat Exchanger Tube External Leak Large	γ	3.0E-08	(/h)	0.3	1.0E+07	NUREG/CR-6928 Table 5-1	
ORPR	Orifice Plug	γ	1.0E-06	(/h)	0.3	3.0E+05	NUREG/CR-6928 Table 5-1	the orifice
STPR	Strainer Plug	γ	7.0E-06	(/h)	0.3	4.3E+04	NUREG/CR-6928 Table 5-1	the strainer
SZPR	Spray nozzle Plug	γ	7.1E-08	(/h)	0.3	4.2E+06	PLG-0500	spray nozzle
PEEL	Piping Service Water System External Leak Large	γ	1.5E-10	(/h -feet)	0.3	2.0E+09	NUREG/CR-6928 Table 5-1	piping and pipe welds in each system. The flanges connecting piping segments are not included in the pipe component
PNEL	Piping Non-Service Water System External Leak Large	γ	2.5E-11	(/h-feet)	0.3	1.2E+10	NUREG/CR-6928 Table 5-1	piping and pipe welds in each system. The flanges connecting piping segments are not included in the pipe component

Table 19.1-14 Component Random Failure Database for US-APWR (Mechanical) (Sheet 2 of 3)

ID	Description	Dist. Type	Mean	α	β	Data Source	Boundary
PMYR	Motor-Driven Pump (Running) Fail to Run	γ	5.0E-06 (/h)	1.5	3.0E+05	NUREG/CR-6928 Table 5-1	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PMBD	Motor-Driven Pump (Running) Fail to Start	β	2.0E-03 (/d)	0.9	4.5E+02	NUREG/CR-6928 Table 5-1	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PCYR	CCW Motor-Driven Pump (Running) Fail to Run	γ	2.8E-06 (/h)	1.5	5.4E+05	NUREG/CR-6928 Table A.2.27-8. Alfa factor is taken from PMYR.	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PCBD	CCW Motor-Driven Pump (Running) Fail to Start	β	1.1E-03 (/d)	0.9	8.2E+02	NUREG/CR-6928 Table A.2.27-8. Alfa factor is taken from PMBD.	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PMSR	Motor-Driven Pump (Standby) Fail to Run During First Hour of Operation	γ	4.0E-04 (/h)	1.5	3.8E+03	NUREG/CR-6928 Table 5-1	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PMLR	Motor-Driven Pump (Standby) Fail to Run After First Hour of Operation	γ	6.0E-06 (/h)	0.5	8.3E+04	NUREG/CR-6928 Table 5-1	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PMAD	Motor-Driven Pump (Standby) Fail to Start	β	1.5E-03 (/d)	0.9	6.0E+02	NUREG/CR-6928 Table 5-1	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PMEL	Motor-Driven Pump External Leak Large	γ	8.0E-09 (/h)	0.3	3.8E+07	NUREG/CR-6928 Table 5-1	the pump, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
PTSR	Turbine-Driven Pump (Standby) Fail to Run During First Hour of Operation	γ	2.5E-03 (/h)	0.8	3.2E+02	NUREG/CR-6928 Table 5-1	the pump, turbine, governor control, steam emission valve, local lubrication or cooling systems, and local instrumentation and controls
PTLR	Turbine-Driven Pump (Standby) Fail to Run After First Hour of Operation	γ	7.0E-05 (/h)	0.5	7.1E+03	NUREG/CR-6928 Table 5-1	the pump, turbine, governor control, steam emission valve, local lubrication or cooling systems, and local instrumentation and controls
PTAD	Turbine-Driven Pump (Standby) Fail to Start	β	7.0E-03 (/d)	0.4	5.7E+01	NUREG/CR-6928 Table 5-1	the pump, turbine, governor control, steam emission valve, local lubrication or cooling systems, and local instrumentation and controls
PTEL	Turbine-Driven Pump External Leak Large	γ	9.0E-09 (/h)	0.3	3.3E+07	NUREG/CR-6928 Table 5-1	the pump, turbine, governor control, steam emission valve, local lubrication or cooling systems, and local instrumentation and controls
PDSR	Diesel-Driven Pump (Standby) Fail to Run During First Hour of Operation	γ	1.5E-03 (/h)	0.3	2.0E+02	NUREG/CR-6928 Table 5-1	the pump, diesel engine, local lubrication or cooling systems, and local instrumentation and control circuitry
PDLR	Diesel-Driven Pump (Standby) Fail to Run After First Hour of Operation	γ	9.0E-05 (/h)	0.3	3.3E+03	NUREG/CR-6928 Table 5-1	the pump, diesel engine, local lubrication or cooling systems, and local instrumentation and control circuitry
PDAD	Diesel-Driven Pump (Standby) Fail to Start	β	4.0E-03 (/d)	0.3	7.5E+01	NUREG/CR-6928 Table 5-1	the pump, diesel engine, local lubrication or cooling systems, and local instrumentation and control circuitry
PDEL	Diesel-Driven Pump External Leak Large	γ	1.5E-08 (/h)	0.3	2.0E+07	NUREG/CR-6928 Table 5-1	the pump, diesel engine, local lubrication or cooling systems, and local instrumentation and control circuitry
CPYR	Motor-Driven Compressor (Running) Fail to Run	γ	9.0E-05 (/h)	1.5	1.7E+04	NUREG/CR-6928 Table 5-1	the compressor, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry.
FABD	Fan (Running) Fail to Start	β	2.0E-03 (/d)	0.3	1.5E+02	NUREG/CR-6928 Table 5-1	the fan, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry.
FASR	Fan (Standby) Fail to Run During First Hour of Operation	γ	2.0E-03 (/h)	0.3	1.5E+02	NUREG/CR-6928 Table 5-1	the fan, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry.
FALR	Fan (Standby) Fail to Run After First Hour of Operation	γ	1.2E-04 (/h)	8.0	6.7E+04	NUREG/CR-6928 Table 5-1	the fan, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry.
CTAD	Cooling Tower Fan (Standby) Fail to Start	β	2.5E-03 (/d)	0.5	2.0E+02	NUREG/CR-6928 Table 5-1	the fan, motor, local circuit breaker, local lubrication or cooling systems, and local instrumentation and control circuitry
CHYR	Chiller (Running) Fail to Run	γ	9.0E-05 (/h)	0.5	5.6E+03	NUREG/CR-6928 Table 5-1	the compressor, motor, local circuit breaker, local lubrication or cooling systems
CHAD	Chiller (Standby) Fail to Start	β	2.0E-03 (/d)	0.5	2.5E+02	NUREG/CR-6928 Table 5-1	the compressor, motor, local circuit breaker, local lubrication or cooling systems

Table 19.1-14 Component Random Failure Database for US-APWR(Mechanical) (Sheet 3 of 3)

ID	Description	Dist. Type	Mean	α	β	Data Source	Boundary
DLSR	Gas Turbine Generator (Standby) Fail to Load and Run During First Hour of Operation	β	3.0E-03 (/d)	1.5	5.0E+02	NUREG/CR-6928 Table 5-1 Emergency Diesel Generator	the gas turbine and auxiliary systems
DLLR	Gas Turbine Generator (Standby) Fail to Run After First Hour of Operation	γ	8.0E-04 (/h)	2.0	2.5E+03	NUREG/CR-6928 Table 5-1 Emergency Diesel Generator	
DLAD	Gas Turbine Generator (Standby) Fail to Start	β	5.0E-03 (/d)	1.0	2.0E+02	NUREG/CR-6928 Table 5-1 Emergency Diesel Generator	
AXFF	RPS Breaker (Combined) Fail to Open or Close	β	1.5E-05 (/d)	0.5	3.3E+04	NUREG/CR-6928 Table 5-1	the entire trip breaker
DPCD	Pneumatic-Operated Damper Fail to Close	β	1.0E-03 (/d)	0.5	5.0E+02	NUREG/CR-6928 Table 5-1	the damper, the damper operator, any associated solenoid operated valves, and local instrumentation and control circuitry
DPOM	Pneumatic-Operated Damper Spurious Operation (Open)	γ	1.2E-07 (/h)	0.5	4.2E+06	NUREG/CR-6928 Table 5-1	
DPCM	Pneumatic-Operated Damper Spurious Operation (Close)	γ	1.2E-07 (/h)	0.5	4.2E+06	NUREG/CR-6928 Table 5-1	
SUPR	Containment Sump Plug During Operation	γ	1.0E-05 (/h)	0.3	3.0E+04	PLG-0500	Containment Sump
IGFF	Igniter Fail to Function	γ	1.9E-08 (/h)	0.3	1.6E+07	NPRD-95	Igniter Electric
Note - It is assumed that alpha factor for all kinds of valves and containment sump plugging are 0.3.							

Table 19.1-15 Basic HEP Values for Type C Subtask Errors

Item	HEP	EF	Application Criteria		
			Stress Level	Task Type	Others
(1)	1.0	-	-	-	No written procedures are available
(2)	Var	-	-	-	If sufficient information can be obtained per task analysis, as described in Chapter 4 of NUREG/CR-1278, adjusted for the effects of dependence, stress, and other performance shaping factors(PSFs), and error recovery factors(RFs) per search scheme in Chapter 20. If this level of information cannot be obtained because of scheduling or other restrictions, use the remainder of this table.
(3)	0.02	5	Moderately High	Step By Step	
(4)	0.05	5	Moderately High	Dynamic	
			Extremely High	Step By Step	
(5)	0.25	5	Extremely High	Dynamic	

Table 19.1-16 Recovery Factors

Item	HEP	EF	Application Criteria		
			Stress Level	Task Type	Others
(6)	0.2	5	Moderately High	Step By Step	The second person can check the performance of the original performer.
(7)	0.5	5	Moderately High	Dynamic	The second person can check the performance of the original performer.
			Extremely High	Step By Step	The second person can check the performance of the original performer.
(8)	0.5	5	Extremely High	Dynamic	The second person can check the performance of the original performer.
(9)	Var	-	-	-	If there are error recovery factors (RFs) in addition to the use of human redundancy in items (6), (7), and (8), the influence of these RFs must be assessed separately. For annunciator RFs, use the annunciator Response Model.
(10)	0.001	10	-	-	Perform a post-diagnosis immediate emergency action for the reactor vessel/containment critical parameters, when (a) it can be judged to have been committed to memory, (b) it can be classified as skill-based actions, and (c) there is a backup written procedure. Assume no immediate RF from a second person for each action.

Table 19.1-17 Summary of US-APWR Front Line System Fault Tree Failure Probabilities

(Sheet 1 of 4)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
Accumulator Injection System (ACC)		
ACC-0LL	Failure of ACC (2/3)	6.4E-06
ACC-0SL	Failure of ACC (1/4)	2.0E-06
High Head Injection System (HHIS)		
HPI-LL	Failure of SIS (2 OUT OF 4 DVI)	3.8E-04
HPI-ML	Failure of SIS (1 OUT OF 3 DVI)	2.1E-04
HPI-SL	Failure of SIS (1 OUT OF 4 DVI)	1.4E-04
HPI-SL-CHI	Failure of SIS (VSLOCA)	1.4E-04
HPI-SL-LP1	Failure of SIS (LOOP:LOSS OF OFFSITE POWER)	2.3E-04
HPI-SL-LP2	Failure of SIS (LOOP)	1.4E-04
HPI-SL-PC	Failure of SIS (PLOCW)	1.3E-03
Charging Injection System		
CHI-VS	Charging Injection System (VSLOCA : EFW Success)	2.1E-04
CS/RHR System (CV Spray Injection)		
RSS-CSS	Failure of CV Spray Injection Mode (Other Initiating Events)	1.4E-04
RSS-CSS-AC	Failure of CV Spray Injection (LOAC)	1.6E-04
RSS-CSS-CHI	Failure of CV Spray Injection (VSLOCA)	1.4E-04
RSS-CSS-DC	Failure of CV Spray Injection (LODC)	1.7E-04
RSS-CSS-LL	Failure of CV Spray Injection (LLOCA)	1.5E-04
RSS-CSS-LP1	Failure of CV Spray Injection (LOOP:LOSS OF OFFSITE POWER)	2.2E-04
RSS-CSS-LP2	Failure of CV Spray Injection (LOOP)	1.4E-04
RSS-CSS-PC	Failure of CV Spray Injection (PLOCW)	6.8E-04
CS/RHR System (Heat Removal : Spray Injection Success)		
RSS-CSS-HR	Failure of Heat Removal (Other Initiating Events)	2.3E-04
RSS-CSS-HR-AC	Failure of Heat Removal (LOAC)	2.6E-04
RSS-CSS-HR-CHI	Failure of Heat Removal (VSLOCA)	2.3E-04
RSS-CSS-HR-DC	Failure of Heat Removal (LODC)	2.7E-04
RSS-CSS-HR-LL	Failure of Heat Removal (LLOCA)	2.4E-04
RSS-CSS-HR-LP1	Failure of Heat Removal (LOOP:LOSS OF OFFSITE POWER)	3.1E-04
RSS-CSS-HR-LP2	Failure of Heat Removal (LOOP)	2.3E-04
RSS-CSS-HR-PC	Failure of Heat Removal (PLOSW)	8.7E-04

Table 19.1-17 Summary of US-APWR Front Line System Fault Tree Failure Probabilities

(Sheet 2 of 4)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
CS/RHR System (Heat Removal: Spray Injection fail)		
RSS-RHR-HRLM	Failure of Heat Removal (MLOCA)	8.9E-03
RSS-RHR-HRLM-LL	Failure of Heat Removal (LLOCA)	8.9E-03
RSS-RHR-HRSL	Failure of Heat Removal (Other Initiating Events)	8.9E-03
RSS-RHR-HRSL-CHI	Failure of Heat Removal (VSLOCA)	8.9E-03
RSS-RHR-HRSL-LP1	Failure of Heat Removal (LOOP:LOSS OF OFFSITE POWER)	9.0E-03
RSS-RHR-HRSL-LP2	Failure of Heat Removal (LOOP)	8.9E-03
RSS-RHR-HRSL-PC	Failure of Heat Removal (PLOSW)	9.6E-03
CS/RHR System (Alternate Core Cooling)		
RSS-RHR-LM	Failure of Heat Removal (MLOCA)	8.8E-03
RSS-RHR-SG	Failure of Heat Removal (SGTR)	1.0E-02
RSS-RHR-SL	Failure of Heat Removal (Other Initiating Events)	8.8E-03
RSS-RHR-SL-CHI	Failure of Heat Removal (VSLOCA)	8.8E-03
RSS-RHR-SL-LP1	Failure of Heat Removal (LOOP:LOSS OF OFFSITE POWER)	8.9E-03
RSS-RHR-SL-LP2	Failure of Heat Removal (LOOP)	8.8E-03
RSS-RHR-SL-PC	Failure of Heat Removal (PLOSW)	9.5E-03
CS/RHR System (RHR Operation)		
RSS-RHR-HRSG	Failure of Heat Removal (SGTR)	1.0E-02
Emergency Feed Water System (EFW)		
EFW-LO-LP1	Failure of EFW (LOOP)	6.6E-05
EFW-LO-LP2	Failure of EFW (LOOP: SBO and loss of AAC)	1.7E-03
EFW-LO-LP3	Failure of EFW (LOOP: Total Loss of ac Power)	1.7E-03
EFW-SB	Failure of EFW (SLB Inside CV)	4.7E-04
EFW-SG	Failure of EFW (SGTR)	3.7E-05
EFW-SL	Failure of EFW (Other Initiating Events Including General Transients and Loss of Main Feed Water)	2.9E-05
EFW-SL-AC	Failure of EFW (LOAC)	3.9E-04
EFW-SLBO	Failure of EFW (SLB Outside CV)	3.2E-04
EFW-SL-DC	Failure of EFW (LODC)	1.2E-03
EFW-SL-LC	Failure of EFW (LOCWS)	1.7E-03
EFW-SL-PC	Failure of EFW (PLOCW)	3.9E-04

Table 19.1-17 Summary of US-APWR Front Line System Fault Tree Failure Probabilities

(Sheet 3 of 4)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
HHI System and Pressurizes Pressure Control System		
HPI-FAB	Failure of Bleed and Feed operation	4.1E-03
HPI-FAB-AC	Failure of Bleed and Feed operation (LOAC)	4.1E-03
HPI-FAB-DC	Failure of Bleed and Feed operation (LODC)	4.1E-03
HPI-FAB-LP1	Failure of Bleed and Feed operation (LOOP)	4.2E-03
HPI-FAB-LP2	Failure of Bleed and Feed operation (LOOP)	4.1E-03
Pressurizes Pressure Control System		
FAB	Failure of Bleed operation (Other Initiating Events)	2.7E-03
PZR-SGT	Failure of Decompress RCS (SGTR)	5.1E-03
Alternate Containment Cooling		
NCC	Failure of Alternate Containment Cooling (Other Initiating Events)	2.5E-02
NCC-AC	Failure of Alternate Containment Cooling (LOAC)	2.6E-02
NCC-DC	Failure of Alternate Containment Cooling (LODC)	2.5E-02
NCC-LL	Failure of Alternate Containment Cooling (LLOCA)	2.5E-02
NCC-LP1	Failure of Alternate Containment Cooling (LOOP)	2.6E-02
NCC-LP2	Failure of Alternate Containment Cooling (LOOP: No breakdown)	2.5E-02
NCC-PC	Failure of Alternate Containment Cooling (PLOCW)	5.5E-02
Secondary Side Cooling (Main Steam Control System and Emergency Feed Water System)		
MSP-LO-LP1	Failure of Secondary Side Cooling (LOOP : Emergency Power Success)	1.6E-02
MSP-LO-LP2	Failure of Secondary Side Cooling (LOOP : Emergency Power Success)	6.8E-03
MSP-SG	Failure of Secondary Side Cooling (SGTR)	2.6E-03
MSP-SL	Failure of Secondary Side Cooling (Other Initiating Events)	7.0E-03
MSP-SL-PC	Failure of Secondary Side Cooling (PLOCW)	5.3E-02
Reactor Trip		
RTA-AT	Failure of Reactor Trip (ATWS : exclude ROD and Digital)	3.0E-06
RTA-MF	Failure of Reactor Trip (Other Initiating Events)	1.3E-07
Main Steam isolation		
MSR-O-00	Failure of Main Steam isolation (SLBO)	6.2E-04
MSR-I-00	Failure of Main Steam isolation (SLBI, FWLB)	4.4E-07
Isolate Rupture SG		
MSP-OS	Failure of Isolate Rupture SG (SGTR)	7.0E-06

Table 19.1-17 Summary of US-APWR Front Line System Fault Tree Failure Probabilities

(Sheet 4 of 4)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
Class 1E GTG		
OPS	Failure of All Class 1E GTG (LOOP)	1.5E-03
Alternative GTG Power		
SDG	Failure of Alternative GTG Power (LOOP)	2.5E-02
Alternate CCW		
ACW	Failure of Alternate CCW	1.1E-02
ACW-LP1	Failure of Alternate CCW (LOOP)	1.2E-02
ACW-LP2	Failure of Alternate CCW (LOOP: Alternative GTG)	1.7E-02
SEC-PLOCW	Failure of Alternative GTG Power (LOCWS)	4.6E-03
CCW Re-Start		
CWS-R2	Failure of CCW Re-Start (Alternative GTG)	5.6E-03
CWS-R4-LP1	Failure of CCW Re-Start (LOOP)	1.7E-04
CWS-R4-LP2	Failure of CCW Re-Start (LOOP : No breakdown)	8.7E-05
Other Headings		
HIT	Failure of Injection Control (SGTR)	9.8E-03
MFW	Failure of Main Water System Recovery (TRANS ,LOAC, LODC)	1.0E-01
RCP-SEAL	RCP Seal LOCA Occurs	1.0E+00
POV	Safety Relief Valve LOCA Occurs	2.8E-04
PRB	Failure of Power Recovery (1 hour) (LOOP)	5.3E-01
PRC	Failure of Power Recovery (3 hours) (LOOP)	4.1E-01
IE-CCW-SWS	LOCWS IE (LOCWS)	2.3E-05
DAS	Failure of Reactor Trip (by Diverse Actuation System fail)	1.0E-02
MTC	Moderator Temperature Coefficient	1.0E-01
ROD	Failure of Reactor Trip (by Control Rod insert fail)	1.0E-07
SCF	Failure of Reactor Trip (by Digital System fail)	1.0E-07

Table 19.1-18 Summary of US-APWR Support System Fault Tree Failure Probabilities

(Sheet 1 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
RWSP		
RWS	RWSP	1.1E-05
RWS-CHI	RWSP (VSLOCA)	1.1E-05
Heating Ventilation and Conditioning System		
HVA-EFW-A	EFW area HVAC A Train	3.7E-02
HVA-EFW-B	EFW area HVAC B Train	1.1E-02
Component Cooling Water System		
CWS-00A	A Train	7.5E-04
CWS-00B	B Train	2.9E-02
CWS-00C	C Train	9.5E-04
CWS-00D	D Train	2.9E-02
CWS-VS-00A1	Charging Pump Cooling A Train	6.1E-05
CWS-VS-00C1	Charging Pump Cooling C Train	6.7E-05
Essential Service Water System		
SWS-01A	A Train	6.1E-04
SWS-01B	B Train	1.5E-02
SWS-01C	C Train	8.2E-04
SWS-01D	D Train	1.5E-02
S SIGNAL		
SGN-SA	A Train	3.6E-04
SGN-SB	B Train	3.7E-04
SGN-SC	C Train	3.7E-04
SGN-SD	D Train	3.6E-04
P SIGNAL		
SGN-PA	A Train	3.8E-04
SGN-PB	B Train	3.8E-04
SGN-PC	C Train	3.8E-04
SGN-PD	D Train	3.8E-04

Table 19.1-18 Summary of US-APWR Support System Fault Tree Failure Probabilities

(Sheet 2 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
6.9kV ac Emergency Power Bus		
EPS-69KA	A Train	2.5E-05
EPS-69KB	B Train	2.3E-04
EPS-69KC	C Train	2.3E-04
EPS-69KD	D Train	2.5E-05
6.9kV ac Permanent Power Bus		
EPS-69KA-P1	P1-A Train	4.3E-02
EPS-69KD-P2	P2-D Train	4.3E-02
480V ac Emergency Power Bus		
EPS-480A	A Train	4.3E-05
EPS-480B	B Train	2.5E-04
EPS-480C	C Train	2.5E-04
EPS-480D	D Train	4.3E-05
480V ac Permanent Power Bus		
EPS-480A-P1	P1-A Train	4.3E-02
EPS-480D-P2	P2-D Train	4.3E-02
480V ac Swing Power Bus		
EPS-48A1	A1Train	5.2E-05
EPS-48D1	D1 Train	5.2E-05
Motor Control Center Power Bus		
EPS-MCA1	A1 Train	5.2E-05
EPS-MCA2	A2 Train	5.2E-05
EPS-MCB1	B1 Train	2.6E-04
EPS-MCB2	B2 Train	2.6E-04
EPS-MCC1	C1 Train	2.6E-04
EPS-MCC2	C2 Train	2.6E-04
EPS-MCD1	D1 Train	5.2E-05
EPS-MCD2	D2 Train	5.2E-05
Motor Control Center Permanent Power Bus		
EPS-MCA1-P1	P1-A Train	4.3E-02
EPS-MCD1-P2	P2-D Train	4.3E-02

Table 19.1-18 Summary of US-APWR Support System Fault Tree Failure Probabilities

(Sheet 3 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
125V DC Emergency Power Bus		
EPS-DCA	A Train	5.8E-06
EPS-DCB	B Train	5.8E-06
EPS-DCC	C Train	5.8E-06
EPS-DCD	D Train	5.8E-06
125V DC Permanent Power Bus		
EPS-DCA-P1	P1-A Train	4.3E-02
EPS-DCD-P2	P2-D Train	4.3E-02
120V ac VILTAL Bus		
EPS-VITALA	A Train	6.5E-06
EPS-VITALB	B Train	6.5E-06
EPS-VITALC	C Train	6.5E-06
EPS-VITALD	D Train	6.5E-06
120V ac VILTAL Bus (No VITAL POWER)		
EPS-VITALA-L	A Train	1.4E-04
EPS-VITALB-L	B Train	1.4E-04
EPS-VITALC-L	C Train	1.4E-04
EPS-VITALD-L	D Train	1.4E-04
125V DC Permanent Power Bus (No VITAL POWER)		
EPS-VITALP1-L	P1-A Train	1.4E-04
EPS-VITALP2-L	P2-D Train	1.4E-04
6.9kV ac PERMANENT BUS		
EPS-P1-69K	P1 Train	2.3E-04
EPS-P2-69K	P2 Train	2.3E-04
480V ac PERMANENT BUS		
EPS-P1-480	P1 Train	2.5E-04
EPS-P2-480	P2 Train	2.5E-04

Table 19.1-19 Core Damage for At-Power Events Contribution of Initiating Events to Plant Core Damage Frequency

Initiating Event	Initiating Event Description	CDF (/RY)	Percent Contribution
LLOCA	Large Pipe Break LOCA	4.7E-10	0.0%
MLOCA	Medium Pipe Break LOCA	1.6E-08	1.4%
SLOCA	Small Pipe Break LOCA	7.8E-08	6.6%
VSLOCA	Very Small Pipe Break LOCA	8.1E-10	0.1%
SGTR	Steam Generator Tube Rupture	6.7E-09	0.6%
RVR	Reactor Vessel Rupture	1.0E-07	8.5%
SLBO	Steam Line Break/Leak (Downstream MSIV : Turbine side)	1.8E-08	1.6%
SLBI	Steam Line Break/Leak (Upstream MSIV : CV side)	1.4E-09	0.1%
FWLB	Feed-water Line Break	4.6E-09	0.4%
TRANS	General Transient	1.4E-08	1.2%
LOFF	Loss of Feed-water Flow	2.3E-08	1.9%
LOCCW	Loss of Component Cooling Water	3.0E-07	25.6%
PLOCW	Partial Loss of Component Cooling Water	1.6E-08	1.3%
LOOP	Loss of Offsite Power	5.8E-07	49.3%
ATWS	ATWS	1.4E-08	1.2%
LOAC	Loss of Vital ac Bus	2.2E-09	0.2%
LODC	Loss of Vital DC Bus	9.1E-10	0.1%
TOTALS=		1.2E-06	

Table 19.1-20 Core Damage for At-Power Events – Conditional Core Damage Probability Given Initiating Event Occurrence

	Initiating Event	CDF (/RY)	Percent Contribution	Initiating Event Frequency	Conditional CDF
1	LOOP	5.8E-07	49.3%	4.0E-02	1.5E-05
2	LOCCW	3.0E-07	25.6%	2.3E-05	1.3E-02
3	RVR	1.0E-07	8.5%	1.0E-07	1.0E+00
4	SLOCA	7.8E-08	6.6%	3.6E-03	2.2E-05
5	LOFF	2.3E-08	1.9%	1.9E-01	1.2E-07
6	SLBO	1.8E-08	1.6%	1.0E-02	1.8E-06
7	MLOCA	1.6E-08	1.4%	5.0E-04	3.2E-05
8	PLOCW	1.6E-08	1.3%	3.2E-03	4.8E-06
9	TRANS	1.4E-08	1.2%	8.0E-01	1.8E-08
10	ATWS	1.4E-08	1.2%	1.0E+00	1.4E-08
11	SGTR	6.7E-09	0.6%	4.0E-03	1.7E-06
12	FWLB	4.6E-09	0.4%	3.4E-03	1.4E-06
13	LOAC	2.2E-09	0.2%	9.0E-03	2.4E-07
14	SLBI	1.4E-09	0.1%	1.0E-03	1.4E-06
15	LODC	9.1E-10	0.1%	1.2E-03	7.8E-07
16	VSLOCA	8.1E-10	0.1%	1.5E-03	5.4E-07
17	LLOCA	4.7E-10	0.0%	1.2E-06	3.9E-04
TOTAL		1.2E-06		2.1E+00	

Table 19.1-21 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 1 of 4)

Number	Sequence ID	Sequence Name	Sequence Frequency (/ry)	Percent Contrib.	Percent Contrib. Total
1	19LOOP_C-0048	19LOOP_C-OPS-ADG-PRB-PRC-SEL	5.0E-07	42.1%	42.1%
2	15LOCCW-0003	15LOCCW-SCA-SEL	2.6E-07	21.6%	63.7%
3	07RVR-0001	07RVR	1.0E-07	8.5%	72.2%
4	19LOOP_A-0004	19LOOP_A-CWR-SCO1-SEL	6.2E-08	5.3%	77.5%
5	03SLOCA-0027	03SLOCA-HIB-CSA-CRB	4.2E-08	3.6%	81.0%
6	15LOCCW-0006	15LOCCW-EFA-SEL	4.0E-08	3.4%	84.4%
7	14LOFF-0007	14LOFF-EFA-FBA	2.3E-08	1.9%	86.3%
8	10SLBO-0017	10SLBO-MSO-BLA	1.7E-08	1.4%	87.7%
9	03SLOCA-0012	03SLOCA-HIB-SRA	1.5E-08	1.3%	88.9%
10	13TRANS-0008	13TRANS-EFA-MFW-FBA1	1.4E-08	1.2%	90.2%
11	19LOOP_A-0048	19LOOP_A-EFO-FBA2	1.2E-08	1.1%	91.2%
12	20ATWS-0008	20ATWS-ROD-MTC	1.0E-08	0.85%	92.1%
13	03SLOCA-0003	03SLOCA-CXB-FNA2	8.6E-09	0.73%	92.8%
14	15LOCCW-0004	15LOCCW-SRV	6.4E-09	0.55%	93.3%
15	03SLOCA-0017	03SLOCA-HIB-CRB	6.2E-09	0.53%	93.9%
16	02MLOCA-0036	02MLOCA-HIB-CSA-CRD	5.8E-09	0.49%	94.4%
17	16PLOCW-0012	16PLOCW-SCK-SEL-CSA-CRB2-FNA7	5.1E-09	0.43%	94.8%
18	12FWLB-0007	12FWLB-EFD-BLA	4.3E-09	0.37%	95.2%
19	03SLOCA-0010	03SLOCA-CSA-CRB-FNA2	4.2E-09	0.36%	95.5%
20	02MLOCA-0026	02MLOCA-HIB-CRD	3.8E-09	0.32%	95.8%
21	16PLOCW-0082	16PLOCW-EFA-BLA	3.3E-09	0.28%	96.1%
22	02MLOCA-0011	02MLOCA-ACA	3.2E-09	0.27%	96.4%
23	20ATWS-0004	20ATWS-RPS-DAS-MTC	3.0E-09	0.25%	96.6%
24	03SLOCA-0028	03SLOCA-HIB-CSA-CRB-FNA2	2.8E-09	0.24%	96.9%
25	19LOOP_B-0005	19LOOP_B-OPS-CWR-SCO1-SEL	2.4E-09	0.21%	97.1%

Table 19.1-21 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 2 of 4)

Number	Sequence ID	Sequence Name	Sequence Frequency (/ry)	Percent Contrib.	Percent Contrib. Total
26	21LOAC-0008	21LOAC-EFA-MFW-FBA1	2.1E-09	0.18%	97.3%
27	19LOOP_D-0017	19LOOP_D-OPS-ADG-EFO-PRB-SEL	2.1E-09	0.18%	97.4%
28	05SGTR-0011	05SGTR-SGI-HT	1.9E-09	0.16%	97.6%
29	19LOOP_D-0015	19LOOP_D-OPS-ADG-EFO-CWR-SEL	1.9E-09	0.16%	97.8%
30	05SGTR-0012	05SGTR-SGI-PZR	1.8E-09	0.15%	97.9%
31	05SGTR-0013	05SGTR-SGI-SRB	1.7E-09	0.14%	98.1%
32	16PLOCW-0014	16PLOCW-SCK-SEL-HIC-SRA2	1.7E-09	0.14%	98.2%
33	16PLOCW-0087	16PLOCW-EFA-HIC	1.6E-09	0.13%	98.3%
34	02MLOCA-0021	02MLOCA-HIB-SRA	1.3E-09	0.11%	98.4%
35	11SLBI-0007	11SLBI-EFD-BLA	1.3E-09	0.11%	98.6%
36	02MLOCA-0003	02MLOCA-CXC-FNA1	1.2E-09	0.10%	98.7%
37	19LOOP_A-0042	19LOOP_A-SRV-CWR	1.0E-09	0.09%	98.7%
38	20ATWS-0006	20ATWS-SCF-DAS	1.0E-09	0.08%	98.8%
39	22LODC-0008	22LODC-EFA-MFW-FBA1	9.0E-10	0.08%	98.9%
40	16PLOCW-0030	16PLOCW-SCK-SEL-HIC-CSA-CRB2-FNA7	8.6E-10	0.07%	99.0%
41	05SGTR-0010	05SGTR-SGI-CRA-BLA1	8.5E-10	0.07%	99.1%
42	10SLBO-0007	10SLBO-EFB-BLA	8.4E-10	0.07%	99.1%
43	10SLBO-0028	10SLBO-HIC-MSO	8.0E-10	0.07%	99.2%
44	16PLOCW-0005	16PLOCW-SCK-SEL-CXB2-FNA7	7.9E-10	0.07%	99.3%
45	16PLOCW-0019	16PLOCW-SCK-SEL-HIC-CRB2	6.7E-10	0.06%	99.3%
46	04VSLOCA-0020	04VSLOCA-CHI-HIF-CSA-CRB1-FNA5	6.7E-10	0.06%	99.4%
47	02MLOCA-0010	02MLOCA-CSA-CRD-FNA1	5.9E-10	0.05%	99.4%
48	16PLOCW-0081	16PLOCW-EFA-CSA-FNA7	5.1E-10	0.04%	99.5%
49	19LOOP_A-0054	19LOOP_A-EFO-CWR-SEL	4.6E-10	0.04%	99.5%
50	01LLOCA-0021	01LLOCA-HIA-CRC	4.3E-10	0.04%	99.5%

Table 19.1-21 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 3 of 4)

Number	Sequence ID	Sequence Name	Sequence Frequency (/ry)	Percent Contrib.	Percent Contrib. Total
51	19LOOP_B-0049	19LOOP_B-OPS-EFO-FBA2	4.2E-10	0.04%	99.6%
52	05SGTR-0019	05SGTR-EFC-BLA1	4.0E-10	0.03%	99.6%
53	02MLOCA-0037	02MLOCA-HIB-CSA-CRD-FNA1	3.9E-10	0.03%	99.6%
54	19LOOP_C-0087	19LOOP_C-OPS-ADG-SRV-PRB	3.4E-10	0.03%	99.7%
55	16PLOCW-0029	16PLOCW-SCK-SEL-HIC-CSA-CRB2	3.2E-10	0.03%	99.7%
56	16PLOCW-0049	16PLOCW-SRV-CSA-CRB2-FNA7	3.1E-10	0.03%	99.7%
57	03SLOCA-0043	03SLOCA-EFA-BLA	2.8E-10	0.02%	99.7%
58	12FWLB-0023	12FWLB-HIC-EFD	2.1E-10	0.02%	99.8%
59	19LOOP_B-0055	19LOOP_B-OPS-EFO-CWR-SEL	1.9E-10	0.02%	99.8%
60	14LOFF-0011	14LOFF-EFA-FBA-CSA-FNA3	1.9E-10	0.02%	99.8%
61	16PLOCW-0095	16PLOCW-EFA-HIC-CSA-CRB2-FNA7	1.8E-10	0.02%	99.8%
62	19LOOP_A-0047	19LOOP_A-EFO-CSA-FNA9	1.4E-10	0.01%	99.8%
63	14LOFF-0010	14LOFF-EFA-FBA-CSA	1.4E-10	0.01%	99.8%
64	19LOOP_A-0031	19LOOP_A-SRV-HIK-CSA-CRB3	1.3E-10	0.01%	99.8%
65	04VSLOCA-0035	04VSLOCA-EFA-BLA	1.2E-10	0.01%	99.9%
66	03SLOCA-0006	03SLOCA-CSA-SRA-FNA2	9.4E-11	0.01%	99.9%
67	19LOOP_C-0046	19LOOP_C-OPS-ADG-PRB-CWR-SEL	9.4E-11	0.01%	99.9%
68	13TRANS-0012	13TRANS-EFA-MFW-FBA1-CSA-FNA4	8.1E-11	0.01%	99.9%
69	10SLBO-0031	10SLBO-HIC-MSO-CSA	7.8E-11	0.01%	99.9%
70	16PLOCW-0051	16PLOCW-SRV-HIC-SRA2	7.2E-11	0.01%	99.9%
71	19LOOP_A-0016	19LOOP_A-SRV-HIK-SRA4	6.7E-11	0.01%	99.9%
72	16PLOCW-0079	16PLOCW-EFA-CXB2-FNA7	6.7E-11	0.01%	99.9%
73	11SLBI-0023	11SLBI-HIC-EFD	6.1E-11	0.01%	99.9%
74	19LOOP_A-0051	19LOOP_A-EFO-FBA2-CSA	6.1E-11	0.01%	99.9%
75	16PLOCW-0008	16PLOCW-SCK-SEL-CSA-SRA2-FNA7	6.1E-11	0.01%	99.9%

Table 19.1-21 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 4 of 4)

Number	Sequence ID	Sequence Name	Sequence Frequency (/ry)	Percent Contrib.	Percent Contrib. Total
76	13TRANS-0011	13TRANS-EFA-MFW-FBA1-CSA	5.9E-11	0.01%	99.9%
77	16PLOCW-0067	16PLOCW-SRV-HIC-CSA-CRB2-FNA7	5.1E-11	0.004%	99.9%
78	19LOOP_A-0052	19LOOP_A-EFO-FBA2-CSA-FNA9	4.6E-11	0.004%	99.9%
79	10SLBO-0016	10SLBO-MSO-CSA-FNA6	4.5E-11	0.004%	99.9%
80	16PLOCW-0042	16PLOCW-SRV-CXB2-FNA7	4.5E-11	0.004%	99.9%
81	03SLOCA-0048	03SLOCA-EFA-HIB	4.4E-11	0.004%	99.9%
82	14LOFF-0006	14LOFF-EFA-CSA-FNA3	4.2E-11	0.004%	99.9%
83	10SLBO-0023	10SLBO-HIC-EFB	4.1E-11	0.003%	100.0%
84	19LOOP_A-0014	19LOOP_A-SRV-CSA-CRB3-FNA9	3.3E-11	0.003%	100.0%
85	05SGTR-0023	05SGTR-HIC-EFC	3.1E-11	0.003%	100.0%
86	19LOOP_B-0043	19LOOP_B-OPS-SRV-CWR	3.0E-11	0.003%	100.0%
87	19LOOP_A-0007	19LOOP_A-SRV-CXB3-FNA9	2.9E-11	0.002%	100.0%
88	16PLOCW-0094	16PLOCW-EFA-HIC-CSA-CRB2	2.6E-11	0.002%	100.0%
89	12FWLB-0026	12FWLB-HIC-EFD-CSA	2.1E-11	0.002%	100.0%
90	19LOOP_A-0045	19LOOP_A-EFO-CXB3-FNA9	2.0E-11	0.002%	100.0%
91	16PLOCW-0066	16PLOCW-SRV-HIC-CSA-CRB2	1.9E-11	0.002%	100.0%
92	13TRANS-0007	13TRANS-EFA-MFW-CSA-FNA4	1.9E-11	0.002%	100.0%
93	01LLOCA-0027	01LLOCA-HIA-CSA-CRC	1.6E-11	0.001%	100.0%
94	10SLBO-0014	10SLBO-MSO-CXA-FNA6	1.5E-11	0.001%	100.0%
95	12FWLB-0006	12FWLB-EFD-CSA-FNA6	1.4E-11	0.001%	100.0%
96	16PLOCW-0016	16PLOCW-SCK-SEL-HIC-CXB2-FNA7	1.4E-11	0.001%	100.0%
97	14LOFF-0004	14LOFF-EFA-CXA-FNA3	1.3E-11	0.001%	100.0%
98	02MLOCA-0006	02MLOCA-CSA-SRA-FNA1	1.3E-11	0.001%	100.0%
99	19LOOP_A-0021	19LOOP_A-SRV-HIK-CRB3	1.3E-11	0.001%	100.0%
100	10SLBO-0032	10SLBO-HIC-MSO-CSA-FNA6	1.2E-11	0.001%	100.0%

Table 19.1-22 Event Heading ID List (Sheet 1 of 5)

Event Heading ID	Event Heading Description
LLOCA	Occurrence of LLOCA (Large Pipe Break LOCA)
MLOCA	Occurrence of MLOCA (Medium Pipe Break LOCA)
SLOCA	Occurrence of SLOCA (Small Pipe Break LOCA)
VSLOCA	Occurrence of VSLOCA (Very Small Pipe Break LOCA)
SGTR	Occurrence of SGTR (Steam Generator Tube Rupture)
RVR	Occurrence of RVR (Reactor Vessel Rupture)
SLBO	Occurrence of SLBO (Steam Line Break/Leak-Downstream MSIV : Turbine side)
SLBI	Occurrence of SLBI (Steam Line Break/Leak − Upstream MSIV : CV side)
FWLB	Occurrence of FWLB (Feed-water Line Break)
TRANS	Occurrence of TRANS (General Transient)
LOFF	Occurrence of LOFF (Loss of Feed-water Flow)
LOCCW	Occurrence of LOCCW (Loss of Component Cooling Water)
PLOCW	Occurrence of PLOCW (Partial Loss of Component Cooling Water)
LOOP	Occurrence of Loss of Offsite Power
AT	Occurrence of Anticipated Transient
LOAC	Occurrence of Loss of Vital ac Bus
LODC	Occurrence of Loss of Vital DC Bus

Table 19.1-22 Event Heading ID List (Sheet 2 of 5)

Event Heading ID	Event Heading Description
Accumulator Tank Injection System (ACC)	
ACA	Failure of ACC (LLOCA,MLOCA)
ACC	Failure of ACC (Other Initiating Events)
High Head Safety Injection System (HHIS)	
HIA	Failure of SIS (LLOCA)
HIB	Failure of SIS (MLOCA, SLOCA)
HIC	Failure of SIS (Other Initiating Events)
HIF	Failure of SIS (VSLOCA)
HIK	Failure of SIS (LOOP)
HIL	Failure of SIS (LOOP : No breakdown)
Charging Injection System	
CHI	Failure of CIS (VSLOCA)
Containment Spray System/Residual Heat Removal System (RSS) (CV Spray Injection)	
CSA	Failure of CV Spray Injection (Other Initiating Events)
Containment Spray System/Residual Heat Removal System (RSS) (Heat Removal)	
CXA	Failure of Heat Removal (Other Initiating Events)
CXB	Failure of Heat Removal (SLOCA)
CXB1	Failure of Heat Removal (VSLOCA)
CXB2	Failure of Heat Removal (PLOCW)
CXB3	Failure of Heat Removal (LOOP)
CXC	Failure of Heat Removal (LLOCA,MLOCA)
CXD	Failure of Heat Removal (SGTR)
Containment Spray System/Residual Heat Removal System (RSS) (Alternate Core Cooling)	
CRB	Failure of Alternate Core Cooling (SLOCA)
CRB1	Failure of Alternate Core Cooling (VSLOCA)
CRB2	Failure of Alternate Core Cooling (PLOCW)
CRB3	Failure of Alternate Core Cooling (LOOP)
CRC	Failure of Alternate Core Cooling (LLOCA)
CRD	Failure of Alternate Core Cooling (MLOCA)

Table 19.1-22 Event Heading ID List (Sheet 3 of 5)

Event Heading ID	Event Heading Description
Containment Spray System/Residual Heat Removal System (RSS) (RHR Mode)	
CRA	Failure of RHR Operation (SGTR)
Emergency Feed Water System (EFW)	
EFA	Failure of EFW (Other Initiating Events)
EFB	Failure of EFW (SLBO)
EFC	Failure of EFW (SGTR)
EFD	Failure of EFW (SLBI,FWLB)
EFO	Failure of EFW (LOOP)
Pressurizes Pressure Control System and Safety Injection System	
FBA	Failure of Feed and Bleed operation (LOFF)
FBA1	Failure of Feed and Bleed operation (Other Initiating Events)
FBA2	Failure of Feed and Bleed operation (LOOP)
Pressurizes Pressure Control System	
PZR	Failure of Decompress RCS (SGTR)
BLA	Failure of Bleed operation (Other Initiating Events)
BLA1	Failure of Bleed operation (SGTR)
Alternate CV Cooling	
FNA	Failure of Alternate CV Cooling (LLOCA)
FNA1	Failure of Alternate CV Cooling (MLOCA)
FNA2	Failure of Alternate CV Cooling (SLOCA)
FNA3	Failure of Alternate CV Cooling (LOFF)
FNA4	Failure of Alternate CV Cooling (LOAC,LOAD,TRANS)
FNA5	Failure of Alternate CV Cooling (VSLOCA)
FNA6	Failure of Alternate CV Cooling (SLBO,SLBI,FWLB)
FNA7	Failure of Alternate CV Cooling (PLOCW)
FNA8	Failure of Alternate CV Cooling (SGTR)
FNA9	Failure of Alternate CV Cooling (LOOP)

Table 19.1-22 Event Heading ID List (Sheet 4 of 5)

Event Heading ID	Event Heading Description
Secondary Side Cooling (Main Steam Control System and Emergency Feed Water System)	
SRA	Failure of Secondary Side Cooling (MLOCA,SLOCA)
SRA1	Failure of Secondary Side Cooling (VSLOCA)
SRA2	Failure of Secondary Side Cooling (PLOCW)
SRA4	Failure of Secondary Side Cooling (LOOP)
SRB	Failure of Secondary Side Cooling (SGTR)
Reactor Trip	
RTA	Failure of Reactor Trip (Other Initiating Events)
RPS	Failure of Reactor Trip (ATWS : exclude ROD and Digital)
Main Steam isolation	
MSO	Failure of Main Steam isolation (SLBO)
MSI	Failure of Main Steam isolation (SLBI, FWLB)
Isolate Rupture SG	
SGI	Failure of Isolate Rupture SG (SGTR)
Emergency Power Source	
OPS	Failure of Class 1E GTG (LOOP)
Alternate ac Power Source	
ADG	Failure of non- Class 1E GTG (LOOP)
Alternate CCW	
SCA	Failure of RCP Seal Cooling (LOCCW)
SEO1	Failure of RCP Seal Cooling (LOOP)
SEK	Failure of RCP Seal Cooling (PLOCW)

Table 19.1-22 Event Heading ID List (Sheet 5 of 5)

Event Heading ID	Event Heading Description
Other Headings	
CWR	CCW RE-START FAIL (LOOP)
HT	Failure of Injection Control (SGTR)
MFW	Failure of Main Water System Recovery (TRANS, LOAC, LODC)
SEL	RCP Seal LOCA Occurs
SRV	Safety Relief Valve LOCA Occurs
PRB	Failure of Power Recovery (1 hour) (LOOP)
PRC	Failure of Power Recovery (3 hours) (LOOP)
DAS	Failure of Reactor Trip (due to Diverse Actuation System failure)
MTC	Moderator Temperature Coefficient
ROD	Failure of Reactor Trip (by Control Rod insert fail)
SCF	Failure of Reactor Trip (by Software CCF)

Table 19.1-23 US-APWR PRA Dominant Cutsets (Sheet 1 of 7)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
1	2.3E-07	19.7	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			RCP----SEAL	RCP SEAL LOCA
2	1.8E-07	15.2	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
3	1.7E-07	14.8	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
4	1.0E-07	8.5	!07RVR	REACTOR VESSEL RUPTURE
5	3.8E-08	3.2	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
6	3.5E-08	3.0	!03SLOCA	SMALL PIPE BREAK LOCA
			RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-23 US-APWR PRA Dominant Cutsets (Sheet 2 of 7)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
7	2.8E-08	2.4	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
8	1.9E-08	1.6	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF
9	1.3E-08	1.1	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
10	1.1E-08	0.90	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF
			RCP----SEAL	RCP SEAL LOCA
11	1.0E-08	0.89	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWCF2PTADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-23 US-APWR PRA Dominant Cutsets (Sheet 3 of 7)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
12	1.0E-08	0.85	!20ATWS	ATWS
			RTPCRDF	ROD INJECTION FAILURE (4< RODS)
			RTPMTCF	MODERATOR TEMPERATURE COEFFICIENT
13	7.6E-09	0.65	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)
			RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
14	6.8E-09	0.58	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4SEFFDG-ALL	GAS TURBINE GENERATOR SEQUENCER FAIL TO OPERATE CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
15	4.9E-09	0.41	!02MLOCA	MEDIUM PIPE BREAK LOCA
			RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF
16	4.7E-09	0.40	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			CHICF2PMBD-R-ALL	CHARGING PUMP FAIL TO START CCF
			RCP----SEAL	RCP SEAL LOCA
17	4.5E-09	0.39	!10SLBO	STEAM LINE BREAK/LEAK (TURBINE SIDE)
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
18	4.0E-09	0.34	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			BOSBTSWCCF	B.O SIGNAL SOFTWARE CCF
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-23 US-APWR PRA Dominant Cutsets (Sheet 4 of 7)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
19	3.6E-09	0.31	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBTDDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO CLOSE CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
20	3.6E-09	0.31	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			ACWTMPZCLTP	COOLING TOWER PUMP OUTAGE
			RCP----SEAL	RCP SEAL LOCA
21	3.5E-09	0.30	!12FWLB	FEED WATER LINE BREAK
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			SGNST-SGIA	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) ISOLATION SIGNAL A FAILURE
22	3.4E-09	0.29	!03SLOCA	SMALL PIPE BREAK LOCA
			HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF
			RSSOO02LNUP	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CORE COOLING (HE)
23	3.0E-09	0.26	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			RCP----SEAL	RCP SEAL LOCA
24	3.0E-09	0.26	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-23 US-APWR PRA Dominant Cutsets (Sheet 5 of 7)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
25	3.0E-09	0.25	!20ATWS	ATWS
			RTPBTRTB	TRIP BREAKER CCF
			RTPDASF	DAS HARD FAILURE
			RTPMTCF	MODERATOR TEMPERATURE COEFFICIENT
26	2.7E-09	0.23	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
27	2.6E-09	0.22	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSDLLRDGP1-L2	AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H)
			EPSDLLRDGP2-L2	AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
28	2.6E-09	0.22	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLADDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO START CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
29	2.6E-09	0.22	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWCF2PTSRFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO RUN (<1H) CCF
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-23 US-APWR PRA Dominant Cutsets (Sheet 6 of 7)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
30	2.5E-09	0.21	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
			SWSTMPESWPB	ESW PUMP-B OUTAGE
31	2.3E-09	0.19	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			RCP----SEAL	RCP SEAL LOCA
32	2.3E-09	0.19	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAB	D-EMERGENCY FEED WATER PUMP(FWP1B) OUTAGE
			RCP----SEAL	RCP SEAL LOCA
33	2.0E-09	0.17	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLSRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (<1H) CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
34	2.0E-09	0.17	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-23 US-APWR PRA Dominant Cutsets (Sheet 7 of 7)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
35	1.8E-09	0.16	!02MLOCA	MEDIUM PIPE BREAK LOCA
			RWSCF4SUPRST01-234	RWSP SUMP STRAINER PLUG CCF
36	1.8E-09	0.15	!19LOOP	LOSS OF OFFSITE POWER
			EPSBTSWCCF	EPS SOFTWARE CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
37	1.8E-09	0.15	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSDLLRDGP1-L2	AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H)
			EPSTMDGP2	AAC GAS TURBINE GENERATOR (GTG P2) OUTAGE
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
38	1.8E-09	0.15	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSDLLRDGP2-L2	AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H)
			EPSTMDGP1	AAC GAS TURBINE GENERATOR (GTG P1) OUTAGE
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
39	1.7E-09	0.15	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)
			RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF
40	1.7E-09	0.15	!14LOFF	LOSS OF FEED WATER FLOW
			EFWCF2CVODEFW03-ALL	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Table 19.1-24 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 1 of 5)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.8E-07	36.0	!19LOOP EPSCF4DLLRDG-ALL EPSOO02RDG OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
2	1.7E-07	35.0	!19LOOP EPSCF4CBTD6H-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER 6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
3	3.8E-08	7.7	!19LOOP EPSCF4DLADDG-ALL EPSOO02RDG OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
4	2.8E-08	5.7	!19LOOP EPSCF4DLSRDG-ALL EPSOO02RDG OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA

Table 19.1-24 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 2 of 5)

No.	Cut Sets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
5	1.3E-08	2.5	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
6	6.8E-09	1.4	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4SEFFDG-ALL	GAS TURBINE GENERATOR SEQUENCER FAIL TO OPERATE CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
7	3.6E-09	0.73	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBTDDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO CLOSE CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
8	2.7E-09	0.54	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-24 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 3 of 5)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
9	2.6E-09	0.53	!19LOOP EPSCF4DLLRDG-ALL EPSDLLRDGP1-L2 EPSDLLRDGP2-L2 OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H) AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
10	2.6E-09	0.52	!19LOOP EPSCF2DLADDGP-ALL EPSCF4DLLRDG-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO START CCF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
11	2.0E-09	0.40	!19LOOP EPSCF2DLSRDGP-ALL EPSCF4DLLRDG-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (<1H) CCF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
12	2.0E-09	0.40	!19LOOP EPSCF2DLLRDGP-ALL EPSCF4DLSRDG-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA

Table 19.1-24 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 4 of 5)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
13	1.8E-09	0.36	!19LOOP EPSBTSWCCF EPSOO02RDG OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EPS SOFTWARE CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
14	1.8E-09	0.36	!19LOOP EPSCF4DLLRDG-ALL EPSDLLRDGP2-L2 EPSTMDGP1 OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H) AAC GAS TURBINE GENERATOR (GTG P1) OUTAGE FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
15	1.8E-09	0.36	!19LOOP EPSCF4DLLRDG-ALL EPSDLLRDGP1-L2 EPSTMDGP2 OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H) AAC GAS TURBINE GENERATOR (GTG P2) OUTAGE FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
16	1.2E-09	0.24	!19LOOP EPSCF2SEFFDGP-ALL EPSCF4DLLRDG-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER SEQUENCER FAIL TO OPERATE CCF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA

Table 19.1-24 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 5 of 5)

No.	Cut Sets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
17	7.4E-10	0.15	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSDLLRDGB	EMERGENCY GAS TURBINE GENERATOR (GTG B) FAIL TO RUN (>1H)
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
18	7.4E-10	0.15	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-124	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSDLLRDGC	EMERGENCY GAS TURBINE GENERATOR (GTG C) FAIL TO RUN (>1H)
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
19	7.4E-10	0.15	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-123	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSDLLRDGD	EMERGENCY GAS TURBINE GENERATOR (GTG D) FAIL TO RUN (>1H)
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
20	7.4E-10	0.15	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-234	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSDLLRDGA	EMERGENCY GAS TURBINE GENERATOR (GTG A) FAIL TO RUN (>1H)
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-25 LOCCW with Reactor Trip Sequence Dominant Cutsets (Sheet 1 of 3)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
1	2.3E-07	90.5	!15LOCCW ACWOO02CT-DP2 ACWOO02FS RCP----SEAL	LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE) OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) RCP SEAL LOCA
2	4.7E-09	1.8	!15LOCCW CHICF2PMBD-R-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER CHARGING PUMP FAIL TO START CCF RCP SEAL LOCA
3	3.6E-09	1.4	!15LOCCW ACWOO02FS ACWTMPZCLTP RCP----SEAL	LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) COOLING TOWER PUMP OUTAGE RCP SEAL LOCA
4	1.1E-09	0.42	!15LOCCW ACWCF2MVODCH4-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER FIRE SUPPRESSION SYSTEM BOUNDARY M/V ACWCH4A,B FAILTO OPEN CCF RCP SEAL LOCA
5	1.1E-09	0.42	!15LOCCW ACWCF2MVODCH6-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER CHI PUMP COOLING DISCHARGE LINE M/V ACWCH6A,B FAILTO OPEN CCF RCP SEAL LOCA
6	1.1E-09	0.42	!15LOCCW ACWCF2MVODCH2-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER FIRE SUPPRESSION SYSTEM BOUNDARY M/V ACWCH2A,B FAILTO OPEN CCF RCP SEAL LOCA
7	6.8E-10	0.27	!15LOCCW ACWOO02FS ACWPMADCLTP RCP----SEAL	LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) COOLING TOWER PUMP FAIL TO START (Standby) RCP SEAL LOCA

Table 19.1-25 LOCCW with Reactor Trip Sequence Dominant Cutsets (Sheet 2 of 3)

No.	Cut Sets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
8	5.5E-10	0.22	!15LOCCW CHIORPRRC1D RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG RCP SEAL LOCA
9	5.5E-10	0.22	!15LOCCW CHIORPROR02 RCP----SEAL	LOSS OF COMPONENT COOLING WATER CHARGING FLOW CONTROL ORIFICE OR02 PLUG RCP SEAL LOCA
10	5.5E-10	0.22	!15LOCCW CHIORPRRC1A RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG RCP SEAL LOCA
11	5.5E-10	0.22	!15LOCCW CHIORPRRC1C RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG RCP SEAL LOCA
12	5.5E-10	0.22	!15LOCCW CHIORPRRC1B RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG RCP SEAL LOCA
13	5.5E-10	0.22	!15LOCCW CHIORPRFE138 RCP----SEAL	LOSS OF COMPONENT COOLING WATER CHARGING LINE ORIFICE FE138 PLUG RCP SEAL LOCA
14	3.3E-10	0.13	!15LOCCW CHIPMBDCHPA-R CHITMPZCHPB RCP----SEAL	LOSS OF COMPONENT COOLING WATER A-CHARGING PUMP FAIL TO START B-CHARGING PUMP OUTAGE RCP SEAL LOCA

Table 19.1-25 LOCCW with Reactor Trip Sequence Dominant Cutsets (Sheet 3 of 3)

15	2.8E-10	0.11	!15LOCCW CHICVODRC4D RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE BOUNDARY ISOLATION C/V VLV-182D(RC4D) FAIL TO OPEN RCP SEAL LOCA
16	2.8E-10	0.11	!15LOCCW CHICVODRC6A RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE SECONDARY ISOLATION C/V VLV-181C(RC6C) FAIL TO OPEN RCP SEAL LOCA
17	2.8E-10	0.11	!15LOCCW CHICVODRC6C RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE SECONDARY ISOLATION C/V VLV-181D(RC6D) FAIL TO OPEN RCP SEAL LOCA
18	2.8E-10	0.11	!15LOCCW CHICVODRC4C RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE BOUNDARY ISOLATION C/V VLV-182C(RC4C) FAIL TO OPEN RCP SEAL LOCA
19	2.8E-10	0.11	!15LOCCW CHICVODRC7A RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE THIRD ISOLATION C/V VLV-179A(RC7A) FAIL TO OPEN RCP SEAL LOCA
20	2.8E-10	0.11	!15LOCCW CHICVODRC7D RCP----SEAL	LOSS OF COMPONENT COOLING WATER RCP SEAL WATER INJECTION LINE THIRD ISOLATION C/V VLV-179D(RC7D) FAIL TO OPEN RCP SEAL LOCA

Table 19.1-26 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 1 of 4)

No.	Cut Sets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.9E-08	31.1	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF
2	1.1E-08	17.1	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF
			RCP----SEAL	RCP SEAL LOCA
3	4.0E-09	6.5	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			BOSBTSWCCF	B.O SIGNAL SOFTWARE CCF
			RCP----SEAL	RCP SEAL LOCA
4	2.5E-09	4.0	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
			SWSTMPESWPB	ESW PUMP-B OUTAGE
5	1.5E-09	2.4	!19LOOP	LOSS OF OFFSITE POWER
			CWSTMRCCWHXB	B-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-26 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 2 of 4)

No.	Cut Sets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	1.3E-09	2.0	!19LOOP CWSTMPCCWPB EPSCF4DLLRDG-134 EPSOO02RDG RCP----SEAL	LOSS OF OFFSITE POWER B-CCW PUMP OUTAGE EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
7	6.6E-10	1.1	!19LOOP ACWOO02FS EPSDLLRDGP1-L2 RCP----SEAL SWSCF4PMBD-R-ALL	LOSS OF OFFSITE POWER OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H) RCP SEAL LOCA ESW PUMP A,B,C,D FAIL TO RE-START CCF
8	5.3E-10	0.85	!19LOOP EPSCF4DLADDG-134 EPSOO02RDG RCP----SEAL SWSTMPESWPB	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA ESW PUMP-B OUTAGE
9	4.5E-10	0.73	!19LOOP ACWOO02FS EPSTMDGP1 RCP----SEAL SWSCF4PMBD-R-ALL	LOSS OF OFFSITE POWER OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) AAC GAS TURBINE GENERATOR (GTG P1) OUTAGE RCP SEAL LOCA ESW PUMP A,B,C,D FAIL TO RE-START CCF
10	3.9E-10	0.64	!19LOOP EPSCF4DLSRDG-134 EPSOO02RDG RCP----SEAL SWSTMPESWPB	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA ESW PUMP-B OUTAGE

Table 19.1-26 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 3 of 4)

No.	Cut Sets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
11	3.9E-10	0.63	!19LOOP CHICF2PMBD-R-ALL RCP----SEAL SWSCF4PMBD-R-ALL	LOSS OF OFFSITE POWER CHARGING PUMP FAIL TO START CCF RCP SEAL LOCA ESW PUMP A,B,C,D FAIL TO RE-START CCF
12	3.7E-10	0.59	!19LOOP ACWOO02FS CWSCF4PCBD-R-ALL EPSDLLRDGP1-L2 RCP----SEAL	LOSS OF OFFSITE POWER OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) CCW PUMP ALL FAIL TO RE-START CCF AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H) RCP SEAL LOCA
13	3.5E-10	0.57	!19LOOP EPSCF4DLLRDG-134 EPSOO02RDG RCP----SEAL SWSPMBDSWPB-R	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA ESW PUMP B FAIL TO RE-START
14	3.5E-10	0.57	!19LOOP EPSCF4DLLRDG-124 EPSOO02RDG RCP----SEAL SWSPMBDSWPC-R	LOSS OF OFFSITE POWER EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA ESW PUMP C FAIL TO RE-START
15	3.1E-10	0.50	!19LOOP CWSTMRCCWHXB EPSCF4DLADDG-134 EPSOO02RDG RCP----SEAL	LOSS OF OFFSITE POWER B-COMPONENT COOLING HEAT EXCHENGER OUTAGE EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA

Table 19.1-26 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 4 of 4)

No.	Cut Sets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
16	3.0E-10	0.49	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			ACWTMPZCLTP	COOLING TOWER PUMP OUTAGE
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF
17	2.6E-10	0.43	!19LOOP	LOSS OF OFFSITE POWER
			CWSTMPCCWPB	B-CCW PUMP OUTAGE
			EPSCF4DLADDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
18	2.5E-10	0.40	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF
			EPSTMDGP1	AAC GAS TURBINE GENERATOR (GTG P1) OUTAGE
			RCP----SEAL	RCP SEAL LOCA
19	2.3E-10	0.37	!19LOOP	LOSS OF OFFSITE POWER
			CWSTMRCCWHXB	B-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			EPSCF4DLSRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
20	2.2E-10	0.35	!19LOOP	LOSS OF OFFSITE POWER
			CHICF2PMBD-R-ALL	CHARGING PUMP FAIL TO START CCF
			CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-27 Basic Events (Hardware Failure, Human Error) FV Importance (Sheet 1 of 2)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr	5.3E-01	4.2E-01	1.4E+00
2	OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs	4.1E-01	4.2E-01	1.6E+00
3	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	2.4E-01	1.2E+01
4	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	2.4E-01	1.3E+01
5	ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	5.1E-01	2.3E-01	1.2E+00
6	EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	9.9E-04	1.9E-01	1.9E+02
7	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.5E-01	7.4E+03
8	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER	2.0E-02	5.3E-02	3.6E+00
9	EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF	2.1E-04	4.0E-02	1.9E+02
10	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	3.6E-02	1.0E+01
11	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	3.4E-02	3.5E+03
12	EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF	1.6E-04	2.9E-02	1.9E+02
13	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	2.2E-02	9.5E+00
14	SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF	4.8E-05	2.0E-02	4.3E+02
15	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO	6.5E-03	1.7E-02	3.6E+00
16	EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF	1.5E-03	1.7E-02	1.3E+01
17	SWSTMPESWPB	ESW PUMP-B OUTAGE	1.2E-02	1.4E-02	2.1E+00
18	EFWCF2PTADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF	4.5E-04	1.3E-02	2.9E+01

Table 19.1-27 Basic Events (Hardware Failure, Human Error) FV Importance (Sheet 2 of 2)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
19	NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)	2.5E-02	1.2E-02	1.5E+00
20	EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE	5.0E-03	1.2E-02	3.3E+00
21	CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF	2.6E-05	1.1E-02	4.3E+02
22	RTPMTCF	MODERATOR TEMPERATURE COEFFICIENT	1.0E-01	1.1E-02	1.1E+00
23	EPSDLLRDGP1-L2	AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN	1.8E-02	1.1E-02	1.6E+00
24	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO	6.5E-03	1.1E-02	2.6E+00
25	MFWHARD	MAIN FEED WATER HARD WARE FAIL	1.0E-01	9.8E-03	1.1E+00
26	EPSDLLRDGP2-L2	AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN	1.8E-02	9.3E-03	1.5E+00
27	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	9.0E-03	2.7E+00
28	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	8.5E-03	8.5E+04
29	HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF	1.1E-04	8.4E-03	7.6E+01
30	EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	2.5E-04	8.3E-03	3.4E+01
31	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	7.6E-03	9.1E+01
32	EPSCF4SEFFDG-ALL	GAS TURBINE GENERATOR SEQUENCER FAIL TO OPERATE CCF	3.8E-05	7.0E-03	1.9E+02
33	SWSTMPESWPD	ESW PUMP-D OUTAGE	1.2E-02	6.9E-03	1.6E+00
34	EFWTMTAB	D-EMERGENCY FEED WATER PUMP(FWP1B) OUTAGE	5.0E-03	6.7E-03	2.3E+00
35	EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)	2.4E-03	6.3E-03	3.6E+00
36	RSSOO02LNUP	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CORE COOLING (HE)	8.5E-03	6.1E-03	1.7E+00
37	EPSTMDGP1	AAC GAS TURBINE GENERATOR (GTG P1) OUTAGE	1.2E-02	5.8E-03	1.5E+00
38	EPSDLLRDGC	EMERGENCY GAS TURBINE GENERATOR (GTG C) FAIL TO RUN (>1H)	1.7E-02	5.4E-03	1.3E+00
39	VCWCHBDB	CHILLER FAIL TO START (RUNNING)	1.0E-02	5.3E-03	1.5E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 1 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	8.5E-03	8.5E+04
2	EPSCF4BYFF-234	EPS BATTERY A,C,D FAIL TO OPERATE CCF	1.2E-08	4.4E-04	3.5E+04
3	EPSCF4BYFF-124	EPS BATTERY A,B,D FAIL TO OPERATE CCF	1.2E-08	4.4E-04	3.5E+04
4	RTPBTSWCCF	SUPPORT SOFTWARE CCF	1.0E-07	1.0E-03	1.0E+04
5	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.5E-01	7.4E+03
6	SWSCF4PMYR-FF	ESW PUMP A,B,C,D FAIL TO RUN CCF	1.2E-08	6.7E-05	5.6E+03
7	CWSCF4RHPR-FF	ALL COMPONENT COOLING HEAT EXCHANGERS PLUG/FOUL OR LARGE EXTERNAL LEAK CCF	3.6E-08	1.9E-04	5.2E+03
8	EPSCF4BYFF-24	EPS BATTERY A,D FAIL TO OPERATE CCF	1.9E-08	9.5E-05	5.0E+03
9	CWSCF4PCYR-FF	CCW PUMP ALL FAIL TO RUN CCF	6.7E-09	3.2E-05	4.8E+03
10	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	3.4E-02	3.5E+03
11	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL LEAK	7.2E-08	2.5E-04	3.5E+03
12	RWSTNELRWSP	REFUELING WATER STORAGE PIT LARGE EXTERNAL	4.8E-08	1.7E-04	3.5E+03
13	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	8.4E-05	3.5E+03
14	RSSPNEL01B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	1.0E-04	3.5E+03
15	RSSPNEL01D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	1.0E-04	3.5E+03
16	RSSPNEL01A	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	1.0E-04	3.5E+03
17	RSSPNEL01C	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	1.0E-04	3.5E+03
18	HPIPNELSUCTSD	SAFETY INJECTION SYSTEM D TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	9.8E-05	3.5E+03
19	HPIPNELSUCTSC	SAFETY INJECTION SYSTEM C TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	9.8E-05	3.5E+03
20	HPIPNELSUCTSB	SAFETY INJECTION SYSTEM B TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	9.8E-05	3.5E+03
21	HPIPNELSUCTSA	SAFETY INJECTION SYSTEM A TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	9.8E-05	3.5E+03
22	HPIMVEL8820C	CONTAINMENT ISOLATION M/V MOV-001C(8820C) LARGE	2.4E-08	8.4E-05	3.5E+03
23	HPIMVEL8820D	CONTAINMENT ISOLATION M/V MOV-001D(8820D) LARGE	2.4E-08	8.4E-05	3.5E+03

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 2 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
24	HPIMVEL8820A	CONTAINMENT ISOLATION M/V MOV-001A(8820A) LARGE	2.4E-08	8.4E-05	3.5E+03
25	HPIMVEL8820B	CONTAINMENT ISOLATION M/V MOV-001B(8820B) LARGE	2.4E-08	8.4E-05	3.5E+03
26	RSSMVEL9007B	RWSP DISCHARGE LINE ISOLATION VALVE (9007B) LARGE EXTERNAL LEAK	2.4E-08	8.4E-05	3.5E+03
27	RSSMVEL9007A	RWSP DISCHARGE LINE ISOLATION VALVE (9007A) LARGE EXTERNAL LEAK	2.4E-08	8.4E-05	3.5E+03
28	RSSMVEL9007D	RWSP DISCHARGE LINE ISOLATION VALVE (9007D) LARGE EXTERNAL LEAK	2.4E-08	8.4E-05	3.5E+03
29	RSSMVEL9007C	RWSP DISCHARGE LINE ISOLATION VALVE (9007C) LARGE EXTERNAL LEAK	2.4E-08	8.4E-05	3.5E+03
30	EPSCF4BYFF-134	EPS BATTERY A,B,C FAIL TO OPERATE CCF	1.2E-08	3.1E-05	2.5E+03
31	EPSCF4BYFF-ALL	EPS BATTERY A,B,C,D FAIL TO OPERATE CCF	5.0E-08	1.2E-04	2.4E+03
32	EPSCF4BYFF-123	EPS BATTERY B,C,D FAIL TO OPERATE CCF	1.2E-08	2.0E-05	1.6E+03
33	EFWCF2CVODEFW03-ALL	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN	2.4E-06	3.1E-03	1.3E+03
34	EFWCF4CVODAW1-ALL	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	1.7E-06	2.2E-03	1.3E+03
35	EFWCF4CVODXW1-ALL	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF	1.7E-06	2.2E-03	1.3E+03
36	EFWXVELPW2A	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006A(PW2A) LARGE LEAK	7.2E-08	9.4E-05	1.3E+03
37	EFWXVELPW2B	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006B(PW2B) LARGE LEAK	7.2E-08	9.4E-05	1.3E+03
38	EFWCF4CVODAW1-123	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	8.1E-05	1.3E+03
39	EFWCF4CVODAW1-234	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	8.1E-05	1.3E+03

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 3 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
40	EFWCF4CVODAW1-124	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	8.1E-05	1.3E+03
41	EFWCF4CVODAW1-134	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	8.1E-05	1.3E+03
42	RTPBTRTB	TRIP BREAKER CCF	3.0E-06	2.5E-03	8.5E+02
43	EPSCF4CBWR4I-ALL	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	1.1E-04	6.9E+02
44	RWSCF4SUPRST01-234	RWSP SUMP STRAINER PLUG CCF	3.7E-06	2.0E-03	5.4E+02
45	ACCCF4CVOD8948-ALL	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.0E-06	4.3E-04	4.3E+02
46	ACCCF4CVOD8956-ALL	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.0E-06	4.3E-04	4.3E+02
47	ACCCF4CVOD8948-134	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
48	ACCCF4CVOD8956-134	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
49	ACCCF4CVOD8948-234	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
50	ACCCF4CVOD8948-124	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
51	ACCCF4CVOD8948-123	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
52	ACCCF4CVOD8956-124	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
53	ACCCF4CVOD8956-123	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
54	ACCCF4CVOD8956-234	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.1E-04	4.3E+02
55	ACCCF4CVOD8956-24	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.6E-07	6.8E-05	4.3E+02

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 4 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
56	ACCCF4CVOD8948-23	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.6E-07	6.8E-05	4.3E+02
57	ACCCF4CVOD8948-13	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.6E-07	6.8E-05	4.3E+02
58	ACCCF4CVOD8948-12	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.6E-07	6.8E-05	4.3E+02
59	ACCCF4CVOD8956-12	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.6E-07	6.8E-05	4.3E+02
60	ACCCF4CVOD8956-14	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.6E-07	6.8E-05	4.3E+02
61	SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF	4.8E-05	2.0E-02	4.3E+02
62	CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF	2.6E-05	1.1E-02	4.3E+02
63	BOSBTSWCCF	B.O SIGNAL SOFTWARE CCF	1.0E-05	4.2E-03	4.3E+02
64	CWSCF4CVOD052-R-ALL	CCW PUMP DISCHARGE LINE C/V VLV-016A,B,C,D(052A,B,C,D)	1.5E-07	6.3E-05	4.2E+02
65	SWSCF4CVOD602-R-ALL	ESW PUMP MOTOR COOLING LINE C/V VLV-602A,B,C,D FAIL TO OPEN CCF	1.5E-07	6.3E-05	4.2E+02
66	SWSCF4CVOD502-R-ALL	ESW PUMP DISCHARGE LINE C/V VLV-502A,B,C,D FAIL TO OPEN CCF	1.5E-07	6.3E-05	4.2E+02
67	EPSCF4CBTD6H-134	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	5.2E-06	1.9E-03	3.7E+02
68	EPSCF4CBTD6H-124	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	5.2E-06	1.8E-03	3.4E+02
69	SGNBTSWCCF	S,P SIGNAL SOFTWARE CCF	1.0E-05	3.3E-03	3.3E+02
70	EPSCF4IVFFINV-ALL	INVERTERS (INVA,B,C,D) FAIL TO OPERATE CFF	1.5E-06	3.2E-04	2.2E+02
71	EPSBTSWCCF	EPS SOFTWARE CCF	1.0E-05	2.1E-03	2.1E+02
72	EPSCF4CBWRVIT4-ALL	CIRCUIT BREAKER BETWEEN 125V DC BUS AND INVERTER (VIT4A,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	3.4E-05	2.1E+02
73	EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	9.9E-04	1.9E-01	1.9E+02

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 5 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
74	EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF	2.1E-04	4.0E-02	1.9E+02
75	EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF	1.6E-04	2.9E-02	1.9E+02
76	EPSCF4SEFFDG-ALL	GAS TURBINE GENERATOR SEQUENCER FAIL TO	3.8E-05	7.0E-03	1.9E+02
77	EPSCF4CBTDDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO CLOSE CCF	2.0E-05	3.8E-03	1.9E+02
78	EPSCF4CBWRDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	3.0E-05	1.9E+02
79	EPSCF4CBWR4I-124	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO	2.9E-08	4.9E-06	1.7E+02
80	EPSCF4CBWR4I-134	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO	2.9E-08	4.8E-06	1.7E+02
81	RSSRIELRHEXC	CS/RHR HEAT EXCHANGER C LARGE LEAK	7.2E-07	1.0E-04	1.4E+02
82	RSSXVELRHR04C	MINIMUM FLOW LINE X/V VLV-13C(RHR04C) LARGE EXTERNAL LEAK	7.2E-08	1.0E-05	1.4E+02
83	RSSCVEL9008C	CS/RHR PUMP SUCTION LINE C/V VLV-004C(9008C) LARGE EXTERNAL LEAK	4.8E-08	6.8E-06	1.4E+02
84	HPIPMELSIPB	SAFETY INJECTION PUMP B LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
85	RSSPMELCSPB	CS/RHR PUMP B LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
86	RSSRIELRHEXA	CS/RHR HEAT EXCHANGER A LARGE LEAK	7.2E-07	1.0E-04	1.4E+02
87	RSSRIELRHEXD	CS/RHR HEAT EXCHANGER D LARGE LEAK	7.2E-07	1.0E-04	1.4E+02
88	RSSRIELRHEXB	CS/RHR HEAT EXCHANGER B LARGE LEAK	7.2E-07	1.0E-04	1.4E+02
89	RSSXVELRHR04B	MINIMUM FLOW LINE X/V VLV-13B(RHR04B) LARGE EXTERNAL LEAK	7.2E-08	1.0E-05	1.4E+02
90	RSSXVELRHR04A	MINIMUM FLOW LINE X/V VLV-13A(RHR04A) LARGE EXTERNAL LEAK	7.2E-08	1.0E-05	1.4E+02

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 6 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
91	RSSXVELRHR04D	MINIMUM FLOW LINE X/V VLV-13D(RHR04D) LARGE EXTERNAL LEAK	7.2E-08	1.0E-05	1.4E+02
92	RSSCVEL9008A	CS/RHR PUMP SUCTION LINE C/V VLV-004A(9008A) LARGE EXTERNAL LEAK	4.8E-08	6.8E-06	1.4E+02
93	RSSCVEL9008B	CS/RHR PUMP SUCTION LINE C/V VLV-004B(9008B) LARGE EXTERNAL LEAK	4.8E-08	6.8E-06	1.4E+02
94	RSSCVEL9008D	CS/RHR PUMP SUCTION LINE C/V VLV-004D(9008D) LARGE EXTERNAL LEAK	4.8E-08	6.8E-06	1.4E+02
95	HPIPMELSIPA	SAFETY INJECTION PUMP A LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
96	RSSPMELCSPA	CS/RHR PUMP A LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
97	RSSPMELCSPC	CS/RHR PUMP C LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
98	HPIPMELSIPC	SAFETY INJECTION PUMP C LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
99	RSSPNEL04A	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-07	3.6E-05	1.4E+02
100	RSSPNEL04C	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-07	3.6E-05	1.4E+02
101	RSSPNEL04D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.5E-07	3.6E-05	1.4E+02
102	RSSPNEL04B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.5E-07	3.6E-05	1.4E+02
103	RSSPMELCSPD	CS/RHR PUMP D LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
104	HPIPMELSIPD	SAFETY INJECTION PUMP D LARGE EXTERNAL LEAK	1.9E-07	2.7E-05	1.4E+02
105	HPIPNELINJSA	SAFETY INJECTION SYSTEM A TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.2E-08	1.3E-05	1.4E+02
106	HPIPNELINJSC	SAFETY INJECTION SYSTEM C TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.2E-08	1.3E-05	1.4E+02
107	HPIPNELINJSB	SAFETY INJECTION SYSTEM B TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.0E-08	1.3E-05	1.4E+02
108	HPIPNELINJSD	SAFETY INJECTION SYSTEM D TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.0E-08	1.3E-05	1.4E+02
109	HPICVEL8804B	SAFETY INJECTION PUMP DISCHARGE C/V VLV004B(8804B) LARGE LEAK	4.8E-08	6.8E-06	1.4E+02
110	HPICVEL8804D	SAFETY INJECTION PUMP DISCHARGE C/V VLV004D(8804D) LARGE LEAK	4.8E-08	6.8E-06	1.4E+02

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 7 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
111	HPICVEL8804C	SAFETY INJECTION PUMP DISCHARGE C/V VLV004C(8804C) LARGE LEAK	4.8E-08	6.8E-06	1.4E+02
112	HPICVEL8804A	SAFETY INJECTION PUMP DISCHARGE C/V VLV004A(8804A) LARGE LEAK	4.8E-08	6.8E-06	1.4E+02
113	RSSPNEL12B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-08	3.6E-06	1.4E+02
114	RSSPNEL12C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.6E-08	3.6E-06	1.4E+02
115	HPIMVEL8805B	M/V 8805B EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
116	HPIMVEL8805D	M/V 8805D EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
117	HPIMVEL8805C	M/V 8805C EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
118	HPIMVEL8805A	M/V 8805A EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
119	RSSPNEL11D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	2.7E-06	1.4E+02
120	RSSPNEL11A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	2.7E-06	1.4E+02
121	HPIPNELSUCTLC	PIPE OUT OF CV EXTERNAL LEAK L	3.3E-08	4.6E-06	1.4E+02
122	HPIPNELSUCTLA	PIPE OUT OF CV EXTERNAL LEAK L	3.3E-08	4.6E-06	1.4E+02
123	HPIPNELSUCTLD	PIPE OUT OF CV EXTERNAL LEAK L	3.1E-08	4.3E-06	1.4E+02
124	HPIPNELSUCTLB	PIPE OUT OF CV EXTERNAL LEAK L	3.1E-08	4.3E-06	1.4E+02
125	RSSXVELSFP01D	X/V SFP01D EXTERNAL LEAK L	7.2E-08	1.0E-05	1.4E+02
126	RSSXVELSFP01A	X/V SFP01A EXTERNAL LEAK L	7.2E-08	1.0E-05	1.4E+02
127	RSSXVELSFP02D	X/V SFP02D EXTERNAL LEAK L	7.2E-08	1.0E-05	1.4E+02
128	RSSXVELSFP02A	X/V SFP02A EXTERNAL LEAK L	7.2E-08	1.0E-05	1.4E+02
129	RSSXVEL9009A	X/V 9009A EXTERNAL LEAK LARGE	7.2E-08	1.0E-05	1.4E+02
130	RSSXVEL9009B	X/V 9009B EXTERNAL LEAK LARGE	7.2E-08	1.0E-05	1.4E+02
131	RSSXVEL9009D	X/V 9009D EXTERNAL LEAK LARGE	7.2E-08	1.0E-05	1.4E+02
132	RSSXVEL9009C	X/V 9009C EXTERNAL LEAK LARGE	7.2E-08	1.0E-05	1.4E+02
133	RWSMVEL003	M/V 003 EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
134	RSSMVEL9011D	M/V 9011D EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
135	RSSMVEL9011C	M/V 9011C EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
136	RSSMVEL9011A	M/V 9011A EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
137	RSSMVEL9011B	M/V 9011B EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 8 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
138	RSSPNEL05A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	5.7E-08	8.0E-06	1.4E+02
139	RSSPNEL05C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	5.7E-08	8.0E-06	1.4E+02
140	RSSPNEL05B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	4.7E-08	6.6E-06	1.4E+02
141	RSSPNEL05D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	4.7E-08	6.6E-06	1.4E+02
142	RSSMVEL9015A	M/V 9015A EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
143	RSSMVEL9015D	M/V 9015D EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
144	RSSMVEL9015C	M/V 9015C EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
145	RSSMVEL9015B	M/V 9015B EXTERNAL LEAK L	2.4E-08	3.4E-06	1.4E+02
146	RSSAVELRHR02B	A/V RHR02B EXTERNAL LEAK L	2.2E-08	3.0E-06	1.4E+02
147	RSSAVELRHR01B	A/V RHR01B EXTERNAL LEAK L	2.2E-08	3.0E-06	1.4E+02
148	RSSAVELRHR01C	A/V RHR01C EXTERNAL LEAK L	2.2E-08	3.0E-06	1.4E+02
149	RSSAVELRHR02C	A/V RHR02C EXTERNAL LEAK L	2.2E-08	3.0E-06	1.4E+02
150	RWSPMELRWPA	M/P RWPA EXTERNAL LEAK L	1.9E-07	2.7E-05	1.4E+02
151	RWSPMELRWPB	M/P RWPB EXTERNAL LEAK L	1.9E-07	2.7E-05	1.4E+02
152	RWSXVELRWS09	X/V RWS09 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
153	RWSXVELRWS07	X/V RWS07 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
154	RWSXVELRWS12	X/V RWS12 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
155	RWSXVEL016	X/V 016 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
156	RWSXVELRWS11	X/V RWS11 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
157	RWSXVELRWS06	X/V RWS06 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
158	RWSXVEL007A	X/V 007A EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
159	RWSXVEL005B	X/V 005B EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
160	RWSXVEL026	X/V 026 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
161	RWSXVEL005A	X/V 005A EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
162	RWSXVEL008	X/V 008 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
163	RWSXVEL004	X/V 004 EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
164	RWSXVEL007B	X/V 007B EXTERNAL LEAK L	7.2E-08	9.9E-06	1.4E+02
165	RWSCVELRWS08	C/V RWS08 EXTERNAL LEAK L	4.8E-08	6.6E-06	1.4E+02

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 9 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
166	RWSCVELRWS13	C/V RWS13 EXTERNAL LEAK L	4.8E-08	6.6E-06	1.4E+02
167	RWSCVEL006B	C/V 006B EXTERNAL LEAK L	4.8E-08	6.6E-06	1.4E+02
168	RWSCVEL006A	C/V 006A EXTERNAL LEAK L	4.8E-08	6.6E-06	1.4E+02
169	RWSCVELRWS10	C/V RWS10 EXTERNAL LEAK L	4.8E-08	6.6E-06	1.4E+02
170	RWSCVEL015	C/V 015 EXTERNAL LEAK L	4.8E-08	6.6E-06	1.4E+02
171	RSSPNEL03C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.7E-09	9.2E-07	1.4E+02
172	RSSPNEL03A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.7E-09	9.2E-07	1.4E+02
173	RSSPNEL03B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.1E-09	8.4E-07	1.4E+02
174	RSSPNEL03D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.1E-09	8.4E-07	1.4E+02
175	RSSPNEL10D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	3.7E-09	5.1E-07	1.4E+02
176	RSSPNEL10A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	3.7E-09	5.1E-07	1.4E+02
177	RSSPNEL08B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
178	RSSPNEL08D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
179	RSSPNEL08C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
180	RSSPNEL08A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
181	RSSPNEL07D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
182	RSSPNEL07A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
183	RSSPNEL07C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
184	RSSPNEL07B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	2.4E-07	1.4E+02
185	RWSCF4SUPRST01-134	RWSP SUMP STRAINER PLUG CCF	3.7E-06	4.6E-04	1.3E+02
186	RWSCF4SUPRST01-123	RWSP SUMP STRAINER PLUG CCF	3.7E-06	3.9E-04	1.1E+02
187	EFWCF4CVODXW1-124	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF	6.2E-08	6.6E-06	1.1E+02
188	RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF	1.9E-05	1.7E-03	9.4E+01
189	RSSCF4RHPRRHEX-ALL	CS/RHR HEAT EXCHANGER PLUG CCF	4.8E-06	4.5E-04	9.4E+01
190	RSSCF4CVOD9008-ALL	CS/RHR PUMP SUCTION LINE C/V VLV004A,B,C,D(9008A,B,C,D) FAIL TO OPEN CCF	4.3E-07	4.0E-05	9.4E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 10 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
191	RSSCF4PMSRCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO RUN (<1H) CCF	5.0E-06	4.6E-04	9.4E+01
192	RSSCF4PMLRCSP-ALL	CS/RHR PUMP FAIL TO RUN (>1H) CCF	1.7E-06	1.6E-04	9.4E+01
193	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	7.6E-03	9.1E+01
194	CCWBTSWCCF	CCW SOFTWARE CCF	1.0E-05	9.0E-04	9.1E+01
195	EPSCF4BYFF-34	EPS BATTERY Fail to Operate CCF	1.9E-08	1.7E-06	9.1E+01
196	EPSCF4CBWR4J-ALL	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	1.3E-05	8.4E+01
197	HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF	1.1E-04	8.4E-03	7.6E+01
198	HPICF4PMSRSIP-ALL	HHI PUMP A,B,C,D FAIL TO RUN (Standby) (<1h) CCF	8.5E-06	6.2E-04	7.4E+01
199	EPSCF4CBWR4J-34	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	2.4E-06	7.4E+01
200	EPSCF4CBWR4I-14	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	2.4E-06	7.4E+01
201	EPSCF4CBWR4J-134	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.1E-06	7.3E+01
202	EPSCF4CBWR4J-234	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.1E-06	7.3E+01
203	HPICF4PMLRSIP-ALL	HHI PUMP A,B,C,D FAIL TO RUN (Standby) (>1h) CCF	2.9E-06	2.1E-04	7.2E+01
204	HPICF4CVOD8808-ALL	C/V 8808 FAIL TO OPEN CCF	1.0E-06	7.1E-05	7.1E+01
205	HPICF4CVOD8806-ALL	C/V 8806 FAIL TO OPEN CCF	1.0E-06	7.1E-05	7.1E+01
206	HPICF4CVOD8809-ALL	C/V 8809 FAIL TO OPEN CCF	1.0E-06	7.1E-05	7.1E+01
207	HPICF4CVOD8804-ALL	C/V 8804 FAIL TO OPEN CCF	1.0E-06	7.1E-05	7.1E+01
208	EFWCF4CVODXW1-123	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	4.0E-06	6.6E+01
209	EPSCF4IVFFINV-134	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	3.1E-05	6.4E+01
210	MSPPNELPA1	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.2E-07	1.3E-05	6.3E+01
211	HPICF4PMADSIP-234	HHI PUMP FAIL TO START (Standby) CCF	9.5E-06	5.5E-04	5.9E+01
212	HPICF4PMSRSIP-234	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	1.9E-04	5.8E+01
213	HPICF4PMLRSIP-134	HHI PUMP FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	6.2E-05	5.6E+01
214	HPICF4CVOD8806-234	C/V 8806 FAIL TO OPEN CCF	2.7E-07	1.4E-05	5.5E+01
215	HPICF4CVOD8804-234	C/V 8804 FAIL TO OPEN CCF	2.7E-07	1.4E-05	5.5E+01
216	HPICF4CVOD8809-234	C/V 8809 FAIL TO OPEN CCF	2.7E-07	1.4E-05	5.5E+01
217	HPICF4CVOD8808-234	C/V 8808 FAIL TO OPEN CCF	2.7E-07	1.4E-05	5.5E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 11 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
218	CHIXVEL240C	X/V 240C EXTERNAL LEAK L	7.2E-08	3.6E-06	5.1E+01
219	RWSTNELRWSAT	TANK UNPRESSURIZED EXTERNAL LEAK L	4.8E-08	2.4E-06	5.1E+01
220	EPSCF4CBWRVIT4-134	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	1.4E-06	5.0E+01
221	EPSCF4CBTD6H-234	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.2E-06	2.3E-04	4.6E+01
222	EFWCF4CVODXW1-234	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	2.7E-06	4.5E+01
223	EFWCF4CVODXW1-134	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	2.7E-06	4.5E+01
224	EPSCF4BYFF-12	EPS BATTERY Fail to Operate CCF	1.9E-08	8.0E-07	4.4E+01
225	EFWXVELTW4B	X/V TW4B EXTERNAL LEAK L	7.2E-08	3.0E-06	4.3E+01
226	EFWXVELTW4A	X/V TW4A EXTERNAL LEAK L	7.2E-08	3.0E-06	4.3E+01
227	EFWCVELTW1A	C/V TW1A EXTERNAL LEAK L	4.8E-08	2.0E-06	4.3E+01
228	EFWCVELTW1B	C/V TW1B EXTERNAL LEAK L	4.8E-08	2.0E-06	4.3E+01
229	EPSCF4CBTD6H-123	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.2E-06	2.1E-04	4.2E+01
230	EFWCVELAW1A	C/V AW1A EXTERNAL LEAK L	4.8E-08	1.8E-06	3.9E+01
231	EFWCVELAW1D	C/V AW1D EXTERNAL LEAK L	4.8E-08	1.8E-06	3.9E+01
232	EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	2.5E-04	8.3E-03	3.4E+01
233	EPSCF4DLADDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF	5.2E-05	1.7E-03	3.4E+01
234	EPSCF4DLSRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF	3.9E-05	1.3E-03	3.4E+01
235	EPSCF4SEFFDG-134	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	4.2E-04	3.4E+01
236	EPSCF4CBTDDG-234	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	1.7E-04	3.4E+01
237	EPSCF4CBWRDG-234	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	9.7E-07	3.4E+01
238	EFWMVELAWAA	M/V AWAA EXTERNAL LEAK L	2.4E-08	8.0E-07	3.4E+01
239	EFWMVELAWAB	M/V AWAB EXTERNAL LEAK L	2.4E-08	8.0E-07	3.4E+01
240	EFWMVELAWDB	M/V AWDB EXTERNAL LEAK L	2.4E-08	8.0E-07	3.4E+01
241	EFWMVELAWDA	M/V AWDA EXTERNAL LEAK L	2.4E-08	8.0E-07	3.4E+01
242	EPSCF4CBTD6H-14	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	1.6E-04	3.4E+01
243	EPSCF4IVFFINV-234	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	1.6E-05	3.3E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 12 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
244	RWSCF4SUPRST01-34	SUMP STRAINER PLUG CCF	3.0E-06	9.5E-05	3.3E+01
245	SWSCF4PMBD-R-124	ESW PUMP FAIL TO RE-START CCF	1.5E-05	4.8E-04	3.2E+01
246	CWSCF4PCBD-R-123	CWS PUMP FAIL TO RE-START CCF	8.4E-06	2.6E-04	3.2E+01
247	EPSCF4IVFFINV-124	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	1.5E-05	3.1E+01
248	EFWCVODEFW03B	C/V EFW03B FAIL TO OPEN	9.6E-06	2.9E-04	3.1E+01
249	EFWCVPREFW03B	C/V EFW03B PLUG	2.4E-06	7.2E-05	3.1E+01
250	EFWCVELEFW03B	C/V EFW03B EXTERNAL LEAK L	4.8E-08	1.4E-06	3.1E+01
251	EFWXVPRPW1B	X/V PW1B PLUG	2.4E-06	7.0E-05	3.0E+01
252	EFWXVELTW3B	X/V TW3B EXTEANAL LEAK L	7.2E-08	2.1E-06	3.0E+01
253	EFWXVELPW1B	X/V PW1B EXTERNAL LEAK L	7.2E-08	2.1E-06	3.0E+01
254	EFWXVELMW3B	X/V MW3B EXTEANAL LEAK L	7.2E-08	2.1E-06	3.0E+01
255	EFWTNELEFWP1B	B-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	1.4E-06	3.0E+01
256	EFWPNELCSTB	LINE EXTERNAL LEAK FROM B-EMERGENCY FEED WATER PIT TO B-TRAIN 2 PUMP	6.0E-10	1.8E-08	3.0E+01
257	EPSCF4CBWRVIT4-234	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	8.5E-07	3.0E+01
258	EFWCVODEFW03A	C/V EFW03A FAIL TO OPEN	9.6E-06	2.8E-04	3.0E+01
259	EFWCVPREFW03A	C/V EFW03A PLUG	2.4E-06	6.9E-05	3.0E+01
260	EFWCVELEFW03A	C/V EFW03A EXTERNAL LEAK L	4.8E-08	1.4E-06	3.0E+01
261	EFWCF2PTADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF	4.5E-04	1.3E-02	2.9E+01
262	EFWCF2PTSRFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO RUN (<1H) CCF	1.1E-04	3.2E-03	2.9E+01
263	EFWCF2PTLRFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO RUN (>1H) CCF	7.2E-05	2.0E-03	2.9E+01
264	EFWXVPRPW1A	X/V PW1A PLUG	2.4E-06	6.7E-05	2.9E+01
265	EFWXVELTW3A	X/V TW3A EXTEANAL LEAK L	7.2E-08	2.0E-06	2.9E+01
266	EFWXVELPW1A	X/V PW1A EXTERNAL LEAK L	7.2E-08	2.0E-06	2.9E+01
267	EFWXVELMW3A	X/V MW3A EXTEANAL LEAK L	7.2E-08	2.0E-06	2.9E+01
268	EFWTNELEFWP1A	A-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	1.3E-06	2.9E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 13 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
269	EFWPNELCSTA	LINE EXTERNAL LEAK FROM A-EMERGENCY FEED WATER PIT TO A-TRAIN 2 PUMP	6.0E-10	1.7E-08	2.9E+01
270	EFWCF2MVODTS1-ALL	EFW M/V TS1 FAIL TO OPEN CCF	4.2E-05	1.2E-03	2.8E+01
271	EFWCF4CVODXW1-24	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	6.0E-06	2.8E+01
272	EPSCF4IVFFINV-123	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	1.3E-05	2.7E+01
273	EFWCF4CVODXW1-13	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	5.8E-06	2.7E+01
274	PZRSVCD0058	PRESSURIZER SAFETY VALV VLV-120(0058)	7.0E-05	1.8E-03	2.7E+01
275	PZRSVCD0057	PRESSURIZER SAFETY VALV VLV-121(0057)	7.0E-05	1.8E-03	2.7E+01
276	PZRSVCD0055	S/V 0055 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.8E-03	2.7E+01
277	PZRSVCD0056	S/V 0056 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.8E-03	2.7E+01
278	EFWXVELEFW01B	X/V EFW01B EXTERNAL LEAK L	7.2E-08	1.8E-06	2.5E+01
279	EFWPNELTESTB	TEST LINE B PIPE LEAK	6.0E-10	1.5E-08	2.5E+01
280	MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED	1.8E-04	4.3E-03	2.5E+01
281	CHICF2PMBD-R-ALL	CHARGING PUMP FAIL TO START CCF	2.0E-04	4.9E-03	2.5E+01
282	MSRCF4AVCD533-13	A/V 533 FAIL TO CLOSE CCF	5.2E-05	1.3E-03	2.5E+01
283	MSRCF4AVCD533-14	A/V 533 FAIL TO CLOSE CCF	5.2E-05	1.3E-03	2.5E+01
284	MSRCF4AVCD533-12	A/V 533 FAIL TO CLOSE CCF	5.2E-05	1.3E-03	2.5E+01
285	MSRCF4AVCD533-134	A/V 533 FAIL TO CLOSE CCF	2.6E-05	6.3E-04	2.5E+01
286	MSRCF4AVCD533-123	A/V 533 FAIL TO CLOSE CCF	2.6E-05	6.3E-04	2.5E+01
287	MSRCF4AVCD533-124	A/V 533 FAIL TO CLOSE CCF	2.6E-05	6.3E-04	2.5E+01
288	MSRCF4AVCD533-34	A/V 533 FAIL TO CLOSE CCF	5.2E-05	1.3E-03	2.5E+01
289	MSRCF4AVCD533-23	A/V 533 FAIL TO CLOSE CCF	5.2E-05	1.3E-03	2.5E+01
290	MSRCF4AVCD533-24	A/V 533 FAIL TO CLOSE CCF	5.2E-05	1.3E-03	2.5E+01
291	MSRCF4AVCD533-234	A/V 533 FAIL TO CLOSE CCF	2.6E-05	6.3E-04	2.5E+01
292	MSRBTSWCCF	MSR STEAM LINE ISORATION SIGNAL SOFTWARE CCF	1.0E-05	2.4E-04	2.5E+01
293	EFWXVELEFW01A	X/V EFW01A EXTERNAL LEAK L	7.2E-08	1.7E-06	2.5E+01
294	EFWPNELTESTA	TEST LINE A PIPE LEAK	6.0E-10	1.4E-08	2.5E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 14 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
295	CHIORPRFE138	CHARGING LINE ORIFICE FE138 PLUG	2.4E-05	5.5E-04	2.4E+01
296	CHIORPROR02	CHARGING FLOW CONTROL ORIFICE OR02 PLUG	2.4E-05	5.5E-04	2.4E+01
297	CHICVOD169	C/V 169 FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
298	CHIAVCM138	A/V 138 MIS-CLOSE	4.8E-06	1.1E-04	2.4E+01
299	CHIAVCM215	A/V 215 MIS-CLOSE	4.8E-06	1.1E-04	2.4E+01
300	CHIAVCM236	A/V 236 MIS-CLOSE	4.8E-06	1.1E-04	2.4E+01
301	CHIMVPR220	M/V 220 PLUG	2.4E-06	5.5E-05	2.4E+01
302	CHIAVPR215	A/V 215 PLUG	2.4E-06	5.5E-05	2.4E+01
303	CHICVPR237	C/V 237 PLUG	2.4E-06	5.5E-05	2.4E+01
304	CHICVPR222	C/V 222 PLUG	2.4E-06	5.5E-05	2.4E+01
305	CHIXVPR242	X/V 242 PLUG	2.4E-06	5.5E-05	2.4E+01
306	CHICVPR239	C/V 239 PLUG	2.4E-06	5.5E-05	2.4E+01
307	CHIAVPR236	A/V 236 PLUG	2.4E-06	5.5E-05	2.4E+01
308	CHIAVPR138	A/V 138 PLUG	2.4E-06	5.5E-05	2.4E+01
309	CHIXVPR241	X/V 241 PLUG	2.4E-06	5.5E-05	2.4E+01
310	CHIXVPR167	X/V 167 PLUG	2.4E-06	5.5E-05	2.4E+01
311	CHIMVPR221	M/V 221 PLUG	2.4E-06	5.5E-05	2.4E+01
312	CHIMVCM220	M/V 220 MIS-CLOSE	9.6E-07	2.2E-05	2.4E+01
313	CHIMVCM221	M/V 221 MIS-CLOSE	9.6E-07	2.2E-05	2.4E+01
314	CHIRIELHXCH	HEAT EXCHANGER HXCH TUBE EXTERNAL LEAK L	7.2E-07	1.6E-05	2.4E+01
315	CHIPMELCHPA	M/P CHPA EXTERNAL LEAK L	1.9E-07	4.4E-06	2.4E+01
316	CHIPMELCHPB	M/P CHPB EXTERNAL LEAK L	1.9E-07	4.4E-06	2.4E+01
317	CHIAVIL227	A/V 227 INTERNAL LEAK L	1.2E-07	2.7E-06	2.4E+01
318	CHIXVEL162A	X/V 162A EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
319	CHIXVEL242	X/V 242 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
320	CHIXVELCVC01	X/V CVC01 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
321	CHIXVELCVC11	X/V CVC11 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
322	CHIXVELCVC06	X/V CVC06 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
323	CHIXVEL167	X/V 167 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
324	CHIXVEL240B	X/V 240B EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 15 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
325	CHIXVEL241	X/V 241 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
326	CHIXVEL166B	X/V 166B EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
327	CHIXVEL162B	X/V 162B EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
328	CHIXVEL240A	X/V 240A EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
329	CHIXVELCVC07	X/V CVC07 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
330	CHIXVELCVC02	X/V CVC02 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
331	CHIXVEL166A	X/V 166A EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
332	CHIXVELCVC09	X/V CVC09 EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
333	CHICVEL239	C/V 239 EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
334	CHICVEL237	C/V 237 EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
335	CHICVEL163A	C/V 163A EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
336	CHICVEL152	C/V 152 EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
337	CHICVEL222	C/V 222 EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
338	CHICVEL165B	C/V 165B EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
339	CHICVEL163B	C/V 163B EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
340	CHICVEL165A	C/V 165A EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
341	CHIMVEL221	M/V 221 EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
342	CHIMVEL121B	M/V 121B EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
343	CHIMVEL220	M/V 220 EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
344	CHIMVEL121C	M/V 121C EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
345	CHIAVEL138	A/V 138 EXTERNAL LEAK L	2.2E-08	4.9E-07	2.4E+01
346	CHIAVEL215	A/V 215 EXTERNAL LEAK L	2.2E-08	4.9E-07	2.4E+01
347	CHIAVELCVC04	A/V CVC04 EXTERNAL LEAK L	2.2E-08	4.9E-07	2.4E+01
348	CHIAVELCVC03	A/V CVC03 EXTERNAL LEAK L	2.2E-08	4.9E-07	2.4E+01
349	CHIAVEL227	A/V 227 EXTERNAL LEAK L	2.2E-08	4.9E-07	2.4E+01
350	CHIAVEL236	A/V 236 EXTERNAL LEAK L	2.2E-08	4.9E-07	2.4E+01
351	CHIORPRRC1D	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	5.5E-04	2.4E+01
352	CHIORPRRC1C	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	5.5E-04	2.4E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 16 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
353	CHIORPRRC1A	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	5.5E-04	2.4E+01
354	CHIORPRRC1B	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	5.5E-04	2.4E+01
355	CHICVODRC7D	RCP SEAL WATER INJECTION LINE THIRD ISOLATION C/V VLV-179D(RC7D) FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
356	CHICVODRC7B	C/V FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
357	CHICVODRC7C	C/V FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
358	CHICVODRC7A	RCP SEAL WATER INJECTION LINE THIRD ISOLATION C/V VLV-179A(RC7A) FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
359	CHICVODRC6C	RCP SEAL WATER INJECTION LINE SECONDARY ISOLATION C/V VLV-181D(RC6D) FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
360	CHICVODRC6B	C/V FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
361	CHICVODRC6A	RCP SEAL WATER INJECTION LINE SECONDARY ISOLATION C/V VLV-181C(RC6C) FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
362	CHICVODRC4D	RCP SEAL WATER INJECTION LINE BOUNDARY ISOLATION C/V VLV-182D(RC4D) FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
363	CHICVODRC4A	C/V FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
364	CHICVODRC6D	C/V FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
365	CHICVODRC4C	RCP SEAL WATER INJECTION LINE BOUNDARY ISOLATION C/V VLV-182C(RC4C) FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
366	CHICVODRC4B	C/V FAIL TO OPEN	1.2E-05	2.7E-04	2.4E+01
367	CHIAVCMCVC03	A/V Mis-Close	4.8E-06	1.1E-04	2.4E+01
368	CHIAVCMCVC04	A/V Mis-Close	4.8E-06	1.1E-04	2.4E+01
369	CHICVPRRC6C	C/V Plug	2.4E-06	5.5E-05	2.4E+01
370	CHICVPRRC6B	C/V Plug	2.4E-06	5.5E-05	2.4E+01
371	CHICVPRRC6A	C/V Plug	2.4E-06	5.5E-05	2.4E+01
372	CHIXVPRRC5B	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
373	CHICVPRRC7A	C/V Plug	2.4E-06	5.5E-05	2.4E+01
374	CHICVPRRC6D	C/V Plug	2.4E-06	5.5E-05	2.4E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 17 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
375	CHICVPRRC4D	C/V Plug	2.4E-06	5.5E-05	2.4E+01
376	CHIAVPRCVC04	A/V PLUG	2.4E-06	5.5E-05	2.4E+01
377	CHIAVPRCVC03	A/V PLUG	2.4E-06	5.5E-05	2.4E+01
378	CHIXVPRRC5D	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
379	CHIXVPRRC5C	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
380	CHICVPRRC4C	C/V Plug	2.4E-06	5.5E-05	2.4E+01
381	CHICVPRRC4B	C/V Plug	2.4E-06	5.5E-05	2.4E+01
382	CHICVPRRC4A	C/V Plug	2.4E-06	5.5E-05	2.4E+01
383	CHICVPRRC7B	C/V Plug	2.4E-06	5.5E-05	2.4E+01
384	CHIXVPRCVC06	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
385	CHIXVPRCVC02	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
386	CHIXVPRRC2C	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
387	CHIXVPRCVC09	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
388	CHIXVPRRC2A	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
389	CHIXVPRCVC11	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
390	CHIXVPRRC2B	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
391	CHIXVPRRC2D	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
392	CHIMVPRRC3A	M/V PLUG	2.4E-06	5.5E-05	2.4E+01
393	CHICVPRRC7D	C/V Plug	2.4E-06	5.5E-05	2.4E+01
394	CHICVPRRC7C	C/V Plug	2.4E-06	5.5E-05	2.4E+01
395	CHIMVPRRC3B	M/V PLUG	2.4E-06	5.5E-05	2.4E+01
396	CHIXVPRRC5A	X/V PLUG	2.4E-06	5.5E-05	2.4E+01
397	CHIMVPRRC3D	M/V PLUG	2.4E-06	5.5E-05	2.4E+01
398	CHIMVPRRC3C	M/V PLUG	2.4E-06	5.5E-05	2.4E+01
399	CHIMVCMRC3D	M/V MIS-CLOSE	9.6E-07	2.2E-05	2.4E+01
400	CHIMVCMRC3A	M/V MIS-CLOSE	9.6E-07	2.2E-05	2.4E+01
401	CHIMVCMRC3B	M/V MIS-CLOSE	9.6E-07	2.2E-05	2.4E+01
402	CHIMVCMRC3C	M/V MIS-CLOSE	9.6E-07	2.2E-05	2.4E+01
403	CHIXVELRC5D	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
404	CHIXVELRC5C	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 18 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
405	CHIXVELRC2B	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
406	CHIXVELRC2A	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
407	CHIXVELRC5A	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
408	CHIXVELRC2D	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
409	CHIXVELRC2C	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
410	CHIXVELRC5B	X/V EXTERNAL LEAK L	7.2E-08	1.6E-06	2.4E+01
411	CHICVELRC4C	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
412	CHICVELRC6D	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
413	CHICVELRC6C	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
414	CHICVELRC6A	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
415	CHICVELRC4D	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
416	CHICVELRC6B	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
417	CHICVELRC7D	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
418	CHICVELRC4B	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
419	CHICVELRC4A	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
420	CHICVELRC7B	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
421	CHICVELRC7A	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
422	CHICVELRC7C	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.4E+01
423	CHIMVELRC3D	M/V EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
424	CHIMVELRC3C	M/V EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
425	CHIMVELRC3B	M/V EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
426	CHIMVELRC3A	M/V EXTERNAL LEAK L	2.4E-08	5.5E-07	2.4E+01
427	ACWCF2MVODCH6-ALL	CHI PUMP COOLING DISCHARGE LINE M/V ACWCH6A,B FAILTO OPEN CCF	4.7E-05	1.1E-03	2.4E+01
428	ACWCF2MVODCH2-ALL	FIRE SUPPRESSION SYSTEM BOUNDARY M/V ACWCH2A,B FAILTO OPEN CCF	4.7E-05	1.1E-03	2.4E+01
429	ACWCF2MVODCH4-ALL	FIRE SUPPRESSION SYSTEM BOUNDARY M/V ACWCH4A,B FAILTO OPEN CCF	4.7E-05	1.1E-03	2.4E+01
430	CHICF2PMYR-R-ALL	CHI PUMP FAIL TO RUN CCF	5.0E-06	1.1E-04	2.4E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 19 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
431	ACWCF2CVCDCH5-ALL	ACW C/V CH5 FAIL TO CLOSE CCF	4.7E-06	1.1E-04	2.4E+01
432	CHIMVOM121B	M/V 121B MIS-OPENING	9.6E-07	2.2E-05	2.3E+01
433	CHIMVOM121C	M/V 121C MIS-OPENING	9.6E-07	2.2E-05	2.3E+01
434	ACWCVELCH5B	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.3E+01
435	ACWCVELCH5A	C/V EXTERNAL LEAK L	4.8E-08	1.1E-06	2.3E+01
436	ACWMVELCH6A	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
437	ACWMVELCH6B	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
438	ACWMVELCH7B	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
439	ACWMVELCH7A	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
440	ACWMVELCH3A	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
441	ACWMVELCH2B	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
442	ACWMVELCH2A	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
443	ACWMVELCH4A	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
444	ACWMVELCH4B	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
445	ACWMVELCH3B	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
446	ACWMVELCH8B	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
447	ACWMVELCH8A	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
448	ACWMVELCH1A	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
449	ACWMVELCH1B	M/V EXTERNAL LEAK L	2.4E-08	5.4E-07	2.3E+01
450	EFWCF4CVODXW1-12	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	5.0E-06	2.3E+01
451	CWSCF4CVOD052-R-134	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	1.1E-06	2.3E+01
452	SWSCF4CVOD502-R-134	ESW C/V 502 FAIL TO OPEN CCF	5.0E-08	1.1E-06	2.3E+01
453	SWSCF4CVOD602-R-134	ESW C/V 602 FAIL TO OPEN CCF	5.0E-08	1.1E-06	2.3E+01
454	EPSCF4CBWRVIT4-124	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	6.5E-07	2.3E+01
455	EFWXVELMW4A	X/V MW4A EXTERNAL LEAK L	7.2E-08	1.5E-06	2.2E+01
456	EFWXVELMW4B	X/V MW4B EXTERNAL LEAK L	7.2E-08	1.5E-06	2.2E+01
457	EFWCVELMW1B	C/V MW1B EXTERNAL LEAK L	4.8E-08	1.0E-06	2.2E+01
458	EFWCVELMW1A	C/V MW1A EXTERNAL LEAK L	4.8E-08	1.0E-06	2.2E+01
459	SWSCF4PMBD-R-134	ESW PUMP FAIL TO RE-START CCF	1.5E-05	3.2E-04	2.2E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 20 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
460	EFWCF4CVODAW1-34	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	4.7E-06	2.2E+01
461	EFWCF4CVODAW1-23	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	4.7E-06	2.2E+01
462	EFWCF4CVODAW1-24	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	4.7E-06	2.2E+01
463	EFWMVELEFW04B	M/V EFW04B EXTERNAL LEAK L	2.4E-08	4.9E-07	2.2E+01
464	EFWMVELEFW04A	M/V EFW04A EXTERNAL LEAK L	2.4E-08	4.9E-07	2.2E+01
465	EFWMVELEFW04C	M/V EFW04C EXTERNAL LEAK L	2.4E-08	4.9E-07	2.2E+01
466	EFWMVELEFW04D	M/V EFW04D EXTERNAL LEAK L	2.4E-08	4.9E-07	2.2E+01
467	CWSCF4PCBD-R-124	CWS PUMP FAIL TO RE-START CCF	8.4E-06	1.7E-04	2.1E+01
468	EPSCF4CBWRVIT4-123	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	5.5E-07	2.0E+01
469	EFWCVELAW1B	C/V AW1B EXTERNAL LEAK L	4.8E-08	8.8E-07	1.9E+01
470	EFWCVELAW1C	C/V AW1C EXTERNAL LEAK L	4.8E-08	8.8E-07	1.9E+01
471	PZRCF2MVOD58R-ALL	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF	1.3E-04	2.2E-03	1.9E+01
472	SWSCF4PMBD-R-234	ESW PUMP FAIL TO RE-START CCF	1.5E-05	2.5E-04	1.7E+01
473	CWSCF4PCBD-R-134	CWS PUMP FAIL TO RE-START CCF	8.4E-06	1.3E-04	1.7E+01
474	RWSCF4SUPRST01-23	SUMP STRAINER PLUG CCF	3.0E-06	4.7E-05	1.7E+01
475	SWSCF4CVOD602-R-124	ESW C/V 602 FAIL TO OPEN CCF	5.0E-08	6.9E-07	1.5E+01
476	CWSCF4CVOD052-R-124	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	6.9E-07	1.5E+01
477	SWSCF4CVOD502-R-124	ESW C/V 502 FAIL TO OPEN CCF	5.0E-08	6.9E-07	1.5E+01
478	EFWMVELAWBB	M/V AWBB EXTERNAL LEAK L	2.4E-08	3.3E-07	1.5E+01
479	EFWMVELAWBA	M/V AWBA EXTERNAL LEAK L	2.4E-08	3.3E-07	1.5E+01
480	EFWMVELAWCB	M/V AWCB EXTERNAL LEAK L	2.4E-08	3.3E-07	1.5E+01
481	EFWMVELAWCA	M/V AWCA EXTERNAL LEAK L	2.4E-08	3.3E-07	1.5E+01
482	EPSCF4DLLRDG-123	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	2.5E-04	3.1E-03	1.3E+01
483	EPSCF4DLADDG-123	EPS GTG A,B,C,D FAIL TO START CCF	5.2E-05	6.5E-04	1.3E+01
484	EPSCF4DLSRDG-123	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	4.9E-04	1.3E+01
485	EPSCF4SEFFDG-123	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.6E-04	1.3E+01
486	EPSCF4CBTDDG-123	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	6.4E-05	1.3E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 21 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
487	EPSCF4CBWRDG-124	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	3.6E-07	1.3E+01
488	EPSCF4DLLRDG-124	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	2.5E-04	3.0E-03	1.3E+01
489	EPSCF4DLADDG-124	EPS GTG A,B,C,D FAIL TO START CCF	5.2E-05	6.4E-04	1.3E+01
490	EPSCF4DLSRDG-124	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	4.8E-04	1.3E+01
491	EPSCF4SEFFDG-124	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.5E-04	1.3E+01
492	EPSCF4CBTDDG-124	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	6.3E-05	1.3E+01
493	EPSCF4CBWRDG-134	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	3.6E-07	1.3E+01
494	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	2.4E-01	1.3E+01
495	EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF	1.5E-03	1.7E-02	1.3E+01
496	EPSCF2DLADDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO START	3.1E-04	3.6E-03	1.3E+01
497	EPSCF2DLSRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (<1H) CCF	2.3E-04	2.7E-03	1.3E+01
498	EPSCF2SEFFDGP-ALL	SEQUENCER FAIL TO OPERATE CCF	1.4E-04	1.7E-03	1.3E+01
499	EPSCF2CBTDDGBP-ALL	EPS C/B GTGBP1,2 FAIL TO CLOSED CCF	2.8E-05	3.3E-04	1.3E+01
500	EPPBTSWCCF	EPS P SOFTWARE CCF	1.0E-05	1.2E-04	1.3E+01
501	EPSCF2CBWRDGBP-ALL	EPS C/B GTGBP1,2 FAIL TO REMAIN CLOSED CCF	2.8E-07	3.3E-06	1.3E+01
502	EPSCF2CBTDSWW-ALL	EPS C/B SWWA,D FAIL TO CLOSED CCF	2.8E-05	3.3E-04	1.3E+01
503	EPSCF2CBTD4A-ALL	EPS TIELINE BREAKER 4AA,4AD FAIL TO CLOSED CCF	2.8E-05	3.3E-04	1.3E+01
504	EPSCF2CBWR4A-ALL	EPS TIELINE BREAKER 4AA,4AD FAIL OPERATE	2.8E-07	3.3E-06	1.3E+01
505	EPSCF2CBWRSWW-ALL	BREAKER FAIL OPERATE (CCF)	2.8E-07	3.3E-06	1.3E+01
506	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	2.4E-01	1.2E+01
507	EPSCF2IVFFINV-ALL	EPS INVP1,P2 FAIL TO OPERATE CCF	5.6E-06	6.4E-05	1.2E+01
508	EPSCF2CBWRVIT4P-ALL	EPS C/B VIT4P1,P2 FAIL TO REMAIN CLOSED CCF	2.8E-07	3.2E-06	1.2E+01
509	EPSCF2BYFFP-ALL	EPS BATTERY P1,P2 Fail to Operate CCF	8.4E-08	9.5E-07	1.2E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 22 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
510	SGIBTSWCCF	EFW M/V AWA SG ISOLATION SIGNAL SOFTWARE CCF	1.0E-05	1.1E-04	1.2E+01
511	SGNCF4SGI-ALL	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	5.3E-06	6.0E-05	1.2E+01
512	SGNCF4SGI-12	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	3.5E-06	4.0E-05	1.2E+01
513	SGNCF4SGI-123	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	1.8E-06	2.0E-05	1.2E+01
514	SGNCF4SGI-124	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	1.8E-06	2.0E-05	1.2E+01
515	EPSCF4DLLRDG-234	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	2.5E-04	2.7E-03	1.2E+01
516	EPSCF4DLADDG-234	EPS GTG A,B,C,D FAIL TO START CCF	5.2E-05	5.7E-04	1.2E+01
517	EPSCF4DLSRDG-234	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	4.2E-04	1.2E+01
518	EPSCF4SEFFDG-234	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.3E-04	1.2E+01
519	EPSCF4CBTDDG-134	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	5.6E-05	1.2E+01
520	EPSCF4CBWRDG-123	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	3.2E-07	1.2E+01
521	SGNST-SGIA	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) ISOLATION SIGNAL A FAILURE	4.0E-04	4.3E-03	1.2E+01
522	SGNCF4SGI-24	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	3.5E-06	3.8E-05	1.2E+01
523	SGNCF4SGI-23	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	3.5E-06	3.8E-05	1.2E+01
524	SGNCF4SGI-234	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	1.8E-06	1.9E-05	1.2E+01
525	HPICF4PMADSIP-134	HHI PUMP FAIL TO START (Standby) CCF	9.5E-06	9.9E-05	1.1E+01
526	RWSCF4SUPRST01-124	SUMP STRAINER PLUG CCF	3.7E-06	3.6E-05	1.1E+01
527	HPICF4PMSRSIP-134	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	3.1E-05	1.1E+01
528	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	3.6E-02	1.0E+01
529	SWSCF4CVOD602-R-123	ESW C/V 602 FAIL TO OPEN CCF	5.0E-08	4.6E-07	1.0E+01
530	CWSCF4CVOD052-R-123	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	4.6E-07	1.0E+01
531	SWSCF4CVOD502-R-123	ESW C/V 502 FAIL TO OPEN CCF	5.0E-08	4.6E-07	1.0E+01
532	SWSCF2PMYRSWPBD-A	ESW PUMP B,D FAIL TO RUN CCF	8.9E-06	7.9E-05	9.9E+00
533	SWSCF2PMBDSWPBD-A	ESW PUMP B,D FAIL TO START CCF	1.4E-04	1.2E-03	9.9E+00
534	HPICF4PMLRSIP-234	HHI PUMP FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	9.9E-06	9.8E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 23 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
535	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	2.2E-02	9.5E+00
536	HPICF4CVOD8804-134	C/V 8804 FAIL TO OPEN CCF	2.7E-07	2.2E-06	9.3E+00
537	HPICF4CVOD8806-134	C/V 8806 FAIL TO OPEN CCF	2.7E-07	2.2E-06	9.3E+00
538	HPICF4CVOD8808-134	C/V 8808 FAIL TO OPEN CCF	2.7E-07	2.2E-06	9.3E+00
539	HPICF4CVOD8809-134	C/V 8809 FAIL TO OPEN CCF	2.7E-07	2.2E-06	9.3E+00
540	SWSCF4PMBD-R-123	ESW PUMP FAIL TO RE-START CCF	1.5E-05	1.2E-04	9.1E+00
541	SWSCF2PMYRSWPAC-A	ESW PUMP A,C FAIL TO RUN CCF	8.9E-06	7.0E-05	8.9E+00
542	CWSCF4PCBD-R-234	CWS PUMP FAIL TO RE-START CCF	8.4E-06	6.6E-05	8.9E+00
543	HPICF4PMADSIP-34	HHI PUMP FAIL TO START (Standby) CCF	2.2E-05	1.6E-04	8.4E+00
544	HPICF4PMSRSIP-34	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	2.4E-05	7.6E+00
545	HPICF4PMLRSIP-34	HHI PUMP FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	7.4E-06	7.0E+00
546	EPSBSFFDCD	125V DC BUS-D FAILURE	5.8E-06	3.5E-05	7.0E+00
547	SWSCF2CVOD602BD-AL	ESW C/V 602 FAIL TO OPEN CCF	5.6E-07	3.3E-06	6.9E+00
548	SWSCF2CVOD502BD-AL	ESW C/V 502 FAIL TO OPEN CCF	5.6E-07	3.3E-06	6.9E+00
549	CWSCF2PCYRCWPAC-A	CWS PUMP A,C FAIL TO RUN CCF	5.0E-06	2.8E-05	6.6E+00
550	HPICF4CVOD8806-34	C/V 8806 FAIL TO OPEN CCF	1.6E-07	7.9E-07	5.9E+00
551	HPICF4CVOD8804-34	C/V 8804 FAIL TO OPEN CCF	1.6E-07	7.9E-07	5.9E+00
552	HPICF4CVOD8809-34	C/V 8809 FAIL TO OPEN CCF	1.6E-07	7.9E-07	5.9E+00
553	HPICF4CVOD8808-34	C/V 8808 FAIL TO OPEN CCF	1.6E-07	7.9E-07	5.9E+00
554	RSSCF4PMADCSP-134	CS/RHR PUMP FAIL TO START CCF	6.3E-06	3.1E-05	5.9E+00
555	RSSCF4PMSRCSP-134	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	7.6E-06	5.6E+00
556	RSSCF4MVOD114-134	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	6.6E-06	5.6E+00
557	SWSSTPRST05	STRAINER ST05 PLUG	1.7E-04	7.5E-04	5.5E+00
558	SWSPEELSWPC1	ESW PIPE C1 LEAK	3.9E-06	1.7E-05	5.5E+00
559	SWSCVPR502C	C/V 502C PLUG	2.4E-06	1.1E-05	5.5E+00
560	SWSXVPR503C	X/V 503C PLUG	2.4E-06	1.1E-05	5.5E+00
561	SWSXVPR509C	X/V 509C PLUG	2.4E-06	1.1E-05	5.5E+00
562	SWSXVPR507C	X/V 507C PLUG	2.4E-06	1.1E-05	5.5E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 24 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
563	SWSXVEL503C	X/V 503C EXTEANAL LEAK L	7.2E-08	3.2E-07	5.5E+00
564	SWSXVEL509C	X/V 509C EXTEANAL LEAK L	7.2E-08	3.2E-07	5.5E+00
565	SWSXVELESS0001C	X/V ESS0001C EXTEANAL LEAK L	7.2E-08	3.2E-07	5.5E+00
566	SWSXVEL507C	X/V 507C EXTEANAL LEAK L	7.2E-08	3.2E-07	5.5E+00
567	SWSXVELESS0002C	X/V ESS0002C EXTEANAL LEAK L	7.2E-08	3.2E-07	5.5E+00
568	SWSCVEL502C	C/V 502C EXTERNAL LEAK L	4.8E-08	2.2E-07	5.5E+00
569	SWSPMYRSWPC	ESW PUMP-C FAIL TO RUN (RUNNING)	1.1E-04	4.9E-04	5.4E+00
570	RSSCF4PMLRCSP-134	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	2.5E-06	5.3E+00
571	SWSORPROR24C	ORIFICE OR24C PLUG	2.4E-05	1.0E-04	5.2E+00
572	SWSORPROR04C	ORIFICE OR04C PLUG	2.4E-05	1.0E-04	5.2E+00
573	SWSXVPR569C	X/V 569C PLUG	2.4E-06	1.0E-05	5.2E+00
574	SWSXVPR570C	X/V 570C PLUG	2.4E-06	1.0E-05	5.2E+00
575	SWSPMELSWPC	ESW PUMP-C EXTERNAL LEAK L	1.9E-07	8.2E-07	5.2E+00
576	SWSFMPR2055C	FM 2055C PLUG	2.4E-05	1.0E-04	5.2E+00
577	SWSORPRESS0003C	ORIFICE ESS0003C PLUG	2.4E-05	1.0E-04	5.2E+00
578	SWSXVPR601C	X/V 601C PLUG	2.4E-06	1.0E-05	5.2E+00
579	SWSCVPR602C	C/V 602C PLUG	2.4E-06	1.0E-05	5.2E+00
580	SWSPEELSWSC2	ESW PIPE C2 LEAK	3.8E-07	1.6E-06	5.2E+00
581	SWSXVEL601C	X/V 601C EXTEANAL LEAK L	7.2E-08	3.1E-07	5.2E+00
582	SWSCVEL602C	C/V 602C EXTERNAL LEAK L	4.8E-08	2.0E-07	5.2E+00
583	RSSCF4PMADCSP-123	CS/RHR PUMP FAIL TO START CCF	6.3E-06	2.6E-05	5.1E+00
584	SWSSTPRST02C	STRAINER ST02C PLUG	1.7E-04	6.8E-04	5.1E+00
585	EPSCF4CBTD6H-34	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	2.0E-05	5.0E+00
586	RSSCF4MVOD114-123	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	5.6E-06	4.9E+00
587	RSSCF4PMSRCSP-123	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	6.4E-06	4.9E+00
588	RSSCF4MVOD9011-ALL	CS/RHR M/V 9011 FAIL TO OPEN CCF	8.4E-05	3.2E-04	4.9E+00
589	RSSCF4PMLRCSP-123	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	2.1E-06	4.6E+00
590	RSSCF4CVOD9008-234	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.2E-07	7.9E-07	4.6E+00
591	RSSCF4RHPRRHEX-134	CS/RHR HX PLUG CCF	6.4E-08	2.3E-07	4.6E+00
592	ACCORPRACC02B	ORIFICE ACC02B PLUG	2.4E-05	8.3E-05	4.5E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 25 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
593	ACCORPRACC02C	ORIFICE ACC02C PLUG	2.4E-05	8.3E-05	4.5E+00
594	ACCORPRACC02D	ORIFICE ACC02D PLUG	2.4E-05	8.3E-05	4.5E+00
595	ACCCVOD8948C	C/V 8948C FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
596	ACCCVOD8956C	C/V 8956C FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
597	ACCCVOD8956B	C/V 8956B FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
598	ACCCVOD8948B	C/V 8948B FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
599	ACCCVOD8948D	C/V 8948D FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
600	ACCCVOD8956D	C/V 8956D FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
601	ACCMVPR8949C	M/V 8949C PLUG	2.4E-06	8.3E-06	4.5E+00
602	ACCCVPR8956C	C/V 8956C PLUG	2.4E-06	8.3E-06	4.5E+00
603	ACCCVPR8948C	C/V 8948C PLUG	2.4E-06	8.3E-06	4.5E+00
604	ACCCVPR8956B	C/V 8956B PLUG	2.4E-06	8.3E-06	4.5E+00
605	ACCCVPR8948B	C/V 8948B PLUG	2.4E-06	8.3E-06	4.5E+00
606	ACCMVPR8949B	M/V 8949B PLUG	2.4E-06	8.3E-06	4.5E+00
607	ACCCVPR8956D	C/V 8956D PLUG	2.4E-06	8.3E-06	4.5E+00
608	ACCMVPR8949D	M/V 8949D PLUG	2.4E-06	8.3E-06	4.5E+00
609	ACCCVPR8948D	C/V 8948D PLUG	2.4E-06	8.3E-06	4.5E+00
610	ACCPNELINJD	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	5.7E-08	2.0E-07	4.5E+00
611	ACCPNELINJC	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	5.5E-08	1.9E-07	4.5E+00
612	ACCPNELINJB	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	5.5E-08	1.9E-07	4.5E+00
613	ACCCVEL8948C	C/V 8948C EXTERNAL LEAK L	4.8E-08	1.7E-07	4.5E+00
614	ACCCVEL8948B	C/V 8948B EXTERNAL LEAK L	4.8E-08	1.7E-07	4.5E+00
615	ACCCVEL8948D	C/V 8948D EXTERNAL LEAK L	4.8E-08	1.7E-07	4.5E+00
616	ACCMVEL8949C	M/V 8949C EXTERNAL LEAK L	2.4E-08	8.3E-08	4.5E+00
617	ACCMVEL8949B	M/V 8949B EXTERNAL LEAK L	2.4E-08	8.3E-08	4.5E+00
618	ACCMVEL8949D	M/V 8949D EXTERNAL LEAK L	2.4E-08	8.3E-08	4.5E+00
619	ACCCF4CVOD8948-34	ACC SECOND C/V FAIL TO OPEN CCF	1.6E-07	5.5E-07	4.4E+00
620	ACCCF4CVOD8956-13	ACC BOUNDARY C/V FAIL TO OPEN CCF	1.6E-07	5.5E-07	4.4E+00
621	ACCCF4CVOD8948-24	ACC SECOND C/V FAIL TO OPEN CCF	1.6E-07	5.5E-07	4.4E+00
622	ACCCF4CVOD8948-14	ACC SECOND C/V FAIL TO OPEN CCF	1.6E-07	5.5E-07	4.4E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 26 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
623	ACCCF4CVOD8956-23	ACC BOUNDARY C/V FAIL TO OPEN CCF	1.6E-07	5.5E-07	4.4E+00
624	ACCCF4CVOD8956-34	ACC BOUNDARY C/V FAIL TO OPEN CCF	1.6E-07	5.5E-07	4.4E+00
625	RSSCVELACC01D	C/V ACC01D EXTERNAL LEAK L	4.8E-08	1.6E-07	4.4E+00
626	RSSCVELACC01B	C/V ACC01B EXTERNAL LEAK L	4.8E-08	1.6E-07	4.4E+00
627	ACCCVEL8956D	C/V 8956D EXTERNAL LEAK L	4.8E-08	1.6E-07	4.4E+00
628	ACCCVEL8956B	C/V 8956B EXTERNAL LEAK L	4.8E-08	1.6E-07	4.4E+00
629	RSSCVELACC01C	C/V ACC01C EXTERNAL LEAK L	4.8E-08	1.6E-07	4.4E+00
630	ACCCVEL8956C	C/V 8956C EXTERNAL LEAK L	4.8E-08	1.6E-07	4.4E+00
631	EPSBSFF6ESBC	6.9KV SAFETY C BUS FAILURE	5.8E-06	1.9E-05	4.3E+00
632	SWSXVPR561C	X/V 561C PLUG	2.4E-06	8.0E-06	4.3E+00
633	SWSXVPR562C	X/V 562C PLUG	2.4E-06	8.0E-06	4.3E+00
634	SWSRIELSWHXC	HEAT EXCHANGER CCWHXC TUBE EXTERNAL LEAK L	7.2E-07	2.4E-06	4.3E+00
635	SWSPEELSWSC3	ESW PIPE C3 LEAK	2.1E-07	7.1E-07	4.3E+00
636	SWSXVEL562C	X/V 562C EXTEANAL LEAK L	7.2E-08	2.4E-07	4.3E+00
637	SWSXVEL561C	X/V 561C EXTEANAL LEAK L	7.2E-08	2.4E-07	4.3E+00
638	HPICF4PMADSIP-123	HHI PUMP FAIL TO START (Standby) CCF	9.5E-06	3.1E-05	4.3E+00
639	EPSBSFFDCA	125V DC BUS-A FAILURE	5.8E-06	1.8E-05	4.2E+00
640	EPSCF4CBTD6H-13	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	1.5E-05	4.1E+00
641	HPICF4PMSRSIP-123	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	9.6E-06	3.9E+00
642	RSSCF4CVOD9012-ALL	CS/RHR C/V 9012 FAIL TO OPEN CCF	4.3E-07	1.3E-06	3.9E+00
643	RSSCF4CVOD9008-124	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.2E-07	6.5E-07	3.9E+00
644	RSSCF4RHPRRHEX-123	CS/RHR HX PLUG CCF	6.4E-08	1.9E-07	3.9E+00
645	EFWCF2PMADFWP2-ALL	EFW M/D FWP2 FAIL TO START CCF	2.2E-04	6.4E-04	3.9E+00
646	HVACF2FAADDGF-ALL	M/D EFW PUMP ROOM HVAC FAN FAIL TO START (CCF)	1.4E-04	4.1E-04	3.9E+00
647	HVACF2FALRDGF-ALL	M/D EFW PUMP ROOM HVAC FAN FAIL TO RUN (>1H)	1.3E-04	3.7E-04	3.9E+00
648	EPSCF4IVFFINV-14	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	2.9E-06	3.9E+00
649	HVACF2FASRDGF-ALL	M/D EFW PUMP ROOM HVAC FAN FAIL TO RUN (<1H)	9.4E-05	2.7E-04	3.9E+00
650	VCWCF4CHYR-ALL	SAFETY CHILLER UNIT A,B,C,D FAIL TO RUN (CCF)	2.7E-05	7.5E-05	3.8E+00
651	VCWCF4CHYR-23	SAFETY CHILLER UNIT FAIL TO RUN (CCF)	1.8E-05	5.0E-05	3.8E+00
652	VCWCF4CHYR-123	SAFETY CHILLER UNIT FAIL TO RUN (CCF)	9.0E-06	2.5E-05	3.8E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 27 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
653	VCWCF4CHYR-234	SAFETY CHILLER UNIT FAIL TO RUN (CCF)	9.0E-06	2.5E-05	3.8E+00
654	EPSCF4IVFFINV-34	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	2.8E-06	3.8E+00
655	HPICF4PMADSIP-124	HHI PUMP FAIL TO START (Standby) CCF	9.5E-06	2.6E-05	3.7E+00
656	EPSCF4CBTD6H-24	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	1.3E-05	3.7E+00
657	HPICF4PMLRSIP-123	HHI PUMP FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	3.1E-06	3.7E+00
658	HPICF4CVOD8809-123	C/V 8809 FAIL TO OPEN CCF	2.7E-07	7.2E-07	3.7E+00
659	HPICF4CVOD8806-123	C/V 8806 FAIL TO OPEN CCF	2.7E-07	7.2E-07	3.7E+00
660	HPICF4CVOD8808-123	C/V 8808 FAIL TO OPEN CCF	2.7E-07	7.2E-07	3.7E+00
661	HPICF4CVOD8804-123	C/V 8804 FAIL TO OPEN CCF	2.7E-07	7.2E-07	3.7E+00
662	EFWCF2PMSRFWP2-ALL	EFW FWP2 FAIL TO RUN (<1h) CCF	1.7E-05	4.5E-05	3.6E+00
663	CWSCF2PCBDCWPBD-ALL	CWS PUMP B,D FAIL TO START CCF	7.5E-05	2.0E-04	3.6E+00
664	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO	6.5E-03	1.7E-02	3.6E+00
665	EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)	2.4E-03	6.3E-03	3.6E+00
666	EFWPTLRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (>1H)	1.5E-03	4.1E-03	3.6E+00
667	EFWPTELFWP1A	T/P FWP1A EXTERNAL LEAK L	2.2E-07	5.7E-07	3.6E+00
668	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER	2.0E-02	5.3E-02	3.6E+00
669	EFWMVODTS1A	M/V TS1A FAIL TO OPEN	9.6E-04	2.5E-03	3.6E+00
670	EPSCF4BYFF-14	EPS BATTERY Fail to Operate CCF	1.9E-08	4.9E-08	3.6E+00
671	EPSCF4BYFF-23	EPS BATTERY Fail to Operate CCF	1.9E-08	4.9E-08	3.6E+00
672	EFMBTSWCCF	EFW MDP START SIGNAL SOFTWARE CCF	1.0E-05	2.6E-05	3.6E+00
673	SGNST-EFWTDA	TURBIN SIGNAL-A FAIL	4.3E-04	1.1E-03	3.6E+00
674	SWSCF4PMBD-R-14	ESW PUMP FAIL TO RE-START CCF	7.1E-05	1.8E-04	3.5E+00
675	EFWCF2PMLRFWP2-ALL	EFW FWP2 FAIL TO RUN (>1h) CCF	5.9E-06	1.5E-05	3.5E+00
676	CWSCF4PCBD-R-12	CWS PUMP FAIL TO RE-START CCF	3.9E-05	9.6E-05	3.5E+00
677	EFWMVFCTS1A	M/V TS1A FAIL TO CONTROL	7.2E-05	1.8E-04	3.4E+00
678	EFWMVPRTS1A	M/V TS1A PLUG	2.4E-06	5.9E-06	3.4E+00
679	EFWMVCMTS1A	M/V TS1A MIS-CLOSE	9.6E-07	2.4E-06	3.4E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 28 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
680	EFWMVELTS1A	M/V TS1A EXTERNAL LEAK L	2.4E-08	5.9E-08	3.4E+00
681	EFWPNELSTA	STEAM LINE A PIPE LEAK	6.0E-10	1.5E-09	3.4E+00
682	CWSCF2PCYRCWPBD-ALL	CWS PUMP B,D FAIL TO RUN CCF	5.0E-06	1.2E-05	3.4E+00
683	EPSTRFFPTA	4PTA TRANSFORMER FAIL TO RUN	8.2E-06	1.9E-05	3.4E+00
684	EPSBSFF4ESBA	480V BUS A FAILURE	5.8E-06	1.4E-05	3.4E+00
685	RSSCF4PMADCSP-234	CS/RHR PUMP FAIL TO START CCF	6.3E-06	1.5E-05	3.4E+00
686	EPSCF4CBWR4I-123	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	6.8E-08	3.3E+00
687	SWSCF4PMBD-R-23	ESW PUMP FAIL TO RE-START CCF	7.1E-05	1.7E-04	3.3E+00
688	EPSCF4CBTD6H-12	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	1.2E-05	3.3E+00
689	EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE	5.0E-03	1.2E-02	3.3E+00
690	HPICF4PMSRSIP-124	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	7.6E-06	3.3E+00
691	CWSCF4PCBD-R-34	CWS PUMP FAIL TO RE-START CCF	3.9E-05	9.1E-05	3.3E+00
692	EPSBSFF4MCCA1	480V MCC A1 BUS FAILURE	5.8E-06	1.3E-05	3.3E+00
693	EPSCBWR4IA	4IA BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	6.9E-06	3.3E+00
694	EPSCBWR4JA	4JA BREAKER FAIL OPERATE (MALFUNCTION)	3.0E-06	6.9E-06	3.3E+00
695	HPICF4PMADSIP-23	HHI PUMP FAIL TO START (Standby) CCF	2.2E-05	4.9E-05	3.3E+00
696	VCWCF4PMYR-ALL	SAFETY CHILLED WATER PUMP A,B,C,D FAIL TO RUN	1.5E-06	3.4E-06	3.3E+00
697	VCWCF4PMYR-23	SAFETY CHILLED WATER PUMP FAIL TO RUN (CCF)	1.0E-06	2.3E-06	3.3E+00
698	VCWCF4PMYR-234	SAFETY CHILLED WATER PUMP FAIL TO RUN (CCF)	5.0E-07	1.1E-06	3.3E+00
699	VCWCF4PMYR-123	SAFETY CHILLED WATER PUMP FAIL TO RUN (CCF)	5.0E-07	1.1E-06	3.3E+00
700	EFWCVODTW1A	C/V TW1A FAIL TO OPEN	9.5E-06	2.1E-05	3.2E+00
701	EFWXVPRTW4A	X/V TW4A PLUG	2.4E-06	5.4E-06	3.2E+00
702	EFWCVPRTW1A	C/V TW1A PLUG	2.4E-06	5.4E-06	3.2E+00
703	EPSTRFFPTD	4PTD TRANSFORMER FAIL TO RUN	8.2E-06	1.8E-05	3.2E+00
704	EPSBSFF4ESBD	480V BUS D FAILURE	5.8E-06	1.3E-05	3.2E+00
705	EFWXVILTW6AA	X/V TW6AA INTERNAL LEAK L	1.1E-05	2.3E-05	3.2E+00
706	EFWXVELTW6AB	X/V TW6AB EXTEANAL LEAK L	7.2E-08	1.6E-07	3.2E+00
707	EFWXVELTW6AA	X/V TW6AA EXTEANAL LEAK L	7.2E-08	1.6E-07	3.2E+00
708	EFWCVELTW7AA	C/V TW7AA EXTERNAL LEAK L	4.8E-08	1.1E-07	3.2E+00
709	EFWCVELTW7AB	C/V TW7AB EXTERNAL LEAK L	4.8E-08	1.1E-07	3.2E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 29 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
710	RSSCF4PMSRCSP-234	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	3.6E-06	3.2E+00
711	HPICF4PMLRSIP-124	HHI PUMP FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	2.4E-06	3.1E+00
712	EPSBSFF4MCCD1	480V MCC D1 BUS FAILURE	5.8E-06	1.2E-05	3.1E+00
713	EPSCBWR4JD	4JD BREAKER FAIL OPERATE (MALFUNCTION)	3.0E-06	6.5E-06	3.1E+00
714	EPSCBWR4ID	4ID BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	6.5E-06	3.1E+00
715	EPSCF4DLLRDG-23	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	5.4E-04	3.1E+00
716	EPSCF4DLADDG-23	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	9.1E-05	3.1E+00
717	EPSCF4DLSRDG-23	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	8.6E-05	3.1E+00
718	EPSCF4SEFFDG-23	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	5.3E-05	3.1E+00
719	EPSCF4CBTDDG-13	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.0E-06	1.1E-05	3.1E+00
720	EPSCF4CBWRDG-12	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	7.2E-08	3.1E+00
721	RSSCF4MVOD114-234	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	3.0E-06	3.1E+00
722	HPICF4CVOD8806-124	C/V 8806 FAIL TO OPEN CCF	2.7E-07	5.6E-07	3.1E+00
723	HPICF4CVOD8809-124	C/V 8809 FAIL TO OPEN CCF	2.7E-07	5.6E-07	3.1E+00
724	HPICF4CVOD8808-124	C/V 8808 FAIL TO OPEN CCF	2.7E-07	5.6E-07	3.1E+00
725	HPICF4CVOD8804-124	C/V 8804 FAIL TO OPEN CCF	2.7E-07	5.6E-07	3.1E+00
726	CWSCF4MVCD043-ALL	CWS M/V 043 FAILTO CLOSE CCF	1.3E-05	2.6E-05	3.1E+00
727	CWSCF4MVCD056-ALL	CWS M/V 056 FAILTO CLOSE	1.3E-05	2.6E-05	3.1E+00
728	EPSCF4DLLRDG-14	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	5.0E-04	3.0E+00
729	EPSCF4DLADDG-14	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	8.4E-05	3.0E+00
730	EPSCF4DLSRDG-14	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	7.9E-05	3.0E+00
731	EPSCF4SEFFDG-14	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	4.9E-05	3.0E+00
732	EPSCF4CBTDDG-24	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.0E-06	9.7E-06	3.0E+00
733	EPSCF4CBWRDG-34	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	6.6E-08	3.0E+00
734	MSROO02533A	OPERATOR FAILS TO CLOSE MAIN STEAM ISOLATION VALVES (HE)	2.6E-03	4.9E-03	2.9E+00
735	RSSCF4PMLRCSP-234	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	1.1E-06	2.9E+00
736	HPICF4PMSRSIP-23	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	6.8E-06	2.9E+00
737	EFWXVPRTW3A	X/V TW3A PLUG	2.4E-06	4.6E-06	2.9E+00
738	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP	2.6E-03	4.8E-03	2.9E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 30 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
739	EPSCF4DLLRDG-13	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	4.5E-04	2.8E+00
740	EPSCF4DLADDG-13	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	7.5E-05	2.8E+00
741	EPSCF4DLSRDG-13	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	7.1E-05	2.8E+00
742	EPSCF4SEFFDG-13	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	4.4E-05	2.8E+00
743	EPSCF4CBTDDG-23	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.0E-06	8.7E-06	2.8E+00
744	EPSCF4CBWRDG-24	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	5.9E-08	2.8E+00
745	EPSCF4DLLRDG-34	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	4.4E-04	2.7E+00
746	EPSCF4DLADDG-34	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	7.4E-05	2.7E+00
747	EPSCF4DLSRDG-34	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	7.0E-05	2.7E+00
748	EPSCF4SEFFDG-34	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	4.3E-05	2.7E+00
749	EPSCF4CBTDDG-34	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.0E-06	8.6E-06	2.7E+00
750	EPSCF4CBWRDG-23	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	5.8E-08	2.7E+00
751	CHIPMBDCHPB-R	CHP-B FAIL TO START (RUNNING)	1.8E-03	3.1E-03	2.7E+00
752	EFWOO04LAAA	EFW PIT WATER LEVEL GAGE A CALIBRATION MISS (HE)	2.2E-04	3.8E-04	2.7E+00
753	EPSCF4CBTD6H-23	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	8.4E-06	2.7E+00
754	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	9.0E-03	2.7E+00
755	HPICF4PMLRSIP-13	HHI PUMP FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	2.1E-06	2.7E+00
756	RWSCF4SUPRST01-13	SUMP STRAINER PLUG CCF	3.0E-06	5.0E-06	2.7E+00
757	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO	6.5E-03	1.1E-02	2.6E+00
758	EFWPTSRFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO RUN (<1H)	2.4E-03	3.9E-03	2.6E+00
759	EFWPTLRFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO RUN (>1H)	1.5E-03	2.5E-03	2.6E+00
760	EFWPTELFWP1B	T/P FWP1B EXTERNAL LEAK L	2.2E-07	3.6E-07	2.6E+00
761	EFWMVODTS1B	M/V TS1B FAIL TO OPEN	9.6E-04	1.5E-03	2.6E+00
762	RWSCF4SUPRST01-24	SUMP STRAINER PLUG CCF	3.0E-06	4.8E-06	2.6E+00
763	SGNST-EFWTDB	TURBIN SIGNAL-B FAIL	4.3E-04	6.7E-04	2.6E+00
764	EFWCF4CVODXW1-14	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	3.4E-07	2.5E+00
765	EFWMVFCTS1B	M/V TS1B FAIL TO CONTROL	7.2E-05	1.1E-04	2.5E+00
766	EFWMVPRTS1B	M/V TS1B PLUG	2.4E-06	3.6E-06	2.5E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 31 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
767	EFWMVCMTS1B	M/V TS1B MIS-CLOSE	9.6E-07	1.4E-06	2.5E+00
768	EFWMVELTS1B	M/V TS1B EXTERNAL LEAK L	2.4E-08	3.6E-08	2.5E+00
769	EFWPNELSTB	STEAM LINE B PIPE LEAK	6.0E-10	8.9E-10	2.5E+00
770	EPSCF4IVFFINV-24	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	1.5E-06	2.5E+00
771	EPSCF4IVFFINV-13	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	1.4E-06	2.4E+00
772	EPSCF4CBWR4J-24	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	4.7E-08	2.4E+00
773	EPSCF4CBWR4J-14	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	4.7E-08	2.4E+00
774	EPSCF4CBWR4I-13	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	4.7E-08	2.4E+00
775	EPSCF4CBWR4I-12	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	4.7E-08	2.4E+00
776	EPSCF4CBWR4J-124	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.1E-08	2.4E+00
777	HPICF4CVOD8806-23	C/V 8806 FAIL TO OPEN CCF	1.6E-07	2.2E-07	2.4E+00
778	HPICF4CVOD8804-23	C/V 8804 FAIL TO OPEN CCF	1.6E-07	2.2E-07	2.4E+00
779	HPICF4CVOD8809-23	C/V 8809 FAIL TO OPEN CCF	1.6E-07	2.2E-07	2.4E+00
780	HPICF4CVOD8808-23	C/V 8808 FAIL TO OPEN CCF	1.6E-07	2.2E-07	2.4E+00
781	EPSCF4CBWR4J-23	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	4.6E-08	2.4E+00
782	EPSCF4CBWR4J-13	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	4.6E-08	2.4E+00
783	EPSCF4CBWR4I-34	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	4.6E-08	2.4E+00
784	EPSCF4CBWR4I-24	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	4.6E-08	2.4E+00
785	EPSCF4CBWR4J-123	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.0E-08	2.4E+00
786	EPSCF4CBWR4I-234	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	4.0E-08	2.4E+00
787	RSSCF4CVOD9008-123	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.2E-07	3.0E-07	2.3E+00
788	RSSCF4RHPRRHEX-234	CS/RHR HX PLUG CCF	6.4E-08	8.6E-08	2.3E+00
789	CWSPCYRCWPC	CCWP-C FAIL TO RUN (RUNNING)	6.2E-05	8.3E-05	2.3E+00
790	EFWCVODTW1B	C/V TW1B FAIL TO OPEN	9.5E-06	1.3E-05	2.3E+00
791	EFWCVPRTW1B	C/V TW1B PLUG	2.4E-06	3.2E-06	2.3E+00
792	EFWXVPRTW4B	X/V TW4B PLUG	2.4E-06	3.2E-06	2.3E+00
793	EFWTMTAB	D-EMERGENCY FEED WATER PUMP(FWP1B) OUTAGE	5.0E-03	6.7E-03	2.3E+00
794	EPSCF4IVFFINV-23	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	1.3E-06	2.3E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 32 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
795	EFWXVILTW6BA	X/V TW6BA INTERNAL LEAK L	1.1E-05	1.4E-05	2.3E+00
796	EFWXVELTW6BB	X/V TW6BB EXTEANAL LEAK L	7.2E-08	9.5E-08	2.3E+00
797	EFWXVELTW6BA	X/V TW6BA EXTEANAL LEAK L	7.2E-08	9.5E-08	2.3E+00
798	EFWCVELTW7BA	C/V TW7BA EXTERNAL LEAK L	4.8E-08	6.3E-08	2.3E+00
799	EFWCVELTW7BB	C/V TW7BB EXTERNAL LEAK L	4.8E-08	6.3E-08	2.3E+00
800	MFWOO02R	OPERATOR FAILS TO RECOVER MAIN FEED WATER	3.8E-03	4.9E-03	2.3E+00
801	CWSORPR1230C	ORIFICE 1230C PLUG	2.4E-05	3.1E-05	2.3E+00
802	CWSCVPR052C	C/V 052C PLUG	2.4E-06	3.1E-06	2.3E+00
803	CWSXVPR014C	X/V 014C PLUG	2.4E-06	3.1E-06	2.3E+00
804	CWSXVPR055C	X/V 055C PLUG	2.4E-06	3.1E-06	2.3E+00
805	CWSXVPR045C	X/V 045C PLUG	2.4E-06	3.1E-06	2.3E+00
806	CWSXVPR101C	X/V 101C PLUG	2.4E-06	3.1E-06	2.3E+00
807	CWSXVPR103C	X/V 103C PLUG	2.4E-06	3.1E-06	2.3E+00
808	SGNTMLGSC	ESFAS and SLS C MAINTENANCE	3.0E-04	3.9E-04	2.3E+00
809	HPICF4PMADSIP-24	HHI PUMP FAIL TO START (Standby) CCF	2.2E-05	2.7E-05	2.2E+00
810	CWSORPR1224C	ORIFICE 1224C PLUG	2.4E-05	3.0E-05	2.2E+00
811	SGNTMLGSB	ESFAS and SLS B MAINTENANCE	3.0E-04	3.7E-04	2.2E+00
812	RSSCF4PMADCSP-124	CS/RHR PUMP FAIL TO START CCF	6.3E-06	7.6E-06	2.2E+00
813	SWSSTPRST03	STRAINER ST03 PLUG	1.7E-04	2.0E-04	2.2E+00
814	SWSPEELSWPB1	ESW PIPE B1 LEAK	3.9E-06	4.6E-06	2.2E+00
815	SWSXVPR503B	X/V 503B PLUG	2.4E-06	2.9E-06	2.2E+00
816	SWSXVPR509B	X/V 509B PLUG	2.4E-06	2.9E-06	2.2E+00
817	SWSCVPR502B	C/V 502B PLUG	2.4E-06	2.9E-06	2.2E+00
818	SWSXVPR507B	X/V 507B PLUG	2.4E-06	2.9E-06	2.2E+00
819	SWSXVEL503B	X/V 503B EXTEANAL LEAK L	7.2E-08	8.6E-08	2.2E+00
820	SWSXVEL509B	X/V 509B EXTEANAL LEAK L	7.2E-08	8.6E-08	2.2E+00
821	SWSXVEL507B	X/V 507B EXTEANAL LEAK L	7.2E-08	8.6E-08	2.2E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 33 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
822	SWSXVELESS0001B	X/V ESS0001B EXTEANAL LEAK L	7.2E-08	8.6E-08	2.2E+00
823	SWSXVELESS0002B	X/V ESS0002B EXTEANAL LEAK L	7.2E-08	8.6E-08	2.2E+00
824	SWSCVEL502B	C/V 502B EXTERNAL LEAK L	4.8E-08	5.7E-08	2.2E+00
825	SWSCF4PMBD-R-24	ESW PUMP FAIL TO RE-START CCF	7.1E-05	8.4E-05	2.2E+00
826	RSSCF4PMADCSP-34	CS/RHR PUMP FAIL TO START CCF	1.3E-05	1.5E-05	2.2E+00
827	SWSPMYRSWPB	ESW PUMP-B FAIL TO RUN (RUNNING)	1.1E-04	1.3E-04	2.2E+00
828	EFWCF4CVODXW1-34	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	2.6E-07	2.2E+00
829	RSSCF4MVOD114-124	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	1.6E-06	2.1E+00
830	CWSCF4PCBD-R-13	CWS PUMP FAIL TO RE-START CCF	3.9E-05	4.4E-05	2.1E+00
831	SWSTMPESWPB	ESW PUMP-B OUTAGE	1.2E-02	1.4E-02	2.1E+00
832	SGNST-BOB	B.O-B SIGNAL LOW FAIL	4.3E-04	4.7E-04	2.1E+00
833	EFWXVPRTW3B	X/V TW3B PLUG	2.4E-06	2.7E-06	2.1E+00
834	SWSORPROR24B	ORIFICE OR24B PLUG	2.4E-05	2.6E-05	2.1E+00
835	SWSORPROR04B	ORIFICE OR04B PLUG	2.4E-05	2.6E-05	2.1E+00
836	SWSXVPR570B	X/V 570B PLUG	2.4E-06	2.6E-06	2.1E+00
837	SWSXVPR569B	X/V 569B PLUG	2.4E-06	2.6E-06	2.1E+00
838	SWSPMELSWPB	ESW PUMP-B EXTERNAL LEAK L	1.9E-07	2.1E-07	2.1E+00
839	SWSORPRESS0003B	ORIFICE ESS0003B PLUG	2.4E-05	2.6E-05	2.1E+00
840	SWSFMPR2055B	FM 2055B PLUG	2.4E-05	2.6E-05	2.1E+00
841	SWSXVPR601B	X/V 601B PLUG	2.4E-06	2.6E-06	2.1E+00
842	SWSCVPR602B	C/V 602B PLUG	2.4E-06	2.6E-06	2.1E+00
843	SWSPEELSWSB2	ESW PIPE B2 LEAK	3.8E-07	4.1E-07	2.1E+00
844	SWSXVEL601B	X/V 601B EXTEANAL LEAK L	7.2E-08	7.9E-08	2.1E+00
845	SWSCVEL602B	C/V 602B EXTERNAL LEAK L	4.8E-08	5.2E-08	2.1E+00
846	RSSCF4PMSRCSP-34	CS/RHR PUMP FAIL TO RUN (<1H) CCF	3.3E-06	3.6E-06	2.1E+00
847	SWSCF4PMBD-R-34	ESW PUMP FAIL TO RE-START CCF	7.1E-05	7.7E-05	2.1E+00
848	RSSCF4PMSRCSP-124	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	1.8E-06	2.1E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-28 Basic Events (Hardware Failure, Human Error) RAW (Sheet 34 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
849	SWSCF4PMBD-R-12	ESW PUMP FAIL TO RE-START CCF	7.1E-05	7.6E-05	2.1E+00
850	EFWCF4CVODXW1-23	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	2.4E-07	2.1E+00
851	RSSCF4MVOD114-34	CS/RHR M/V 114 FAIL TO OPEN CCF	5.7E-06	6.0E-06	2.1E+00
852	EFWXVPRPW2B	X/V PW2B PLUG	2.4E-06	2.5E-06	2.0E+00
853	CWSCF2CVOD052BD-ALL	CWS C/V 052B,D FAIL TO OPEN CCF	5.6E-07	5.9E-07	2.0E+00
854	CWSCF4PCBD-R-14	CWS PUMP FAIL TO RE-START CCF	3.9E-05	4.1E-05	2.0E+00
855	CWSCF4PCBD-R-23	CWS PUMP FAIL TO RE-START CCF	3.9E-05	4.0E-05	2.0E+00
856	RSSCF4PMLRCSP-34	CS/RHR PUMP FAIL TO RUN (>1H) CCF	1.2E-06	1.2E-06	2.0E+00
857	EPSBSFF6ESBD	6.9KV SAFETY D BUS FAILURE	5.8E-06	5.8E-06	2.0E+00
858	RSSCF4PMLRCSP-124	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	5.6E-07	2.0E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-29 Common Cause Failure FV Importance

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	9.9E-04	1.9E-01	1.9E+02
2	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.5E-01	7.4E+03
3	EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF	2.1E-04	4.0E-02	1.9E+02
4	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	3.4E-02	3.5E+03
5	EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF	1.6E-04	2.9E-02	1.9E+02
6	SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF	4.8E-05	2.0E-02	4.3E+02
7	EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF	1.5E-03	1.7E-02	1.3E+01
8	EFWCF2PTADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF	4.5E-04	1.3E-02	2.9E+01
9	CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF	2.6E-05	1.1E-02	4.3E+02
10	HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF	1.1E-04	8.4E-03	7.6E+01

Table 19.1-30 Common Cause Failure RAW

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4BYFF-234	EPS BATTERY A,C,D FAIL TO OPERATE CCF	1.2E-08	4.4E-04	3.5E+04
2	EPSCF4BYFF-124	EPS BATTERY A,B,D FAIL TO OPERATE CCF	1.2E-08	4.4E-04	3.5E+04
3	RTPBTSWCCF	SUPPORT SOFTWARE CCF	1.0E-07	1.0E-03	1.0E+04
4	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.5E-01	7.4E+03
5	SWSCF4PMYR-FF	ESW PUMP A,B,C,D FAIL TO RUN CCF	1.2E-08	6.7E-05	5.6E+03
6	CWSCF4RHPR-FF	ALL COMPONENT COOLING HEAT EXCHANGERS PLUG/FOUL OR LARGE EXTERNAL LEAK CCF	3.6E-08	1.9E-04	5.2E+03
7	EPSCF4BYFF-24	EPS BATTERY A,D FAIL TO OPERATE CCF	1.9E-08	9.5E-05	5.0E+03
8	CWSCF4PCYR-FF	CCW PUMP ALL FAIL TO RUN CCF	6.7E-09	3.2E-05	4.8E+03
9	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	3.4E-02	3.5E+03
10	EPSCF4BYFF-134	EPS BATTERY A,B,C FAIL TO OPERATE CCF	1.2E-08	3.1E-05	2.5E+03

Table 19.1-31 Human Error FV Importance

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	2.4E-01	1.2E+01
2	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	2.4E-01	1.3E+01
3	ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	5.1E-01	2.3E-01	1.2E+00
4	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER	2.0E-02	5.3E-02	3.6E+00
5	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	3.6E-02	1.0E+01
6	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	2.2E-02	9.5E+00
7	NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)	2.5E-02	1.2E-02	1.5E+00
8	RSSOO02LNUP	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CORE COOLING (HE)	8.5E-03	6.1E-03	1.7E+00
9	MSROO02533A	OPERATOR FAILS TO CLOSE MAIN STEAM ISOLATION VALVES (HE)	2.6E-03	4.9E-03	2.9E+00
10	MFWOO02R	OPERATOR FAILS TO RECOVER MAIN FEED WATER SYSTEM (HE)	3.8E-03	4.9E-03	2.3E+00

Table 19.1-32 Human Error RAW

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	2.4E-01	1.3E+01
2	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	2.4E-01	1.2E+01
3	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	3.6E-02	1.0E+01
4	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	2.2E-02	9.5E+00
5	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER	2.0E-02	5.3E-02	3.6E+00
6	MSROO02533A	OPERATOR FAILS TO CLOSE MAIN STEAM ISOLATION VALVES (HE)	2.6E-03	4.9E-03	2.9E+00
7	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP	2.6E-03	4.8E-03	2.9E+00
8	EFWOO04LAAA	EFW PIT WATER LEVEL GAGE A CALIBRATION MISS (HE)	2.2E-04	3.8E-04	2.7E+00
9	MFWOO02R	OPERATOR FAILS TO RECOVER MAIN FEED WATER SYSTEM (HE)	3.8E-03	4.9E-03	2.3E+00
10	EFWOO04LBBB	EFW PIT WATER LEVEL GAGE B CALIBRATION MISS (HE)	2.2E-04	1.8E-04	1.8E+00

Table 19.1-33 Hardware Single Failure FV Importance

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START	6.5E-03	1.7E-02	3.6E+00
2	RTPMTCF	MODERATOR TEMPERATURE COEFFICIENT	1.0E-01	1.1E-02	1.1E+00
3	EPSDLLRDGP1-L2	AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN	1.8E-02	1.1E-02	1.6E+00
4	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START	6.5E-03	1.1E-02	2.6E+00
5	MFWHARD	MAIN FEED WATER HARD WARE FAIL	1.0E-01	9.8E-03	1.1E+00
6	EPSDLLRDGP2-L2	AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN	1.8E-02	9.3E-03	1.5E+00
7	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	9.0E-03	2.7E+00
8	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	8.5E-03	8.5E+04
9	EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)	2.4E-03	6.3E-03	3.6E+00
10	EPSDLLRDGC	EMERGENCY GAS TURBINE GENERATOR (GTG C) FAIL TO RUN (>1H)	1.7E-02	5.4E-03	1.3E+00

Table 19.1-34 Hardware Single Failure RAW

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	8.5E-03	8.5E+04
2	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL LEAK	7.2E-08	2.5E-04	3.5E+03
3	RWSTNELRWSP	REFUELING WATER STORAGE PIT LARGE EXTERNAL	4.8E-08	1.7E-04	3.5E+03
4	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	8.4E-05	3.5E+03
5	RSSPNEL01B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	1.0E-04	3.5E+03
6	RSSPNEL01D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	1.0E-04	3.5E+03
7	RSSPNEL01A	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	1.0E-04	3.5E+03
8	RSSPNEL01C	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	1.0E-04	3.5E+03
9	HPIPNELSUCTSD	SAFETY INJECTION SYSTEM D TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	9.8E-05	3.5E+03
10	HPIPNELSUCTSC	SAFETY INJECTION SYSTEM C TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	9.8E-05	3.5E+03

Table 19.1-35 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 1 of 4)

Key Sources of Uncertainty and Key Assumptions		Type (Note)	Summary Results of Qualitative Assessments	Quantitative Approach
Unique Equipments and their Duty to the US-APWR Design	SDVs	M	Motor-operated valves will be more reliable than air-operated valves for feed and bleed operation.	NA
	Motor-Operated Main Steam Relief Valves (MSRVs)	M	Hardware failure probabilities of MSRVs are not significant contributors to CDF.	NA
	Advanced Accumulators	M	The failure modes of the advanced accumulators are assumed similar to existing accumulators in the current PWR plants. Advanced accumulators are not significant contributors to CDF.	NA
	CSS/RHRS system	M	Appropriate conservative and simplified assumptions are made in the event tree / fault tree models.	NA
	Gas turbine generators	M	Sensitivity analysis of failure probability and failure rates was performed.	Sensitivity Analysis (Case 8)
	Digital I&C	M	Applied requirement or reliability for digital I&C.	NA
Initiating Event Analysis	Completeness of initiating events to the US-APWR design	C	Rare initiating events to the US-APWR design are assessed.	NA
	Statistical uncertainty of initiating event frequency	P	(Statistical uncertainty is considered)	Uncertainty Analysis

Table 19.1-35 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 2 of 4)

Key Sources of Uncertainty and Key Assumptions		Type (Note)	Summary Results of Qualitative Assessments	Quantitative Approach
Event Tree Analysis	Identification of accident sequences	M	Considered realistic accident sequences.	NA
Success Criteria Analysis	Boundary conditions Plant parameters	M	Appropriate simplified evaluations for the US-APWR have been performed.	NA
System Analysis	Plugging before events occurred is not modeled.	M	It would be hard to plug during normal operation in RCS and safety related systems.	NA
	System unavailability	M	US generic data is considered appropriate at design stage. However, Sensitivity analyses were performed.	Sensitivity Analysis (Case 1, Case 2)
Data Analysis	Applicability of failure modes to the US-APWR equipment design	M	Potentially valuable generic data sources were collected. All the failure modes of the US-APWR component types were considered.	NA

Table 19.1-35 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 3 of 4)

Key Sources of Uncertainty and Key Assumptions		Type (Note)	Summary Results of Qualitative Assessments	Quantitative Approach
Data Analysis	Failure probability and failure rates for diesel generators are applied to gas turbine generators.	M	Sensitivity analysis of failure probability and failure rates was performed.	Sensitivity Analysis (Case 8)
	Statistical uncertainty of failure rate	P	(Statistical uncertainty is considerable)	Uncertainty Analysis
Common Cause Failure Analysis	CCF parameters of emergency diesel generators are applied to gas turbine generators.	M	Sensitivity analysis of gas turbine generator CCF parameters was performed.	Sensitivity Analysis (Case 07)
	CCF of inter-systems is not included in the CCF model.	M	The environment, operation or service, design, and maintenance are different between inter-systems.	NA
	Statistical uncertainty of CCF probabilities.	P	(Statistical uncertainty is involved in data base)	Uncertainty Analysis

Table 19.1-35 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 4 of 4)

Key Sources of Uncertainty and Key Assumptions		Type (Note)	Summary Results of Qualitative Assessments	Quantitative Approach
HRA	Human error probability	M	Sensitivity analyses of post initiating event operator action failure probabilities were performed to study the impact of human errors to CDF. Set all the HEPs to 1.0 or 0.0.	Sensitivity Analysis (Case 05, Case 06)
	Statistical uncertainty of human error probability	P	(Statistical uncertainty is considered)	Uncertainty Analysis
Note - Uncertainty sources are categorized into three types, Parametric (P), Modeling (M) or Completeness(C).				

Table 19.1-36 Definition of Plant Damage States

Primary System Pressure	Reactor Cavity Flooding Status		C/V Isolated								C/V not Isolated		C/V failure before core damage	C/V Bypass (SGTR)
			Igniter Functional				Igniter not Functional							
			CSS Injected		CSS not Injected		CSS Injected		CSS not Injected		CSS Injected	CSS not Injected		
			C/V Cooled	C/V not Cooled	C/V Cooled	C/V not Cooled	C/V Cooled	C/V not Cooled	C/V Cooled	C/V not Cooled				
			A	B	C	D	E	F	G	H	I	J	K	L
Low	Not Flooded	1	NA	NA	1C	1D	NA	NA	1G	1H	NA	1J	1K	NA
	Flooded after RV Failure	2	2A	2B	2C	2D	2E	2F	2G	2H	2I	2J		
	Flooded before RV Failure	3	3A	3B	3C	3D	3E	3F	3G	3H				
Medium	Not Flooded	4	NA	NA	4C	4D	NA	NA	4G	4H	NA	4J	4K	4L
	Flooded after RV Failure	5	5A	5B	5C	5D	5E	5F	5G	5H	5I	5J		
	Flooded before RV Failure	6	6A	6B	6C	6D	6E	6F	6G	6H				
High	Not Flooded	7	NA	NA	7C	7D	NA	NA	7G	7H	NA	7J	NA	NA
	Flooded after RV Failure	8	8A	8B	8C	8D	8E	8F	8G	8H	8I	8J		
	Flooded before RV Failure	9	9A	9B	9C	9D	9E	9F	9G	9H				

Number of PDS= 72

·NA means combination has no possibility.

: Reactor Cavity is flooded when CS success.

: As water is not injected into RV in high pressure sequences, C/V failure before core damage never occurs. Injection with charging pumps is not considered.

: The primary system pressure during SGTR accident sequences is equivalent to medium one.

Table19.1- 37 Definition of CSET Top Events

(Sheet 1 of 3)

Name	Containment Isolation
Symbol	CI
Definition	Defined as a failure, when a containment isolation valve on the containment penetration line except for screening out lines is fails to close. Screening criteria are follows: (1) It connects to the closed loop in containment and its integrity is kept at severe accident. (2) There is an isolation valve, and the outside part of containment is a closed loop that has tolerance at severe accident. (3) It has one blind flange at least. (4) It is managed and has a valve that is normally close or locked close either when power is supplied or lost. (5) It has a normally close or automatic close valve other than containment isolation valves and is inside of containment. Extracted penetrations are as follows. · Chemical volume control system - seal water return line · Liquid waste management system - C/V sump pump discharge line · Instrument air system - instrument air line · Containment purge system - containment low volume purge exhaust line
Success Criteria	One isolation valve in each penetration closed.
Thermal/Hydraulic Computer Code	None.
Operation	(1) Automatic (2) When automatic control is not available due to software CCF, manual closing operation from DAS

Name	RCS Depressurization
Symbol	FD
Definition	Defined as a failure, when RCS pressure does not decrease to the degree that high pressure melt ejection does not occur, due to depressurization operation failure etc. Concretely defined as a success, when depressurization valves for severe accident that is a motor operated valves open successfully. Operation delay time is considered that is basis of the design, which guarantees the necessary valve size for depressurization. The necessary valve size for depressurization is confirmed by the MAAP analysis.
Success Criteria	2 of 2 depressurization valves for severe accident open successfully.
Thermal/Hydraulic Computer Code	MAAP
Operation	(1) Detect core damage with core outlet thermometer and C/V high-range area monitor (2) Manual opening operation from central control room

Table19.1- 37 Definition of CSET Top Events

(Sheet 2 of 3)

Name	Hydrogen Control
Symbol	IG
Definition	Defined as a success, when necessary igniters are functional for the control of hydrogen concentration in the containment. The effectiveness of igniters is confirmed by the GOTHIC analysis.
Success Criteria	20 of 20 igniters are functional.
Thermal/Hydraulic Computer Code	GOTHIC
Operation	(1) Automatic by S signal

Name	Reactor Cavity Flooding
Symbol	CF
Definition	Defined as a success, when the reactor cavity injection (with CSS or firewater injection into the reactor cavity manually operated) successes by a mission time. The mission time is considered that is basis of the design, which guarantees the necessary flow rate for sufficiently filling the reactor cavity before vessel melt through and cooling the debris in the reactor cavity. The mission time and necessary flow rate of the reactor cavity injection confirmed by the MAAP analysis.
Success Criteria	1 of 4 CSSs is functional. or 1 of 1 firewater injection into the reactor cavity is functional.
Thermal/Hydraulic Computer Code	MAAP
Operation	(1) Detect core damage with core outlet thermometer and C/V high-range area monitor (2) Inject water into the reactor cavity through CSS (3) When failure of CSS, inject water into the reactor cavity through firewater injection

Table19.1- 37 Definition of CSET Top Events

(Sheet 3 of 3)

Name	Recovery of CSS and CS/RHR HX
Symbol	RS
Definition	Defined as a success, when recovery of CSS and CS/RHR HX success by the time to maintain the containment integrity. Electric power supply is a target of the recovery when there is LOOP as the initiating event with the loss of emergency power supply and power is not recovered yet. CCWS or ESWS is a target of the recovery when there is loss of CCW or essential service water as the initiating event. Also they are target of the recovery when there are common cause failures of all CCW to restart after power recovery. Firewater injection to the spray header is considered to extend the mission time to recovery of CCWS or ESWS. The mission time to recovery of these support systems is determined by the MAAP analysis.
Success Criteria	1 of 4 CSS and same train of CS/RHR HX are functional.
Thermal/Hydraulic Computer Code	MAAP
Operation	The operation of the firewater injection to the spray header is follows: (1) Identify containment pressure is greater than the containment design pressure in the monitor. (2) Start firewater injection to spray header (3) Identify containment pressure is less than the containment design pressure minus about 7 psi in the monitor. (5) Stop firewater injection to spray header (6) Return to (1)

Table19.1-38 Dependencies between Frontline Systems and Supporting Systems of the CSET

System	Supporting Systems																																																		
	ESW				CCW				6.9kV						480V						125V						120V						HVA				IAS	SI				P				Others					
	A	B	C	D	A	B	C	D	A	B	C	D	P1	P2	A	B	C	D	P1	P2	A	B	C	D	P1	P2	A	B	C	D	P1	P2	A	B	C	D	-	A	B	C	D	A	B	C	D	A	B	C	D	P1	P2
Firewater injection to the reactor cavity									×																																										
																								×																											
																			×																																
															×																																				
Firewater injection to the spray header									×																																										
																								×																											
																			×																																
															×																																				
															×												×															×									
Depressurization valves for severe accident															×																																				
																		×																																	
Hydrogen Control																			×								×											×													
																				×								×											×												
Containment isolation																								×						×															×				T+U		
																					×						×															×				T+U					
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Table19.1-39 Dominant Cutsets of LRF (Sheet 1 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.4E-08	13.1	!19LOOP 1CF 1FD EPSCF4CBTD6H-ALL OPS----PRBF OPS----PRCF OPSRSB RCP----SEAL	LOSS OF OFFSITE POWER REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY 6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs FAILURE OF OFFSITE POWER RECOVERY AFTER CORE MELT WITHIN 24hrs RCP SEAL LOCA
2	9.8E-09	8.9	!15LOCCW ACWOO02CT-DP2 ACWOO02FS RCP----SEAL RSAOO02FWP	LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE) OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) RCP SEAL LOCA OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)
3	7.7E-09	6.9	!03SLOCA NCCOO02CCW RSSCF4MVOD114-ALL	SMALL PIPE BREAK LOCA OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE) CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 2 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
4	6.0E-09	5.5	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CFAMVFCFSV5	TIE LINE FROM FIRE SUPPRESSION SYSTEM TO CSS M/V MOV-011 (FSV5) FAIL TO CONTROL
			RCP----SEAL	RCP SEAL LOCA
5	6.0E-09	5.5	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CFAMVFCFSV2	FIRE WATER PUMP DISCHARGE M/V (FSV2) FAIL TO CONTROL
			RCP----SEAL	RCP SEAL LOCA
6	3.6E-09	3.3	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CCWRSA	FAILURE OF CCW RECOVERY AFTER CORE MELT
			RCP----SEAL	RCP SEAL LOCA

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 3 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	2.9E-09	2.6	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			LR-3A	CCFP for Specific PDS
			RCP----SEAL	RCP SEAL LOCA
8	1.7E-09	1.6	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)
			RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF
9	1.2E-09	1.1	!07RVR	REACTOR VESSEL RUPTURE
			LR-3A	CCFP for Specific PDS
10	1.1E-09	1.0	!02MLOCA	MEDIUM PIPE BREAK LOCA
			NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)
			RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
11	1.0E-09	0.9	!19LOOP	LOSS OF OFFSITE POWER
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			OPSRSB	FAILURE OF OFFSITE POWER RECOVERY AFTER CORE MELT WITHIN 24hrs
			RCP----SEAL	RCP SEAL LOCA

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LR (Sheet 4 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
12	9.1E-10	0.8	!03SLOCA CCWBTSWCCF NCCOO02CCW	SMALL PIPE BREAK LOCA CCW SOFTWARE CCF OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)
13	9.1E-10	0.8	!03SLOCA NCCOO02CCW SGNBTSWCCF	SMALL PIPE BREAK LOCA OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE) S,P SIGNAL SOFTWARE CCF
14	8.9E-10	0.8	!03SLOCA NCCOO02CCW RWSCF4SUPRST01-ALL	SMALL PIPE BREAK LOCA OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE) RWSP SUMP STRAINER PLUG CCF
15	8.2E-10	0.7	!19LOOP ACWOO02CT-DP2 ACWOO02FS RCP----SEAL RSAOO02FWP SWSCF4PMBD-R-ALL	LOSS OF OFFSITE POWER OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE) OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) RCP SEAL LOCA OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE) ESW PUMP A,B,C,D FAIL TO RE-START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 5 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
16	5.7E-10	0.5	!19LOOP	LOSS OF OFFSITE POWER
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			LR-5A	CCFP for Specific PDS
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA
17	5.6E-10	0.5	!19LOOP	LOSS OF OFFSITE POWER
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
			LR-5A	CCFP for Specific PDS
			OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs
			RCP----SEAL	RCP SEAL LOCA

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 6 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
18	5.0E-10	0.5	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CFAMVFCFSV5	TIE LINE FROM FIRE SUPPRESSION SYSTEM TO CSS M/V MOV-011 (FSV5) FAIL TO CONTROL
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF
19	5.0E-10	0.5	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CFAMVFCFSV2	FIRE WATER PUMP DISCHARGE M/V (FSV2) FAIL TO CONTROL
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF
20	4.9E-10	0.5	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	RCP SEAL LOCA
			RSSTMRPRHEXC	RHEXC OUTAGE
			SWSTMPESWPD	ESW PUMP-D OUTAGE
21	4.6E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)
			RSSCF4PMSRCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO RUN (<1H) CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 7 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
22	4.5E-10	0.4	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF
			RCP----SEAL	RCP SEAL LOCA
			RSAOO02FWP	OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)
23	4.4E-10	0.4	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWCF2TPADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF
			RCP----SEAL	RCP SEAL LOCA
			RSAOO02FWP	OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)
24	4.4E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)
			RSSCF4RHPRRHEX-ALL	CS/RHR HEAT EXCHANGER PLUG CCF
25	4.4E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			LR-3C	CCFP for Specific PDS
			RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF
26	4.0E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 8 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
27	3.9E-10	0.4	!16PLOCW CHIOO01CHIB RCP----SEAL RSSTMPICSPC SWSTMPESWPD	PARTIAL LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE) RCP SEAL LOCA PUMP C OUTAGE ESW PUMP-D OUTAGE
28	3.9E-10	0.4	!03SLOCA EPSCF4CBTD6H-ALL OPSLOOP	SMALL PIPE BREAK LOCA 6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
29	3.6E-10	0.3	!03SLOCA RTPDASF SGNBTSWCCF	SMALL PIPE BREAK LOCA DAS HARD FAILURE S,P SIGNAL SOFTWARE CCF
30	3.5E-10	0.3	!16PLOCW CHIPMBDCHPB-R RCP----SEAL RSSTMRPRHEXC SWSTMPESWPD	PARTIAL LOSS OF COMPONENT COOLING WATER CHP-B FAIL TO START (RUNNING) RCP SEAL LOCA RHEXC OUTAGE ESW PUMP-D OUTAGE
31	3.1E-10	0.3	!19LOOP 1CF 1FD EPSCF4DLLRDG-ALL EPSOO02RDG OPS----PRBF OPS----PRCF OPSRSB RCP----SEAL RSBOO02RDG	LOSS OF OFFSITE POWER REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs FAILURE OF OFFSITE POWER RECOVERY AFTER CORE MELT WITHIN 24hrs RCP SEAL LOCA OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS AFTER CORE MELT(HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 9 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
32	3.0E-10	0.3	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CCWRSA	FAILURE OF CCW RECOVERY AFTER CORE MELT
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF
33	2.9E-10	0.3	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	RCP SEAL LOCA
			RSSTMRPRHEXC	RHEXC OUTAGE
34	2.8E-10	0.3	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CFAMVFCFSV2	FIRE WATER PUMP DISCHARGE M/V (FSV2) FAIL TO CONTROL
			CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF
			RCP----SEAL	RCP SEAL LOCA

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 10 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
35	2.8E-10	0.3	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			CFAMVFCFSV5	TIE LINE FROM FIRE SUPPRESSION SYSTEM TO CSS M/V MOV-011 (FSV5) FAIL TO CONTROL
			CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF
			RCP----SEAL	RCP SEAL LOCA
36	2.8E-10	0.3	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	CHP-B FAIL TO START (RUNNING)
			RCP----SEAL	RCP SEAL LOCA
			RSSTMPICSPC	PUMP C OUTAGE
			SWSTMPESWPD	ESW PUMP-D OUTAGE
37	2.7E-10	0.3	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			CFAMVFCFSV5	TIE LINE FROM FIRE SUPPRESSION SYSTEM TO CSS M/V MOV-011 (FSV5) FAIL TO CONTROL
			EFWCF2TPADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF
			RCP----SEAL	RCP SEAL LOCA
38	2.7E-10	0.3	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			CFAMVFCFSV2	FIRE WATER PUMP DISCHARGE M/V (FSV2) FAIL TO CONTROL
			EFWCF2TPADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF
			RCP----SEAL	RCP SEAL LOCA

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 39 Dominant Cutsets of LRF (Sheet 11 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
39	2.7E-10	0.3	!19LOOP EPSCF4IVFFINV-ALL EPSOO02RDG OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER INVERTERS (INVA,B,C,D) FAIL TO OPERATE CFF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs RCP SEAL LOCA
40	2.5E-10	0.2	!16PLOCW CHIOO01CHIB CWSTMPCCWPD RCP----SEAL RSSTMRPRHEXC	PARTIAL LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE) D-CCW PUMP OUTAGE RCP SEAL LOCA RHEXC OUTAGE

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-40 Contribution of Initiating Events to LRF

Initiating Event ID	Initiating Event Description	Percent Contribution
LOCCW	Loss of Component Cooling Water	34.6%
LOOP	Loss of Offsite Power	29.4%
SLOCA	Small Pipe Break LOCA	15.2%
PLOCW	Partial Loss of Component Cooling Water	7.3%
SGTR	Steam Generator Tube Rupture	6.0%
MLOCA	Medium Pipe Break LOCA	2.1%
LOFF	Loss of Feedwater Flow	1.3%
RVR	RV Rupture	1.1%
SLBO	Steam Line Break/Leak (Downstream MSIV: Turbine side)	0.9%
TRANS	General Transient	0.8%
VSLOCA	Very Small Pipe Break LOCA	0.6%
FWLB	Feed-water Line Break	0.2%
ATWS	Anticipated Transient Without Scram	0.1%
LOAC	Loss of Vital AC Bus	0.1%
SLBI	Steam Line Break/Leak (Upstream MSIV: C/V side)	0.1%
LODC	Loss of Vital DC Bus	0.0%
LLOCA	Large Pipe Break LOCA	0.0%
	TOTALS=	100.0%

Table19.1- 41 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 1 of 3)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	3.2E-01	1.7E+01
2	ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	5.1E-01	3.1E-01	1.3E+00
3	OPS----PRBF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr	5.3E-01	2.1E-01	1.2E+00
4	OPS----PRCF	FAILURE OF OFFSITE POWER RECOVERY WITHIN 3hrs	4.1E-01	2.1E-01	1.3E+00
5	OPSRSB	FAILURE OF OFFSITE POWER RECOVERY AFTER CORE MELT WITHIN	8.3E-02	1.8E-01	3.0E+00
6	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN	2.0E-05	1.5E-01	7.2E+03
7	NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT	2.5E-02	1.4E-01	6.4E+00
8	RSAOO02FWP	OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)	4.2E-02	1.4E-01	4.2E+00
9	CFAMVFCFSV2	FIRE WATER PUMP DISCHARGE M/V (FSV2) FAIL TO CONTROL	2.6E-02	8.7E-02	4.2E+00
10	CFAMVFCFSV5	TIE LINE FROM FIRE SUPPRESSION SYSTEM TO CSS M/V MOV-011 (FSV5) FAIL TO CONTROL	2.6E-02	8.7E-02	4.2E+00
11	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	8.1E-02	9.7E+02
12	MSROO02533A	OPERATOR FAILS TO CLOSE MAIN STEAM ISOLATION VALVES (HE)	2.6E-03	5.3E-02	2.1E+01
13	CCWRSA	FAILURE OF CCW RECOVERY AFTER CORE MELT	1.6E-02	5.2E-02	4.2E+00
14	EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	9.9E-04	5.1E-02	5.3E+01
15	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	4.9E-02	3.3E+00
16	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	4.9E-02	3.4E+00
17	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	3.5E-02	1.5E+01
18	SWSTMPESWPD	ESW PUMP-D OUTAGE	1.2E-02	3.1E-02	3.5E+00
19	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	3.0E-02	6.6E+00
20	SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF	4.8E-05	2.8E-02	5.8E+02
21	CHIPMBDCHPB-R	CHP-B FAIL TO START (RUNNING)	1.8E-03	2.4E-02	1.4E+01
22	RSSTMRPRHEXC	RHEXC OUTAGE	5.0E-03	2.2E-02	5.5E+00
23	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.9E-02	6.0E+00
24	EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF	1.5E-03	1.9E-02	1.4E+01
25	RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF	1.9E-05	1.9E-02	9.9E+02
26	RSSTMPICSPC	PUMP C OUTAGE	4.0E-03	1.8E-02	5.5E+00
27	CWSTMRCCWHXD	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE	7.0E-03	1.8E-02	3.5E+00
28	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START	6.5E-03	1.7E-02	3.5E+00
29	EFWCF2TPADFWP1-	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF	4.5E-04	1.6E-02	3.6E+01
30	CWSTMPCCWPD	D-CCW PUMP OUTAGE	6.0E-03	1.5E-02	3.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 41 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 2 of 3)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
31	CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF	2.6E-05	1.5E-02	5.8E+02
32	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	1.5E-02	6.9E+00
33	SGNBTSWCCF	S,P SIGNAL SOFTWARE CCF	1.0E-05	1.5E-02	1.5E+03
34	HITOO02-DP3	SAFETY INJECTION CONTROL HUMAN ERROR	1.5E-01	1.5E-02	1.1E+00
35	EPSDLLRDGP1-L2	AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H)	1.8E-02	1.4E-02	1.8E+00
36	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	1.4E-02	1.5E+03
37	PZROO02PORV-DP3	BLEED OPERATION FAIL (HE)	1.5E-01	1.4E-02	1.1E+00
38	MSPOO02STRV-SG-DP3	MAIN STEAM RELIEF VALVE (MSRV) OPEN OPERATION FAIL (HE)	1.5E-01	1.4E-02	1.1E+00
39	FDAMVFC58MC	DEPRESSURIZATION VALVE FOR SEVERE ACCIDENT M/V MOV-118 (58MC) FAIL TO CONTROL	2.6E-02	1.3E-02	1.5E+00
40	FDAMVFC58RC	DEPRESSURIZATION VALVE FOR SEVERE ACCIDENT M/V MOV-119(58RC) FAIL TO CONTROL	2.6E-02	1.3E-02	1.5E+00
41	SWSTMPESWPB	ESW PUMP-B OUTAGE	1.2E-02	1.1E-02	1.9E+00
42	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START	6.5E-03	1.1E-02	2.7E+00
43	EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE	5.0E-03	1.1E-02	3.2E+00
44	EPSDLLRDGP2-L2	AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H)	1.8E-02	1.1E-02	1.6E+00
45	EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START	2.1E-04	1.1E-02	5.3E+01
46	MSPOO0250A1-DP2	TURBINE BYPASS LINE X/V 50A1 CLOSED OPERATION FAIL (HE)	5.8E-02	1.0E-02	1.2E+00
47	MSPOO0250B1-DP2	TURBINE BYPASS LINE X/V 50B1 CLOSED OPERATION FAIL (HE)	5.8E-02	1.0E-02	1.2E+00
48	MSPOO0250C1-DP2	TURBINE BYPASS LINE X/V 50C1 CLOSED OPERATION FAIL (HE)	5.8E-02	1.0E-02	1.2E+00
49	CCWBTSWCCF	CCW SOFTWARE CCF	1.0E-05	9.7E-03	9.7E+02
50	EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	2.5E-04	9.4E-03	3.9E+01
51	CHICF2PMBD-ALL	CHI PUMP FAIL TO START CCF	2.0E-04	8.8E-03	4.4E+01
52	EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	1.6E-04	8.1E-03	5.3E+01
53	EPSTMDGP1	AAC GAS TURBINE GENERATOR (GTG P1) OUTAGE	1.2E-02	7.9E-03	1.7E+00
54	RSSOO02LNUP-SG-DP3	ALTERNATIVE CORE COOLING LINE UP FAIL (HE)	1.5E-01	7.4E-03	1.0E+00
55	HPIOO02FWBD-S-DP4	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	5.0E-01	7.4E-03	1.0E+00
56	MSPOO0250A2-DP2	TURBINE BYPASS LINE X/V 50A2 CLOSED OPERATION FAIL (HE)	5.8E-02	7.0E-03	1.1E+00
57	MSPOO0250B2-DP2	TURBINE BYPASS LINE X/V 50B2 CLOSED OPERATION FAIL (HE)	5.8E-02	7.0E-03	1.1E+00
58	MSPOO0250C2-DP2	TURBINE BYPASS LINE X/V 50C2 CLOSED OPERATION FAIL (HE)	5.8E-02	7.0E-03	1.1E+00
59	EFWTMTAB	D-EMERGENCY FEED WATER PUMP(FWP1B) OUTAGE	5.0E-03	6.7E-03	2.3E+00
60	RSSPMADCSPC	CS/RHR PUMP FAIL TO START (STANDBY)	1.4E-03	6.5E-03	5.6E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 41 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 3 of 3)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
61	MFWHARD	MAIN FEED WATER HARD WARE FAIL	1.0E-01	6.4E-03	1.1E+00
62	EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)	2.4E-03	6.1E-03	3.5E+00
63	BOSBTSWCCF	B.O SIGNAL SOFTWARE CCF	1.0E-05	5.7E-03	5.7E+02
64	EPSTMDGP2	AAC GAS TURBINE GENERATOR (GTG P2) OUTAGE	1.2E-02	5.6E-03	1.5E+00
65	NCCOO02CCW-DP2	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT	7.4E-02	5.5E-03	1.1E+00
66	ACWTMPZCLTP	COOLING TOWER PUMP OUTAGE	8.0E-03	5.0E-03	1.6E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 1 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	SWSCF4PMYR-FF	ESW PUMP A,B,C,D FAIL TO RUN CCF	1.2E-08	6.7E-04	5.6E+04
2	CWSCF4RHPR-FF	ALL COMPONENT COOLING HEAT EXCHANGERS PLUG/FOUL OR LARGE EXTERNAL LEAK CCF	3.6E-08	1.9E-03	5.1E+04
3	CWSCF4PCYR-FF	CCW PUMP ALL FAIL TO RUN CCF	6.7E-09	3.4E-04	5.1E+04
4	EPSCF4BYFF-234	EPS BATTERY A,C,D FAIL TO OPERATE CCF	1.2E-08	5.2E-04	4.2E+04
5	EPSCF4BYFF-124	EPS BATTERY A,B,D FAIL TO OPERATE CCF	1.2E-08	5.1E-04	4.1E+04
6	RTPBTSWCCF	SUPPORT SOFTWARE CCF	1.0E-07	2.6E-03	2.6E+04
7	EPSCF4BYFF-ALL	EPS BATTERY A,B,C,D FAIL TO OPERATE CCF	5.0E-08	1.0E-03	2.0E+04
8	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	1.1E-03	1.1E+04
9	EPSCF4BYFF-134	EPS BATTERY A,B,C FAIL TO OPERATE CCF	1.2E-08	1.0E-04	8.2E+03
10	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN	2.0E-05	1.5E-01	7.2E+03
11	EPSCF4BYFF-123	EPS BATTERY B,C,D FAIL TO OPERATE CCF	1.2E-08	8.6E-05	7.0E+03
12	EPSCF4CBWR4I-ALL	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	9.0E-04	5.7E+03
13	EPSCF4BYFF-24	EPS BATTERY A,D FAIL TO OPERATE CCF	1.9E-08	1.1E-04	5.6E+03
14	EPSCF4IVFFINV-ALL	INVERTERS (INVA,B,C,D) FAIL TO OPERATE CFF	1.5E-06	3.4E-03	2.2E+03
15	EPSCF4CBWRVIT4-ALL	CIRCUIT BREAKER BETWEEN 125V DC BUS AND INVERTER (VIT4A,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	3.5E-04	2.2E+03
16	EPSCF4CBWR4I-124	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	2.9E-08	4.6E-05	1.6E+03
17	EPSCF4CBWR4I-134	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	2.9E-08	4.5E-05	1.5E+03
18	SGNBTSWCCF	S,P SIGNAL SOFTWARE CCF	1.0E-05	1.5E-02	1.5E+03
19	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	1.4E-02	1.5E+03
20	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL	7.2E-08	1.0E-04	1.5E+03
21	RWSTNELRWSP	REFUELING WATER STORAGE PIT LARGE EXTERNAL LEAK	4.8E-08	7.0E-05	1.5E+03
22	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	3.5E-05	1.5E+03
23	HPIMVEL8820B	CONTAINMENT ISOLATION M/V MOV-001B(8820B) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
24	HPIMVEL8820C	CONTAINMENT ISOLATION M/V MOV-001C(8820C) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
25	HPIMVEL8820A	CONTAINMENT ISOLATION M/V MOV-001A(8820A) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
26	HPIMVEL8820D	CONTAINMENT ISOLATION M/V MOV-001D(8820D) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
27	RSSPNEL01B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	4.1E-05	1.4E+03
28	RSSPNEL01D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	4.1E-05	1.4E+03
29	RSSPNEL01C	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	4.1E-05	1.4E+03
30	RSSPNEL01A	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	4.1E-05	1.4E+03

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 2 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
31	HPIPNELSUCTSC	SAFETY INJECTION SYSTEM C TRAIN PIPE INSIDE CV LARGE EXTERNAL	2.8E-08	4.0E-05	1.4E+03
32	HPIPNELSUCTSD	SAFETY INJECTION SYSTEM D TRAIN PIPE INSIDE CV LARGE EXTERNAL	2.8E-08	4.0E-05	1.4E+03
33	HPIPNELSUCTSB	SAFETY INJECTION SYSTEM B TRAIN PIPE INSIDE CV LARGE EXTERNAL	2.8E-08	4.0E-05	1.4E+03
34	HPIPNELSUCTSA	SAFETY INJECTION SYSTEM A TRAIN PIPE INSIDE CV LARGE EXTERNAL	2.8E-08	4.0E-05	1.4E+03
35	RSSMVEL9007B	RWSP DISCHARGE LINE ISOLATION VALVE (9007B) LARGE EXTERNAL	2.4E-08	3.5E-05	1.4E+03
36	RSSMVEL9007D	RWSP DISCHARGE LINE ISOLATION VALVE (9007D) LARGE EXTERNAL	2.4E-08	3.5E-05	1.4E+03
37	RSSMVEL9007A	RWSP DISCHARGE LINE ISOLATION VALVE (9007A) LARGE EXTERNAL	2.4E-08	3.5E-05	1.4E+03
38	RSSMVEL9007C	RWSP DISCHARGE LINE ISOLATION VALVE (9007C) LARGE EXTERNAL	2.4E-08	3.5E-05	1.4E+03
39	RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF	1.9E-05	1.9E-02	9.9E+02
40	RSSCF4PMSRCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO RUN (<1H) CCF	5.0E-06	5.0E-03	9.9E+02
41	RSSCF4PMLRCSP-ALL	CS/RHR PUMP FAIL TO RUN (>1H) CCF	1.7E-06	1.7E-03	9.9E+02
42	RSSCF4RHPRRHEX-ALL	CS/RHR HEAT EXCHANGER PLUG CCF	4.8E-06	4.7E-03	9.9E+02
43	RSSCF4CVOD9008-ALL	CS/RHR PUMP SUCTION LINE C/V VLV004A,B,C,D(9008A,B,C,D) FAIL TO	4.3E-07	4.2E-04	9.9E+02
44	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	8.1E-02	9.7E+02
45	CCWBTSWCCF	CCW SOFTWARE CCF	1.0E-05	9.7E-03	9.7E+02
46	EFWCF2CVODEFW03-	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN	2.4E-06	2.0E-03	8.6E+02
47	EFWCF4CVODXW1-ALL	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF	1.7E-06	1.4E-03	8.5E+02
48	EFWCF4CVODAW1-ALL	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	1.7E-06	1.4E-03	8.5E+02
49	EPSCF4CBWR4I-14	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	2.7E-05	8.2E+02
50	EFWXVELPW2B	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006B(PW2B) LARGE LEAK	7.2E-08	5.9E-05	8.1E+02
51	EFWXVELPW2A	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006A(PW2A) LARGE LEAK	7.2E-08	5.9E-05	8.1E+02
52	EFWCF4CVODAW1-234	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	5.1E-05	8.1E+02
53	EFWCF4CVODAW1-134	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	5.1E-05	8.1E+02
54	EFWCF4CVODAW1-124	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	5.1E-05	8.1E+02
55	EFWCF4CVODAW1-123	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	5.1E-05	8.1E+02
56	MSPPNELPA1	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.2E-07	1.4E-04	6.6E+02
57	SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF	4.8E-05	2.8E-02	5.8E+02
58	CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF	2.6E-05	1.5E-02	5.8E+02
59	BOSBTSWCCF	B.O SIGNAL SOFTWARE CCF	1.0E-05	5.7E-03	5.7E+02
60	CWSCF4CVOD052-R-ALL	CCW PUMP DISCHARGE LINE C/V VLV-016A,B,C,D(052A,B,C,D) FAIL TO RE-OPEN CCF	1.5E-07	8.3E-05	5.5E+02

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 3 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
61	SWSCF4CVOD602-R-	ESW PUMP MOTOR COOLING LINE C/V VLV-602A,B,C,D FAIL TO OPEN	1.5E-07	8.3E-05	5.5E+02
62	SWSCF4CVOD502-R-	ESW PUMP DISCHARGE LINE C/V VLV-502A,B,C,D FAIL TO OPEN CCF	1.5E-07	8.3E-05	5.5E+02
63	EPSBTSWCCF	EPS SOFTWARE CCF	1.0E-05	4.7E-03	4.7E+02
64	EPSCF4CBTD6H-134	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN	5.2E-06	2.0E-03	3.9E+02
65	EPSCF4CBTD6H-124	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN	5.2E-06	1.7E-03	3.3E+02
66	EPSCF4BYFF-34	EPS BATTERY Fail to Operate CCF	1.9E-08	4.5E-06	2.4E+02
67	EPSCF4BYFF-12	EPS BATTERY Fail to Operate CCF	1.9E-08	3.4E-06	1.8E+02
68	EPSCF4IVFFINV-134	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	8.1E-05	1.6E+02
69	EPSCF4IVFFINV-124	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	5.9E-05	1.2E+02
70	RTPBTRTB	TRIP BREAKER CCF	3.0E-06	3.4E-04	1.1E+02
71	EFWCF4CVODAW1-34	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	2.4E-05	1.1E+02
72	EFWCF4CVODAW1-24	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	2.4E-05	1.1E+02
73	EFWCF4CVODAW1-23	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	2.4E-05	1.1E+02
74	RWSCF4SUPRST01-234	RWSP SUMP STRAINER PLUG CCF	3.7E-06	3.5E-04	9.7E+01
75	EPSCF4CBWR4J-ALL	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	1.5E-05	9.4E+01
76	EPSCF4CBWR4J-34	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	2.9E-06	8.8E+01
77	EPSCF4CBWR4J-234	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.5E-06	8.8E+01
78	EPSCF4CBWR4J-134	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.5E-06	8.8E+01
79	EPSCF4CBWRVIT4-134	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.3E-06	8.1E+01
80	EPSCF4CBWRVIT4-124	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.1E-06	7.3E+01
81	RWSCF4SUPRST01-134	RWSP SUMP STRAINER PLUG CCF	3.7E-06	2.6E-04	7.1E+01
82	HPIPMELSIPC	SAFETY INJECTION PUMP C LARGE EXTERNAL LEAK	1.9E-07	1.3E-05	6.6E+01
83	RSSPMELCSPC	CS/RHR PUMP C LARGE EXTERNAL LEAK	1.9E-07	1.2E-05	6.5E+01
84	HPIPMELSIPD	SAFETY INJECTION PUMP D LARGE EXTERNAL LEAK	1.9E-07	1.2E-05	6.4E+01
85	RSSPMELCSPD	CS/RHR PUMP D LARGE EXTERNAL LEAK	1.9E-07	1.2E-05	6.3E+01
86	RSSRIELRHEXC	CS/RHR HEAT EXCHANGER C LARGE LEAK	7.2E-07	4.4E-05	6.2E+01
87	RSSXVELRHR04C	MINIMUM FLOW LINE X/V VLV-13C(RHR04C) LARGE EXTERNAL LEAK	7.2E-08	4.4E-06	6.2E+01
88	RSSCVEL9008C	CS/RHR PUMP SUCTION LINE C/V VLV-004C(9008C) LARGE EXTERNAL	4.8E-08	2.9E-06	6.2E+01
89	RSSPNEL04C	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-07	1.5E-05	6.1E+01
90	RSSPNEL12C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.6E-08	1.5E-06	6.1E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 4 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
91	SWSCF2PMYRSWPAC-ALL	ESW PUMP A,C FAIL TO RUN CCF	8.9E-06	5.3E-04	6.1E+01
92	RWSCF4SUPRST01-123	RWSP SUMP STRAINER PLUG CCF	3.7E-06	2.1E-04	5.9E+01
93	RSSRIELRHEXA	CS/RHR HEAT EXCHANGER A LARGE LEAK	7.2E-07	4.2E-05	5.9E+01
94	RSSRIELRHEXD	CS/RHR HEAT EXCHANGER D LARGE LEAK	7.2E-07	4.2E-05	5.9E+01
95	RSSRIELRHEXB	CS/RHR HEAT EXCHANGER B LARGE LEAK	7.2E-07	4.2E-05	5.9E+01
96	RSSXVELRHR04B	MINIMUM FLOW LINE X/V VLV-13B(RHR04B) LARGE EXTERNAL LEAK	7.2E-08	4.2E-06	5.9E+01
97	RSSXVELRHR04A	MINIMUM FLOW LINE X/V VLV-13A(RHR04A) LARGE EXTERNAL LEAK	7.2E-08	4.2E-06	5.9E+01
98	RSSXVELRHR04D	MINIMUM FLOW LINE X/V VLV-13D(RHR04D) LARGE EXTERNAL LEAK	7.2E-08	4.2E-06	5.9E+01
99	RSSCVEL9008B	CS/RHR PUMP SUCTION LINE C/V VLV-004B(9008B) LARGE EXTERNAL	4.8E-08	2.8E-06	5.9E+01
100	RSSCVEL9008A	CS/RHR PUMP SUCTION LINE C/V VLV-004A(9008A) LARGE EXTERNAL	4.8E-08	2.8E-06	5.9E+01
101	RSSCVEL9008D	CS/RHR PUMP SUCTION LINE C/V VLV-004D(9008D) LARGE EXTERNAL	4.8E-08	2.8E-06	5.9E+01
102	HPIPMELSIPB	SAFETY INJECTION PUMP B LARGE EXTERNAL LEAK	1.9E-07	1.1E-05	5.8E+01
103	HPIPMELSIPA	SAFETY INJECTION PUMP A LARGE EXTERNAL LEAK	1.9E-07	1.1E-05	5.8E+01
104	HPIPNELINJSA	SAFETY INJECTION SYSTEM A TRAIN PIPE OUTSIDE CV LARGE	9.2E-08	5.3E-06	5.8E+01
105	HPIPNELINJSC	SAFETY INJECTION SYSTEM C TRAIN PIPE OUTSIDE CV LARGE	9.2E-08	5.3E-06	5.8E+01
106	HPIPNELINJSD	SAFETY INJECTION SYSTEM D TRAIN PIPE OUTSIDE CV LARGE	9.0E-08	5.2E-06	5.8E+01
107	HPIPNELINJSB	SAFETY INJECTION SYSTEM B TRAIN PIPE OUTSIDE CV LARGE	9.0E-08	5.2E-06	5.8E+01
108	HPICVEL8804D	SAFETY INJECTION PUMP DISCHARGE C/V VLV004D(8804D) LARGE LEAK	4.8E-08	2.8E-06	5.8E+01
109	HPICVEL8804B	SAFETY INJECTION PUMP DISCHARGE C/V VLV004B(8804B) LARGE LEAK	4.8E-08	2.8E-06	5.8E+01
110	HPICVEL8804A	SAFETY INJECTION PUMP DISCHARGE C/V VLV004A(8804A) LARGE LEAK	4.8E-08	2.8E-06	5.8E+01
111	HPICVEL8804C	SAFETY INJECTION PUMP DISCHARGE C/V VLV004C(8804C) LARGE LEAK	4.8E-08	2.8E-06	5.8E+01
112	HPIMVEL8805B	M/V 8805B EXTERNAL LEAK L	2.4E-08	1.4E-06	5.8E+01
113	HPIMVEL8805D	M/V 8805D EXTERNAL LEAK L	2.4E-08	1.4E-06	5.8E+01
114	HPIMVEL8805C	M/V 8805C EXTERNAL LEAK L	2.4E-08	1.4E-06	5.8E+01
115	HPIMVEL8805A	M/V 8805A EXTERNAL LEAK L	2.4E-08	1.4E-06	5.8E+01
116	RSSXVEL9009A	X/V 9009A EXTERNAL LEAK LARGE	7.2E-08	4.1E-06	5.8E+01
117	RSSMVEL9011A	M/V 9011A EXTERNAL LEAK L	2.4E-08	1.4E-06	5.8E+01
118	RSSPNEL04A	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-07	1.5E-05	5.8E+01
119	RSSPNEL04D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.5E-07	1.5E-05	5.8E+01
120	RSSPNEL04B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.5E-07	1.4E-05	5.8E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 5 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
121	RSSPNEL12B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-08	1.5E-06	5.8E+01
122	RSSPNEL11D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	1.1E-06	5.8E+01
123	RSSPNEL11A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	1.1E-06	5.8E+01
124	RWSPMELRWPA	M/P RWPA EXTERNAL LEAK L	1.9E-07	1.1E-05	5.8E+01
125	RWSPMELRWPB	M/P RWPB EXTERNAL LEAK L	1.9E-07	1.1E-05	5.8E+01
126	RWSXVEL007B	X/V 007B EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
127	RWSXVEL004	X/V 004 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
128	RWSXVEL005A	X/V 005A EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
129	RWSXVEL008	X/V 008 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
130	RWSXVEL007A	X/V 007A EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
131	RWSXVELRWS06	X/V RWS06 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
132	RWSXVEL016	X/V 016 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
133	RWSXVELRWS07	X/V RWS07 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
134	RWSXVELRWS09	X/V RWS09 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
135	RWSXVEL005B	X/V 005B EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
136	RWSXVEL026	X/V 026 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
137	RWSXVELRWS12	X/V RWS12 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
138	RWSXVELRWS11	X/V RWS11 EXTERNAL LEAK L	7.2E-08	4.1E-06	5.8E+01
139	RWSCVELRWS13	C/V RWS13 EXTERNAL LEAK L	4.8E-08	2.7E-06	5.8E+01
140	RWSCVELRWS08	C/V RWS08 EXTERNAL LEAK L	4.8E-08	2.7E-06	5.8E+01
141	RWSCVELRWS10	C/V RWS10 EXTERNAL LEAK L	4.8E-08	2.7E-06	5.8E+01
142	RWSCVEL006B	C/V 006B EXTERNAL LEAK L	4.8E-08	2.7E-06	5.8E+01
143	RWSCVEL006A	C/V 006A EXTERNAL LEAK L	4.8E-08	2.7E-06	5.8E+01
144	RWSCVEL015	C/V 015 EXTERNAL LEAK L	4.8E-08	2.7E-06	5.8E+01
145	RSSPMELCSPB	CS/RHR PUMP B LARGE EXTERNAL LEAK	1.9E-07	1.1E-05	5.8E+01
146	RSSPMELCSPA	CS/RHR PUMP A LARGE EXTERNAL LEAK	1.9E-07	1.1E-05	5.8E+01
147	ACCCF4CVOD8948-ALL	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.0E-06	5.7E-05	5.8E+01
148	ACCCF4CVOD8956-ALL	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.0E-06	5.7E-05	5.8E+01
149	ACCCF4CVOD8956-234	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01
150	ACCCF4CVOD8948-234	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 6 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
151	ACCCF4CVOD8948-123	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01
152	ACCCF4CVOD8956-123	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01
153	ACCCF4CVOD8956-134	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01
154	ACCCF4CVOD8948-134	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01
155	ACCCF4CVOD8956-124	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01
156	ACCCF4CVOD8948-124	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	2.7E-07	1.5E-05	5.8E+01
157	ACCCF4CVOD8948-13	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.6E-07	9.1E-06	5.8E+01
158	ACCCF4CVOD8948-23	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.6E-07	9.1E-06	5.8E+01
159	ACCCF4CVOD8956-14	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.6E-07	9.1E-06	5.8E+01
160	ACCCF4CVOD8956-12	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.6E-07	9.1E-06	5.8E+01
161	ACCCF4CVOD8956-24	BOUNDARY C/V SI-V103A,B,C,D(8956A,B,C,D) FAIL TO OPEN CCF	1.6E-07	9.1E-06	5.8E+01
162	ACCCF4CVOD8948-12	DISCHARGE LINE SECONDARY ISOLATION C/V SI-V102A,B,C,D(8948A,B,C,D) FAIL TO OPEN CCF	1.6E-07	9.1E-06	5.8E+01
163	EPSCF4CBTD6H-123	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.2E-06	2.9E-04	5.7E+01
164	RSSXVELSFP01D	X/V SFP01D EXTERNAL LEAK L	7.2E-08	4.0E-06	5.6E+01
165	RSSXVELSFP02D	X/V SFP02D EXTERNAL LEAK L	7.2E-08	4.0E-06	5.6E+01
166	RSSXVELSFP01A	X/V SFP01A EXTERNAL LEAK L	7.2E-08	4.0E-06	5.6E+01
167	RSSXVELSFP02A	X/V SFP02A EXTERNAL LEAK L	7.2E-08	4.0E-06	5.6E+01
168	RSSXVEL9009D	X/V 9009D EXTERNAL LEAK LARGE	7.2E-08	4.0E-06	5.6E+01
169	RSSXVEL9009B	X/V 9009B EXTERNAL LEAK LARGE	7.2E-08	4.0E-06	5.6E+01
170	RSSXVEL9009C	X/V 9009C EXTERNAL LEAK LARGE	7.2E-08	4.0E-06	5.6E+01
171	RSSPNEL05A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	5.7E-08	3.2E-06	5.6E+01
172	RSSPNEL05C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	5.7E-08	3.2E-06	5.6E+01
173	RSSPNEL05B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	4.7E-08	2.6E-06	5.6E+01
174	RSSPNEL05D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	4.7E-08	2.6E-06	5.6E+01
175	RSSMVEL9011D	M/V 9011D EXTERNAL LEAK L	2.4E-08	1.3E-06	5.6E+01
176	RSSMVEL9011C	M/V 9011C EXTERNAL LEAK L	2.4E-08	1.3E-06	5.6E+01
177	RSSMVEL9011B	M/V 9011B EXTERNAL LEAK L	2.4E-08	1.3E-06	5.6E+01
178	RSSAVELRHR01C	A/V RHR01C EXTERNAL LEAK L	2.2E-08	1.2E-06	5.6E+01
179	RSSAVELRHR02C	A/V RHR02C EXTERNAL LEAK L	2.2E-08	1.2E-06	5.6E+01
180	RSSAVELRHR02B	A/V RHR02B EXTERNAL LEAK L	2.2E-08	1.2E-06	5.6E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 7 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
181	RSSAVELRHR01B	A/V RHR01B EXTERNAL LEAK L	2.2E-08	1.2E-06	5.6E+01
182	CWSCF2PCYRCWPAC-	CWS PUMP A,C FAIL TO RUN CCF	5.0E-06	2.7E-04	5.6E+01
183	HPIPNELSUCTLC	PIPE OUT OF CV EXTERNAL LEAK L	3.3E-08	1.8E-06	5.5E+01
184	HPIPNELSUCTLA	PIPE OUT OF CV EXTERNAL LEAK L	3.3E-08	1.8E-06	5.5E+01
185	HPIPNELSUCTLB	PIPE OUT OF CV EXTERNAL LEAK L	3.1E-08	1.7E-06	5.5E+01
186	HPIPNELSUCTLD	PIPE OUT OF CV EXTERNAL LEAK L	3.1E-08	1.7E-06	5.5E+01
187	RSSCF4PMADCSP-134	CS/RHR PUMP FAIL TO START CCF	6.3E-06	3.4E-04	5.5E+01
188	RSSMVEL9015D	M/V 9015D EXTERNAL LEAK L	2.4E-08	1.3E-06	5.4E+01
189	RSSMVEL9015A	M/V 9015A EXTERNAL LEAK L	2.4E-08	1.3E-06	5.4E+01
190	RSSMVEL9015B	M/V 9015B EXTERNAL LEAK L	2.4E-08	1.3E-06	5.4E+01
191	RSSMVEL9015C	M/V 9015C EXTERNAL LEAK L	2.4E-08	1.3E-06	5.4E+01
192	RWSMVEL003	M/V 003 EXTERNAL LEAK L	2.4E-08	1.3E-06	5.4E+01
193	RSSCF4PMSRCSP-134	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	8.6E-05	5.3E+01
194	EFWCF4CVODXW1-124	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF	6.2E-08	3.2E-06	5.3E+01
195	EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	9.9E-04	5.1E-02	5.3E+01
196	EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START	2.1E-04	1.1E-02	5.3E+01
197	EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	1.6E-04	8.1E-03	5.3E+01
198	EPSCF4SEFFDG-ALL	GAS TURBINE GENERATOR SEQUENCER FAIL TO OPERATE CCF	3.8E-05	1.9E-03	5.3E+01
199	EPSCF4CBTDDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO	2.0E-05	1.1E-03	5.3E+01
200	EPSCF4CBWRDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	8.2E-06	5.3E+01
201	RSSCF4MVOD114-134	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	7.4E-05	5.2E+01
202	RSSCF4PMLRCSP-134	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	2.8E-05	5.0E+01
203	EPSCF4CBWR4I-123	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	1.4E-06	5.0E+01
204	RSSPNEL03C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.7E-09	3.2E-07	4.9E+01
205	RSSPNEL03A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.7E-09	3.2E-07	4.9E+01
206	RSSPNEL03B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.1E-09	3.0E-07	4.9E+01
207	RSSPNEL03D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.1E-09	3.0E-07	4.9E+01
208	RSSPNEL10D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	3.7E-09	1.8E-07	4.9E+01
209	RSSPNEL10A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	3.7E-09	1.8E-07	4.9E+01
210	RSSCF4CVOD9008-234	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.2E-07	1.0E-05	4.8E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 8 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
211	RSSCF4RHPRRHEX-134	CS/RHR HX PLUG CCF	6.4E-08	3.0E-06	4.8E+01
212	PZRSVCD0055	S/V 0055 FAIL TO CLOSE (RECLOSE)	7.0E-05	3.2E-03	4.7E+01
213	PZRSVCD0058	PRESSURIZER SAFETY VALV VLV-120(0058)	7.0E-05	3.2E-03	4.7E+01
214	PZRSVCD0057	PRESSURIZER SAFETY VALV VLV-121(0057)	7.0E-05	3.2E-03	4.7E+01
215	PZRSVCD0056	S/V 0056 FAIL TO CLOSE (RECLOSE)	7.0E-05	3.2E-03	4.7E+01
216	RSSCF4MVOD9011-ALL	CS/RHR M/V 9011 FAIL TO OPEN CCF	8.4E-05	3.8E-03	4.6E+01
217	RSSCF4PMADCSP-123	CS/RHR PUMP FAIL TO START CCF	6.3E-06	2.8E-04	4.6E+01
218	RSSCF4MVOD114-123	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	6.3E-05	4.5E+01
219	RSSCF4PMSRCSP-123	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	7.2E-05	4.4E+01
220	CHICF2PMBD-ALL	CHI PUMP FAIL TO START CCF	2.0E-04	8.8E-03	4.4E+01
221	RSSCF4PMLRCSP-123	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	2.4E-05	4.2E+01
222	SWSCF4PMBD-R-124	ESW PUMP FAIL TO RE-START CCF	1.5E-05	6.1E-04	4.1E+01
223	CWSCF4PCBD-R-123	CWS PUMP FAIL TO RE-START CCF	8.4E-06	3.3E-04	4.1E+01
224	RSSCF4CVOD9008-124	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.2E-07	8.8E-06	4.1E+01
225	RSSCF4RHPRRHEX-123	CS/RHR HX PLUG CCF	6.4E-08	2.5E-06	4.1E+01
226	EPSCF4DLLRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	2.5E-04	9.4E-03	3.9E+01
227	EPSCF4DLADDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START	5.2E-05	2.0E-03	3.9E+01
228	EPSCF4DLSRDG-134	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	3.9E-05	1.5E-03	3.9E+01
229	EPSCF4SEFFDG-134	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	4.7E-04	3.9E+01
230	EPSCF4CBTDDG-234	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	2.0E-04	3.9E+01
231	EPSCF4CBWRDG-234	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	1.1E-06	3.9E+01
232	EFWCF4CVODXW1-123	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	2.3E-06	3.7E+01
233	EPSCF4CBTD6H-234	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.2E-06	1.9E-04	3.7E+01
234	RSSCF4CVOD9012-ALL	CS/RHR C/V 9012 FAIL TO OPEN CCF	4.3E-07	1.5E-05	3.6E+01
235	EFWCF2PTSRFWP1-	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO RUN (<1H) CCF	1.1E-04	3.9E-03	3.6E+01
236	EFWCF2PTLRFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO RUN (>1H) CCF	7.2E-05	2.5E-03	3.6E+01
237	EFWCF2TPADFWP1-	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF	4.5E-04	1.6E-02	3.6E+01
238	EFWCF2MVODTS1-ALL	EFW M/V TS1 FAIL TO OPEN CCF	4.2E-05	1.4E-03	3.4E+01
239	EFWXVELTW4B	X/V TW4B EXTERNAL LEAK L	7.2E-08	2.3E-06	3.4E+01
240	EFWCVELTW1B	C/V TW1B EXTERNAL LEAK L	4.8E-08	1.6E-06	3.4E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 9 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
241	CHIORPRFE138	CHARGING LINE ORIFICE FE138 PLUG	2.4E-05	7.4E-04	3.2E+01
242	CHIORPROR02	CHARGING FLOW CONTROL ORIFICE OR02 PLUG	2.4E-05	7.4E-04	3.2E+01
243	CHICVOD169	C/V 169 FAIL TO OPEN	1.2E-05	3.7E-04	3.2E+01
244	CHIAVCM138	A/V 138 MIS-CLOSE	4.8E-06	1.5E-04	3.2E+01
245	CHIAVCM215	A/V 215 MIS-CLOSE	4.8E-06	1.5E-04	3.2E+01
246	CHIAVCM236	A/V 236 MIS-CLOSE	4.8E-06	1.5E-04	3.2E+01
247	CHIAVPR236	A/V 236 PLUG	2.4E-06	7.4E-05	3.2E+01
248	CHIAVPR138	A/V 138 PLUG	2.4E-06	7.4E-05	3.2E+01
249	CHIXVPR241	X/V 241 PLUG	2.4E-06	7.4E-05	3.2E+01
250	CHICVPR222	C/V 222 PLUG	2.4E-06	7.4E-05	3.2E+01
251	CHICVPR239	C/V 239 PLUG	2.4E-06	7.4E-05	3.2E+01
252	CHICVPR237	C/V 237 PLUG	2.4E-06	7.4E-05	3.2E+01
253	CHIXVPR167	X/V 167 PLUG	2.4E-06	7.4E-05	3.2E+01
254	CHIAVPR215	A/V 215 PLUG	2.4E-06	7.4E-05	3.2E+01
255	CHIMVPR221	M/V 221 PLUG	2.4E-06	7.4E-05	3.2E+01
256	CHIXVPR242	X/V 242 PLUG	2.4E-06	7.4E-05	3.2E+01
257	CHIMVPR220	M/V 220 PLUG	2.4E-06	7.4E-05	3.2E+01
258	CHIMVCM220	M/V 220 MIS-CLOSE	9.6E-07	2.9E-05	3.2E+01
259	CHIMVCM221	M/V 221 MIS-CLOSE	9.6E-07	2.9E-05	3.2E+01
260	CHIRIELHXCH	HEAT EXCHANGER HXCH TUBE EXTERNAL LEAK L	7.2E-07	2.2E-05	3.2E+01
261	CHIPMELCHPB	M/P CHPB EXTERNAL LEAK L	1.9E-07	5.9E-06	3.2E+01
262	CHIPMELCHPA	M/P CHPA EXTERNAL LEAK L	1.9E-07	5.9E-06	3.2E+01
263	CHIAVIL227	A/V 227 INTERNAL LEAK L	1.2E-07	3.7E-06	3.2E+01
264	CHIXVEL166A	X/V 166A EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
265	CHIXVEL240A	X/V 240A EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
266	CHIXVEL167	X/V 167 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
267	CHIXVEL241	X/V 241 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
268	CHIXVELCVC07	X/V CVC07 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
269	CHIXVELCVC09	X/V CVC09 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
270	CHIXVEL242	X/V 242 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 10 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
271	CHIXVELCVC01	X/V CVC01 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
272	CHIXVELCVC11	X/V CVC11 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
273	CHIXVELCVC06	X/V CVC06 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
274	CHIXVELCVC02	X/V CVC02 EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
275	CHIXVEL162B	X/V 162B EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
276	CHIXVEL166B	X/V 166B EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
277	CHIXVEL162A	X/V 162A EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
278	CHIXVEL240B	X/V 240B EXTERNAL LEAK L	7.2E-08	2.2E-06	3.2E+01
279	CHICVEL165A	C/V 165A EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
280	CHICVEL239	C/V 239 EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
281	CHICVEL237	C/V 237 EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
282	CHICVEL163A	C/V 163A EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
283	CHICVEL152	C/V 152 EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
284	CHICVEL222	C/V 222 EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
285	CHICVEL165B	C/V 165B EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
286	CHICVEL163B	C/V 163B EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
287	CHIMVEL121C	M/V 121C EXTERNAL LEAK L	2.4E-08	7.4E-07	3.2E+01
288	CHIMVEL220	M/V 220 EXTERNAL LEAK L	2.4E-08	7.4E-07	3.2E+01
289	CHIMVEL221	M/V 221 EXTERNAL LEAK L	2.4E-08	7.4E-07	3.2E+01
290	CHIMVEL121B	M/V 121B EXTERNAL LEAK L	2.4E-08	7.4E-07	3.2E+01
291	CHIAVEL138	A/V 138 EXTERNAL LEAK L	2.2E-08	6.6E-07	3.2E+01
292	CHIAVEL236	A/V 236 EXTERNAL LEAK L	2.2E-08	6.6E-07	3.2E+01
293	CHIAVEL227	A/V 227 EXTERNAL LEAK L	2.2E-08	6.6E-07	3.2E+01
294	CHIAVELCVC03	A/V CVC03 EXTERNAL LEAK L	2.2E-08	6.6E-07	3.2E+01
295	CHIAVEL215	A/V 215 EXTERNAL LEAK L	2.2E-08	6.6E-07	3.2E+01
296	CHIAVELCVC04	A/V CVC04 EXTERNAL LEAK L	2.2E-08	6.6E-07	3.2E+01
297	EPSCF4CBTD6H-14	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	1.5E-04	3.1E+01
298	CHIORPRRC1C	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	7.3E-04	3.1E+01
299	CHIORPRRC1B	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	7.3E-04	3.1E+01
300	CHIORPRRC1A	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	7.3E-04	3.1E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 11 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
301	CHIORPRRC1D	RCP SEAL WATER INJECTION LINE ORIFICE FE160A(RC1A) PLUG	2.4E-05	7.3E-04	3.1E+01
302	CHICVODRC6B	C/V FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
303	CHICVODRC6A	RCP SEAL WATER INJECTION LINE SECONDARY ISOLATION C/V VLV-181C(RC6C) FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
304	CHICVODRC6D	C/V FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
305	CHICVODRC6C	RCP SEAL WATER INJECTION LINE SECONDARY ISOLATION C/V VLV-181D(RC6D) FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
306	CHICVODRC4B	C/V FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
307	CHICVODRC4A	C/V FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
308	CHICVODRC4D	RCP SEAL WATER INJECTION LINE BOUNDARY ISOLATION C/V VLV-182D(RC4D) FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
309	CHICVODRC4C	RCP SEAL WATER INJECTION LINE BOUNDARY ISOLATION C/V VLV-182C(RC4C) FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
310	CHICVODRC7C	C/V FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
311	CHICVODRC7D	RCP SEAL WATER INJECTION LINE THIRD ISOLATION C/V VLV-179D(RC7D) FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
312	CHICVODRC7B	C/V FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
313	CHICVODRC7A	RCP SEAL WATER INJECTION LINE THIRD ISOLATION C/V VLV-179A(RC7A) FAIL TO OPEN	1.2E-05	3.7E-04	3.1E+01
314	CHIAVCMCVC03	A/V Mis-Close	4.8E-06	1.5E-04	3.1E+01
315	CHIAVCMCVC04	A/V Mis-Close	4.8E-06	1.5E-04	3.1E+01
316	CHIXVPRRC2A	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
317	CHIXVPRRC2B	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
318	CHICVPRRC7D	C/V Plug	2.4E-06	7.3E-05	3.1E+01
319	CHIXVPRRC2C	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
320	CHIXVPRCVC02	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
321	CHIXVPRCVC06	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
322	CHIMVPRRC3D	M/V PLUG	2.4E-06	7.3E-05	3.1E+01
323	CHIMVPRRC3A	M/V PLUG	2.4E-06	7.3E-05	3.1E+01
324	CHIMVPRRC3B	M/V PLUG	2.4E-06	7.3E-05	3.1E+01
325	CHIMVPRRC3C	M/V PLUG	2.4E-06	7.3E-05	3.1E+01
326	CHICVPRRC7C	C/V Plug	2.4E-06	7.3E-05	3.1E+01
327	CHICVPRRC4A	C/V Plug	2.4E-06	7.3E-05	3.1E+01
328	CHICVPRRC6A	C/V Plug	2.4E-06	7.3E-05	3.1E+01
329	CHICVPRRC4D	C/V Plug	2.4E-06	7.3E-05	3.1E+01
330	CHICVPRRC4C	C/V Plug	2.4E-06	7.3E-05	3.1E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 12 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
331	CHICVPRRC4B	C/V Plug	2.4E-06	7.3E-05	3.1E+01
332	CHICVPRRC7A	C/V Plug	2.4E-06	7.3E-05	3.1E+01
333	CHICVPRRC7B	C/V Plug	2.4E-06	7.3E-05	3.1E+01
334	CHICVPRRC6D	C/V Plug	2.4E-06	7.3E-05	3.1E+01
335	CHICVPRRC6B	C/V Plug	2.4E-06	7.3E-05	3.1E+01
336	CHICVPRRC6C	C/V Plug	2.4E-06	7.3E-05	3.1E+01
337	CHIAVPRCVC04	A/V PLUG	2.4E-06	7.3E-05	3.1E+01
338	CHIXVPRCVC11	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
339	CHIXVPRRC5A	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
340	CHIAVPRCVC03	A/V PLUG	2.4E-06	7.3E-05	3.1E+01
341	CHIXVPRRC5D	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
342	CHIXVPRRC5C	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
343	CHIXVPRRC5B	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
344	CHIXVPRRC2D	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
345	CHIXVPRCVC09	X/V PLUG	2.4E-06	7.3E-05	3.1E+01
346	CHIMVCMRC3B	M/V MIS-CLOSE	9.6E-07	2.9E-05	3.1E+01
347	CHIMVCMRC3D	M/V MIS-CLOSE	9.6E-07	2.9E-05	3.1E+01
348	CHIMVCMRC3A	M/V MIS-CLOSE	9.6E-07	2.9E-05	3.1E+01
349	CHIMVCMRC3C	M/V MIS-CLOSE	9.6E-07	2.9E-05	3.1E+01
350	CHIXVELRC5C	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
351	CHIXVELRC5D	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
352	CHIXVELRC5B	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
353	CHIXVELRC2D	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
354	CHIXVELRC5A	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
355	CHIXVELRC2A	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
356	CHIXVELRC2B	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
357	CHIXVELRC2C	X/V EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
358	CHICVELRC4D	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
359	CHICVELRC6A	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
360	CHICVELRC6B	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 13 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
361	CHICVELRC7B	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
362	CHICVELRC7C	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
363	CHICVELRC7D	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
364	CHICVELRC6C	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
365	CHICVELRC6D	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
366	CHICVELRC7A	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
367	CHICVELRC4A	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
368	CHICVELRC4B	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
369	CHICVELRC4C	C/V EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
370	CHIMVELRC3B	M/V EXTERNAL LEAK L	2.4E-08	7.3E-07	3.1E+01
371	CHIMVELRC3C	M/V EXTERNAL LEAK L	2.4E-08	7.3E-07	3.1E+01
372	CHIMVELRC3D	M/V EXTERNAL LEAK L	2.4E-08	7.3E-07	3.1E+01
373	CHIMVELRC3A	M/V EXTERNAL LEAK L	2.4E-08	7.3E-07	3.1E+01
374	EFWXVELTW4A	X/V TW4A EXTERNAL LEAK L	7.2E-08	2.2E-06	3.1E+01
375	EFWCVELTW1A	C/V TW1A EXTERNAL LEAK L	4.8E-08	1.5E-06	3.1E+01
376	ACWCF2MVODCH2-ALL	FIRE SUPPRESSION SYSTEM BOUNDARY M/V ACWCH2A,B FAILTO OPEN	4.7E-05	1.4E-03	3.1E+01
377	ACWCF2MVODCH4-ALL	FIRE SUPPRESSION SYSTEM BOUNDARY M/V ACWCH4A,B FAILTO OPEN	4.7E-05	1.4E-03	3.1E+01
378	ACWCF2MVODCH6-ALL	CHI PUMP COOLING DISCHARGE LINE M/V ACWCH6A,B FAILTO OPEN CCF	4.7E-05	1.4E-03	3.1E+01
379	CHICF2PMYR-R-ALL	CHI PUMP FAIL TO RUN CCF	5.0E-06	1.5E-04	3.1E+01
380	ACWCF2CVCDCH5-ALL	ACW C/V CH5 FAIL TO CLOSE CCF	4.7E-06	1.4E-04	3.1E+01
381	CHIMVOM121C	M/V 121C MIS-OPENING	9.6E-07	2.9E-05	3.1E+01
382	CHIMVOM121B	M/V 121B MIS-OPENING	9.6E-07	2.9E-05	3.1E+01
383	ACWCVELCH5A	C/V EXTERNAL LEAK L	4.8E-08	1.4E-06	3.0E+01
384	ACWCVELCH5B	C/V EXTERNAL LEAK L	4.8E-08	1.4E-06	3.0E+01
385	ACWMVELCH4B	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
386	ACWMVELCH8B	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
387	ACWMVELCH1A	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
388	ACWMVELCH6A	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
389	ACWMVELCH1B	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
390	ACWMVELCH2A	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 14 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
391	ACWMVELCH2B	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
392	ACWMVELCH4A	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
393	ACWMVELCH3B	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
394	ACWMVELCH3A	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
395	ACWMVELCH6B	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
396	ACWMVELCH7B	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
397	ACWMVELCH8A	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
398	ACWMVELCH7A	M/V EXTERNAL LEAK L	2.4E-08	7.0E-07	3.0E+01
399	EPSTRFFPTA	4PTA TRANSFORMER FAIL TO RUN	8.2E-06	2.3E-04	3.0E+01
400	EPSBSFF4ESBA	480V BUS A FAILURE	5.8E-06	1.7E-04	3.0E+01
401	EPSCF4IVFFINV-123	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	1.4E-05	2.9E+01
402	EPSCBWR4IA	4IA BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	8.4E-05	2.9E+01
403	SWSCF4PMBD-R-134	ESW PUMP FAIL TO RE-START CCF	1.5E-05	4.0E-04	2.8E+01
404	CWSCF4PCBD-R-124	CWS PUMP FAIL TO RE-START CCF	8.4E-06	2.2E-04	2.7E+01
405	EFWCF4CVODXW1-12	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	5.8E-06	2.7E+01
406	EFWCVELAW1D	C/V AW1D EXTERNAL LEAK L	4.8E-08	1.2E-06	2.7E+01
407	EFWCVELAW1A	C/V AW1A EXTERNAL LEAK L	4.8E-08	1.2E-06	2.7E+01
408	RSSCF4PMADCSP-234	CS/RHR PUMP FAIL TO START CCF	6.3E-06	1.6E-04	2.7E+01
409	RSSCF4PMSRCSP-234	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	4.1E-05	2.6E+01
410	RSSCF4MVOD114-234	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	3.5E-05	2.5E+01
411	CWSCF2RHPRHXAC-	CWS HX-A,C PLUG CCF	6.8E-08	1.6E-06	2.4E+01
412	EFWMVELAWDB	M/V AWDB EXTERNAL LEAK L	2.4E-08	5.6E-07	2.4E+01
413	EFWMVELAWAB	M/V AWAB EXTERNAL LEAK L	2.4E-08	5.6E-07	2.4E+01
414	EFWMVELAWDA	M/V AWDA EXTERNAL LEAK L	2.4E-08	5.6E-07	2.4E+01
415	EFWMVELAWAA	M/V AWAA EXTERNAL LEAK L	2.4E-08	5.6E-07	2.4E+01
416	RSSCF4PMLRCSP-234	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	1.3E-05	2.4E+01
417	RSSCF4CVOD9008-123	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.2E-07	4.7E-06	2.2E+01
418	RSSCF4RHPRRHEX-234	CS/RHR HX PLUG CCF	6.4E-08	1.4E-06	2.2E+01
419	EPSCF4CBWR4I-13	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	6.9E-07	2.2E+01
420	EPSCF4CBWR4I-12	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	6.9E-07	2.2E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 15 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
421	MSROO02533A	OPERATOR FAILS TO CLOSE MAIN STEAM ISOLATION VALVES (HE)	2.6E-03	5.3E-02	2.1E+01
422	SWSCF4PMBD-R-234	ESW PUMP FAIL TO RE-START CCF	1.5E-05	3.1E-04	2.1E+01
423	CHIXVEL240C	X/V 240C EXTERNAL LEAK L	7.2E-08	1.5E-06	2.1E+01
424	RWSTNELRWSAT	TANK UNPRESSURIZED EXTERNAL LEAK L	4.8E-08	9.7E-07	2.1E+01
425	CWSCF4PCBD-R-134	CWS PUMP FAIL TO RE-START CCF	8.4E-06	1.6E-04	2.1E+01
426	EFWCVODEFW03B	EFW PIT-B DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	1.8E-04	2.0E+01
427	EFWCVPREFW03B	EFW PIT-B DISCHARGE LINE C/V PLUG	2.4E-06	4.6E-05	2.0E+01
428	EFWCVELEFW03B	C/V EFW03B EXTERNAL LEAK L	4.8E-08	9.1E-07	2.0E+01
429	CWSCF4CVOD052-R-	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	9.1E-07	1.9E+01
430	SWSCF4CVOD602-R-	ESW C/V 602 FAIL TO OPEN CCF	5.0E-08	9.1E-07	1.9E+01
431	SWSCF4CVOD502-R-	ESW C/V 502 FAIL TO OPEN CCF	5.0E-08	9.1E-07	1.9E+01
432	HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF	1.1E-04	2.0E-03	1.9E+01
433	EFWCVODEFW03A	EFW PIT-A DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	1.7E-04	1.9E+01
434	EFWCVPREFW03A	EFW PIT-A DISCHARGE LINE C/V PLUG	2.4E-06	4.3E-05	1.9E+01
435	EFWCVELEFW03A	C/V EFW03A EXTERNAL LEAK L	4.8E-08	8.6E-07	1.9E+01
436	EFWXVPRPW1B	EFW PIT-B DISCHARGE LINE MANUAL VALVE FAIL TO OPEN	2.4E-06	4.2E-05	1.9E+01
437	EFWXVELMW3B	X/V MW3B EXTEANAL LEAK L	7.2E-08	1.3E-06	1.9E+01
438	EFWXVELTW3B	X/V TW3B EXTEANAL LEAK L	7.2E-08	1.3E-06	1.9E+01
439	EFWXVELPW1B	X/V PW1B EXTERNAL LEAK L	7.2E-08	1.3E-06	1.9E+01
440	EFWTNELEFWP1B	B-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	8.5E-07	1.9E+01
441	EFWPNELCSTB	LINE EXTERNAL LEAK FROM B-EMERGENCY FEED WATER PIT TO B-	6.0E-10	1.1E-08	1.9E+01
442	EFWXVPRPW1A	EFW PIT-A DISCHARGE LINE MANUAL VALVE FAIL TO OPEN	2.4E-06	4.1E-05	1.8E+01
443	EFWXVELMW3A	X/V MW3A EXTEANAL LEAK L	7.2E-08	1.2E-06	1.8E+01
444	EFWXVELTW3A	X/V TW3A EXTEANAL LEAK L	7.2E-08	1.2E-06	1.8E+01
445	EFWXVELPW1A	X/V PW1A EXTERNAL LEAK L	7.2E-08	1.2E-06	1.8E+01
446	EFWTNELEFWP1A	A-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	8.2E-07	1.8E+01
447	EFWPNELCSTA	LINE EXTERNAL LEAK FROM A-EMERGENCY FEED WATER PIT TO A-	6.0E-10	1.0E-08	1.8E+01
448	RWSCF4SUPRST01-34	SUMP STRAINER PLUG CCF	3.0E-06	4.9E-05	1.7E+01
449	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	3.2E-01	1.7E+01
450	MSPPNELPA2	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	5.6E-08	8.6E-07	1.6E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 16 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
451	HPICF4PMSRSIP-ALL	HHI PUMP A,B,C,D FAIL TO RUN (Standby) (<1h) CCF	8.5E-06	1.3E-04	1.6E+01
452	MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO	1.8E-04	2.6E-03	1.6E+01
453	MSRCF4AVCD533-12	A/V 533 FAIL TO CLOSE CCF	5.2E-05	7.7E-04	1.6E+01
454	MSRCF4AVCD533-14	A/V 533 FAIL TO CLOSE CCF	5.2E-05	7.7E-04	1.6E+01
455	MSRCF4AVCD533-13	A/V 533 FAIL TO CLOSE CCF	5.2E-05	7.7E-04	1.6E+01
456	MSRCF4AVCD533-124	A/V 533 FAIL TO CLOSE CCF	2.6E-05	3.8E-04	1.6E+01
457	MSRCF4AVCD533-134	A/V 533 FAIL TO CLOSE CCF	2.6E-05	3.8E-04	1.6E+01
458	MSRCF4AVCD533-123	A/V 533 FAIL TO CLOSE CCF	2.6E-05	3.8E-04	1.6E+01
459	SWSCF4CVOD502-R-	ESW C/V 502 FAIL TO OPEN CCF	5.0E-08	7.3E-07	1.6E+01
460	SWSCF4CVOD602-R-	ESW C/V 602 FAIL TO OPEN CCF	5.0E-08	7.3E-07	1.6E+01
461	CWSCF4CVOD052-R-	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	7.3E-07	1.6E+01
462	RWSCF4SUPRST01-124	SUMP STRAINER PLUG CCF	3.7E-06	5.2E-05	1.5E+01
463	RSSCF4PMADCSP-124	CS/RHR PUMP FAIL TO START CCF	6.3E-06	8.6E-05	1.5E+01
464	MSRCF4AVCD533-34	A/V 533 FAIL TO CLOSE CCF	5.2E-05	7.2E-04	1.5E+01
465	MSRCF4AVCD533-23	A/V 533 FAIL TO CLOSE CCF	5.2E-05	7.2E-04	1.5E+01
466	MSRCF4AVCD533-24	A/V 533 FAIL TO CLOSE CCF	5.2E-05	7.2E-04	1.5E+01
467	MSRCF4AVCD533-234	A/V 533 FAIL TO CLOSE CCF	2.6E-05	3.6E-04	1.5E+01
468	MSRBTSWCCF	MSR STEAM LINE ISORATION SIGNAL SOFTWARE CCF	1.0E-05	1.4E-04	1.5E+01
469	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	3.5E-02	1.5E+01
470	RSSCF4MVOD114-124	CS/RHR M/V 114 FAIL TO OPEN CCF	1.5E-06	2.0E-05	1.5E+01
471	EFWCF4CVODXW1-24	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	3.0E-06	1.5E+01
472	EFWCF4CVODXW1-13	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	3.0E-06	1.5E+01
473	HPICF4CVOD8809-ALL	C/V 8809 FAIL TO OPEN CCF	1.0E-06	1.4E-05	1.4E+01
474	HPICF4CVOD8808-ALL	C/V 8808 FAIL TO OPEN CCF	1.0E-06	1.4E-05	1.4E+01
475	HPICF4CVOD8804-ALL	C/V 8804 FAIL TO OPEN CCF	1.0E-06	1.4E-05	1.4E+01
476	HPICF4CVOD8806-ALL	C/V 8806 FAIL TO OPEN CCF	1.0E-06	1.4E-05	1.4E+01
477	EFWCF4CVODXW1-134	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	8.2E-07	1.4E+01
478	EFWCF4CVODXW1-234	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	8.2E-07	1.4E+01
479	CHIPMBDCHPB-R	CHP-B FAIL TO START (RUNNING)	1.8E-03	2.4E-02	1.4E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 17 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
480	EPSBSFFDCD	125V DC BUS-D FAILURE	5.8E-06	7.6E-05	1.4E+01
481	HPICF4PMLRSIP-ALL	HHI PUMP A,B,C,D FAIL TO RUN (Standby) (>1h) CCF	2.9E-06	3.8E-05	1.4E+01
482	RSSCF4PMSRCSP-124	CS/RHR PUMP FAIL TO RUN (<1H) CCF	1.7E-06	2.2E-05	1.4E+01
483	EPSCF4CBWR4I-234	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	3.8E-07	1.4E+01
484	EPSCF2DLADDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO START CCF	3.1E-04	3.9E-03	1.4E+01
485	EPSCF2DLSRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (<1H) CCF	2.3E-04	3.0E-03	1.4E+01
486	EPSCF2SEFFDGP-ALL	SEQUENCER FAIL TO OPERATE CCF	1.4E-04	1.8E-03	1.4E+01
487	EPSCF2CBTDDGBP-ALL	EPS C/B GTGBP1,2 FAIL TO CLOSED CCF	2.8E-05	3.6E-04	1.4E+01
488	EPPBTSWCCF	EPS P SOFTWARE CCF	1.0E-05	1.3E-04	1.4E+01
489	EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF	1.5E-03	1.9E-02	1.4E+01
490	EPSCF2CBWRDGBP-	EPS C/B GTGBP1,2 FAIL TO REMAIN CLOSED CCF	2.8E-07	3.6E-06	1.4E+01
491	RSSCF4PMADCSP-34	CS/RHR PUMP FAIL TO START CCF	1.3E-05	1.6E-04	1.4E+01
492	EPSCF4IVFFINV-234	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	6.3E-06	1.4E+01
493	SGIBTSWCCF	EFW M/V AWA SG ISOLATION SIGNAL SOFTWARE CCF	1.0E-05	1.3E-04	1.4E+01
494	RSSCF4PMSRCSP-34	CS/RHR PUMP FAIL TO RUN (<1H) CCF	3.3E-06	4.1E-05	1.3E+01
495	SGNCF4SGI-ALL	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	5.3E-06	6.6E-05	1.3E+01
496	SGNCF4SGI-12	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	3.5E-06	4.4E-05	1.3E+01
497	SGNCF4SGI-124	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	1.8E-06	2.1E-05	1.3E+01
498	SGNCF4SGI-123	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	1.8E-06	2.1E-05	1.3E+01
499	RSSCF4PMLRCSP-124	CS/RHR PUMP FAIL TO RUN (>1H) CCF	5.8E-07	6.9E-06	1.3E+01
500	EPSCF2IVFFINV-ALL	EPS INVP1,P2 FAIL TO OPERATE CCF	5.6E-06	6.7E-05	1.3E+01
501	EPSCF4CBWRVIT4P-	EPS C/B VIT4P1,P2 FAIL TO REMAIN CLOSED CCF	2.8E-07	3.4E-06	1.3E+01
502	EPSCF2BYFFP-ALL	EPS BATTERY P1,P2 Fail to Operate CCF	8.4E-08	1.0E-06	1.3E+01
503	RSSCF4MVOD114-34	CS/RHR M/V 114 FAIL TO OPEN CCF	5.7E-06	6.6E-05	1.3E+01
504	RSSCF4PMLRCSP-34	CS/RHR PUMP FAIL TO RUN (>1H) CCF	1.2E-06	1.3E-05	1.3E+01
505	EPSCF2CBTD4A-ALL	EPS TIELINE BREAKER 4AA,4AD FAIL TO CLOSED CCF	2.8E-05	3.2E-04	1.2E+01
506	EPSCF2CBTDSWW-ALL	EPS C/B SWWA,D FAIL TO CLOSED CCF	2.8E-05	3.2E-04	1.2E+01
507	EPSCF2CBWRSWW-	BREAKER FAIL OPERATE (CCF)	2.8E-07	3.2E-06	1.2E+01
508	EPSCF2CBWR4A-ALL	EPS TIELINE BREAKER 4AA,4AD FAIL OPERATE	2.8E-07	3.2E-06	1.2E+01
509	SWSCF4PMBD-R-123	ESW PUMP FAIL TO RE-START CCF	1.5E-05	1.7E-04	1.2E+01
510	RSSCF4CVOD9008-134	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.2E-07	2.4E-06	1.2E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 18 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
511	RSSCF4RHPRRHEX-124	CS/RHR HX PLUG CCF	6.4E-08	6.9E-07	1.2E+01
512	RSSCF4CVOD9008-23	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.0E-07	2.1E-06	1.2E+01
513	RSSCF4RHPRRHEX-34	CS/RHR HX PLUG CCF	1.7E-07	1.9E-06	1.2E+01
514	EFWXVELEFW01B	X/V EFW01B EXTERNAL LEAK L	7.2E-08	7.6E-07	1.2E+01
515	EFWXVELEFW01A	X/V EFW01A EXTERNAL LEAK L	7.2E-08	7.6E-07	1.2E+01
516	EFWPNELTESTB	TEST LINE B PIPE LEAK	6.0E-10	6.4E-09	1.2E+01
517	EFWPNELTESTA	TEST LINE A PIPE LEAK	6.0E-10	6.4E-09	1.2E+01
518	PZRCF2MVOD58R-ALL	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN	1.3E-04	1.3E-03	1.1E+01
519	CWSCF4PCBD-R-234	CWS PUMP FAIL TO RE-START CCF	8.4E-06	8.6E-05	1.1E+01
520	MSPSVCD526A	S/V 526A FAIL TO RECLOSE	7.0E-05	6.7E-04	1.1E+01
521	MSPSVCD527A	S/V 527A FAIL TO RECLOSE	7.0E-05	6.7E-04	1.1E+01
522	MSPSVOM526A	S/V 526A MIS-OPENING	4.8E-06	4.6E-05	1.1E+01
523	MSPSVOM527A	S/V 527A MIS-OPENING	4.8E-06	4.6E-05	1.1E+01
524	SWSSTPRST05	STRAINER ST05 PLUG	1.7E-04	1.6E-03	1.0E+01
525	SWSPEELSWPC1	ESW PIPE C1 LEAK	3.9E-06	3.7E-05	1.0E+01
526	SWSXVPR503C	X/V 503C PLUG	2.4E-06	2.3E-05	1.0E+01
527	SWSXVPR507C	X/V 507C PLUG	2.4E-06	2.3E-05	1.0E+01
528	SWSCVPR502C	C/V 502C PLUG	2.4E-06	2.3E-05	1.0E+01
529	SWSXVPR509C	X/V 509C PLUG	2.4E-06	2.3E-05	1.0E+01
530	SWSXVEL507C	X/V 507C EXTEANAL LEAK L	7.2E-08	6.8E-07	1.0E+01
531	SWSXVELESS0002C	X/V ESS0002C EXTEANAL LEAK L	7.2E-08	6.8E-07	1.0E+01
532	SWSXVEL503C	X/V 503C EXTEANAL LEAK L	7.2E-08	6.8E-07	1.0E+01
533	SWSXVELESS0001C	X/V ESS0001C EXTEANAL LEAK L	7.2E-08	6.8E-07	1.0E+01
534	SWSXVEL509C	X/V 509C EXTEANAL LEAK L	7.2E-08	6.8E-07	1.0E+01
535	SWSCVEL502C	C/V 502C EXTERNAL LEAK L	4.8E-08	4.6E-07	1.0E+01
536	SWSPMYRSWPC	ESW PUMP-C FAIL TO RUN (RUNNING)	1.1E-04	1.0E-03	1.0E+01
537	SWSORPROR04C	ORIFICE OR04C PLUG	2.4E-05	2.2E-04	1.0E+01
538	SWSORPROR24C	ORIFICE OR24C PLUG	2.4E-05	2.2E-04	1.0E+01
539	SWSFMPR2055C	FM 2055C PLUG	2.4E-05	2.2E-04	1.0E+01
540	SWSORPRESS0003C	ORIFICE ESS0003C PLUG	2.4E-05	2.2E-04	1.0E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 19 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
541	SWSXVPR570C	X/V 570C PLUG	2.4E-06	2.2E-05	1.0E+01
542	SWSXVPR569C	X/V 569C PLUG	2.4E-06	2.2E-05	1.0E+01
543	SWSCVPR602C	C/V 602C PLUG	2.4E-06	2.2E-05	1.0E+01
544	SWSXVPR601C	X/V 601C PLUG	2.4E-06	2.2E-05	1.0E+01
545	SWSPEELSWSC2	ESW PIPE C2 LEAK	3.8E-07	3.4E-06	1.0E+01
546	SWSPMELSWPC	ESW PUMP-C EXTERNAL LEAK L	1.9E-07	1.7E-06	1.0E+01
547	SWSXVEL601C	X/V 601C EXTEANAL LEAK L	7.2E-08	6.6E-07	1.0E+01
548	SWSCVEL602C	C/V 602C EXTERNAL LEAK L	4.8E-08	4.4E-07	1.0E+01
549	EPSCF4IVFFINV-14	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	9.1E-06	1.0E+01
550	SWSSTPRST02C	STRAINER ST02C PLUG	1.7E-04	1.5E-03	9.9E+00
551	EPSBSFF6ESBA	6.9KV SAFETY A BUS FAILURE	5.8E-06	4.8E-05	9.3E+00
552	ACWTNELFWT	Extinction water TANK EXTERNAL LEAK L	4.8E-08	4.0E-07	9.2E+00
553	EPSCF4DLLRDG-123	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	2.5E-04	2.0E-03	9.2E+00
554	EPSCF4DLADDG-123	EPS GTG A,B,C,D FAIL TO START CCF	5.2E-05	4.3E-04	9.2E+00
555	EPSCF4DLSRDG-123	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	3.2E-04	9.2E+00
556	EPSCF4SEFFDG-123	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.0E-04	9.2E+00
557	EPSCF4CBTDDG-123	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	4.2E-05	9.2E+00
558	EPSCF4CBWRDG-124	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	2.4E-07	9.2E+00
559	CIABTSWTCCF	T-SIGNAL SOFTWARE CCF	1.0E-05	8.0E-05	9.0E+00
560	CIABTSWVCCF	V-SIGNAL SOFTWARE CCF	1.0E-05	8.0E-05	9.0E+00
561	EPSCF4DLLRDG-124	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	2.5E-04	2.0E-03	9.0E+00
562	EPSCF4DLADDG-124	EPS GTG A,B,C,D FAIL TO START CCF	5.2E-05	4.2E-04	9.0E+00
563	EPSCF4DLSRDG-124	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	3.1E-04	9.0E+00
564	EPSCF4SEFFDG-124	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.0E-04	9.0E+00
565	EPSCF4CBTDDG-124	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	4.2E-05	9.0E+00
566	EPSCF4CBWRDG-134	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	2.3E-07	9.0E+00
567	EPSBSFF6ESBC	6.9KV SAFETY C BUS FAILURE	5.8E-06	4.5E-05	8.8E+00
568	EFWXVELMW4B	X/V MW4B EXTERNAL LEAK L	7.2E-08	5.6E-07	8.8E+00
569	EFWCVELMW1B	C/V MW1B EXTERNAL LEAK L	4.8E-08	3.7E-07	8.8E+00
570	SWSXVPR562C	X/V 562C PLUG	2.4E-06	1.8E-05	8.7E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 20 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
571	SWSXVPR561C	X/V 561C PLUG	2.4E-06	1.8E-05	8.7E+00
572	SWSRIELSWHXC	HEAT EXCHANGER CCWHXC TUBE EXTERNAL LEAK L	7.2E-07	5.5E-06	8.7E+00
573	SWSPEELSWSC3	ESW PIPE C3 LEAK	2.1E-07	1.6E-06	8.7E+00
574	SWSXVEL562C	X/V 562C EXTEANAL LEAK L	7.2E-08	5.5E-07	8.7E+00
575	SWSXVEL561C	X/V 561C EXTEANAL LEAK L	7.2E-08	5.5E-07	8.7E+00
576	HPICF4PMADSIP-234	HHI PUMP FAIL TO START (Standby) CCF	9.5E-06	6.9E-05	8.3E+00
577	CWSPCYRCWPC	CCWP-C FAIL TO RUN (RUNNING)	6.2E-05	4.3E-04	7.9E+00
578	CWSORPR1230C	ORIFICE 1230C PLUG	2.4E-05	1.6E-04	7.9E+00
579	CWSCVPR052C	C/V 052C PLUG	2.4E-06	1.6E-05	7.9E+00
580	CWSXVPR045C	X/V 045C PLUG	2.4E-06	1.6E-05	7.9E+00
581	CWSXVPR014C	X/V 014C PLUG	2.4E-06	1.6E-05	7.9E+00
582	CWSXVPR103C	X/V 103C PLUG	2.4E-06	1.6E-05	7.9E+00
583	CWSXVPR101C	X/V 101C PLUG	2.4E-06	1.6E-05	7.9E+00
584	CWSXVPR055C	X/V 055C PLUG	2.4E-06	1.6E-05	7.9E+00
585	CWSORPR1224C	ORIFICE 1224C PLUG	2.4E-05	1.6E-04	7.7E+00
586	HPICF4PMSRSIP-234	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	2.2E-05	7.7E+00
587	RSSCF4MVOD9011-134	CS/RHR M/V 9011 FAIL TO OPEN CCF	1.5E-06	9.5E-06	7.5E+00
588	SGNST-SGIA	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) ISOLATION SIGNAL A FAILURE	4.0E-04	2.5E-03	7.1E+00
589	RWSCF4SUPRST01-23	SUMP STRAINER PLUG CCF	3.0E-06	1.8E-05	7.0E+00
590	HPICF4PMLRSIP-134	HHI PUMP FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	6.7E-06	6.9E+00
591	HPICF4CVOD8808-234	C/V 8808 FAIL TO OPEN CCF	2.7E-07	1.6E-06	6.9E+00
592	HPICF4CVOD8809-234	C/V 8809 FAIL TO OPEN CCF	2.7E-07	1.6E-06	6.9E+00
593	HPICF4CVOD8804-234	C/V 8804 FAIL TO OPEN CCF	2.7E-07	1.6E-06	6.9E+00
594	HPICF4CVOD8806-234	C/V 8806 FAIL TO OPEN CCF	2.7E-07	1.6E-06	6.9E+00
595	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	1.5E-02	6.9E+00
596	SGNCF4SGI-24	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	3.5E-06	2.1E-05	6.8E+00
597	SGNCF4SGI-23	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	3.5E-06	2.1E-05	6.8E+00
598	CWSCF4MVCD056-ALL	CWS M/V 056 FAILTO CLOSE	1.3E-05	7.1E-05	6.7E+00
599	CWSCF4MVCD043-ALL	CWS M/V 043 FAILTO CLOSE CCF	1.3E-05	7.1E-05	6.7E+00
600	CWSCVEL052C	C/V 052C EXTERNAL LEAK L	4.8E-08	2.7E-07	6.7E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 21 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
601	CWSMVEL043C	M/V 043C EXTEANAL LEAK L	2.4E-08	1.4E-07	6.7E+00
602	CWSMVEL056C	M/V 056C EXTEANAL LEAK L	2.4E-08	1.4E-07	6.7E+00
603	CWSPMELCWPC	M/P CCWPC EXTERNAL LEAK L	1.9E-07	1.1E-06	6.7E+00
604	CWSPNELCWC	CWS TRAIN C PIPE LEAK	1.1E-06	6.4E-06	6.7E+00
605	CWSRIELCWHXC	HEAT EXCHANGER CCWHXC TUBE EXTERNAL LEAK L	7.2E-07	4.1E-06	6.7E+00
606	CWSXVEL014C	X/V 014C EXTEANAL LEAK L	7.2E-08	4.1E-07	6.7E+00
607	CWSXVEL045C	X/V 045C EXTEANAL LEAK L	7.2E-08	4.1E-07	6.7E+00
608	CWSXVEL055C	X/V 055C EXTEANAL LEAK L	7.2E-08	4.1E-07	6.7E+00
609	CWSXVEL101C	X/V 101C EXTEANAL LEAK L	7.2E-08	4.1E-07	6.7E+00
610	CWSXVEL103C	X/V 103C EXTEANAL LEAK L	7.2E-08	4.1E-07	6.7E+00
611	CWSXVELCCW0001B	X/V CCW0001B EXTEANAL LEAK L	7.2E-08	4.1E-07	6.7E+00
612	HPIXVEL132C	X/V 132C EXTERNAL LEAK L	7.2E-08	4.1E-07	6.7E+00
613	HPIXVEL133C	X/V 133C EXTERNAL LEAK L	7.2E-08	4.1E-07	6.7E+00
614	HPIXVEL160C	X/V 160C EXTERNAL LEAK L	7.2E-08	4.1E-07	6.7E+00
615	HPIXVEL161C	X/V 161C EXTERNAL LEAK L	7.2E-08	4.1E-07	6.7E+00
616	HPIXVELCCW0002C	X/V CCW0002C EXTERNAL LEAK L	7.2E-08	4.1E-07	6.7E+00
617	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	3.0E-02	6.6E+00
618	SGNCF4SGI-234	SG ISOLATION SIGNAL A,B,C,D FAILURE (CCF)	1.8E-06	1.0E-05	6.6E+00
619	EFWXVELMW4A	X/V MW4A EXTERNAL LEAK L	7.2E-08	4.0E-07	6.5E+00
620	EFWCVELMW1A	C/V MW1A EXTERNAL LEAK L	4.8E-08	2.7E-07	6.5E+00
621	EPSCF4CBWR4I-24	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	1.8E-07	6.5E+00
622	EPSBSFF4ESBC	480V BUS C FAILURE	5.8E-06	3.2E-05	6.5E+00
623	EPSTRFFPTC	4PTC TRANSFORMER FAIL TO RUN	8.2E-06	4.5E-05	6.5E+00
624	EPSBSFF4ESBP1	480V BUS P1 FAILURE	5.8E-06	3.1E-05	6.5E+00
625	EPSBSFF6ESBP1	NON SAFETY ALTERNATIVE 6.9KV P1 BUS FAILURE	5.8E-06	3.1E-05	6.5E+00
626	EPSCBWR4IP1	4IP1 BREAKER FAIL OPERATE (MALFUNCTION)	3.4E-06	1.8E-05	6.5E+00
627	EPSTRFF4PTP1	4PTP1 TRANSFORMER FAIL TO RUN	8.2E-06	4.4E-05	6.5E+00
628	NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT	2.5E-02	1.4E-01	6.4E+00
629	CWSRHPFCWHXC	HEAT EXCHANGER CCWHXC PLUG / FOUL (CCW OR RHR)	1.4E-06	7.4E-06	6.4E+00
630	SWSCF2PMBDSWPBD-ALL	ESW PUMP B,D FAIL TO START CCF	1.4E-04	7.2E-04	6.3E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 22 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
631	RSSCF4PMADCSP-13	CS/RHR PUMP FAIL TO START CCF	1.3E-05	6.4E-05	6.1E+00
632	SGNTMLGSC	ESFAS and SLS C MAINTENANCE	3.0E-04	1.6E-03	6.1E+00
633	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.9E-02	6.0E+00
634	EPSCBWR4IC	4IC BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	1.5E-05	5.9E+00
635	RSSCF4MVOD114-13	CS/RHR M/V 114 FAIL TO OPEN CCF	5.7E-06	2.7E-05	5.8E+00
636	RWSCF4SUPRST01-13	SUMP STRAINER PLUG CCF	3.0E-06	1.4E-05	5.7E+00
637	SGNTMLGSA	ESFAS and SLS A MAINTENANCE	3.0E-04	1.4E-03	5.7E+00
638	RSSCF4PMSRCSP-13	CS/RHR PUMP FAIL TO RUN (<1H) CCF	3.3E-06	1.6E-05	5.7E+00
639	RSSCF4MVOD9011-123	CS/RHR M/V 9011 FAIL TO OPEN CCF	1.5E-06	6.7E-06	5.6E+00
640	RSSCF4PMADCSP-23	CS/RHR PUMP FAIL TO START CCF	1.3E-05	5.7E-05	5.6E+00
641	EFWMVELEFW04B	M/V EFW04B EXTERNAL LEAK L	2.4E-08	1.1E-07	5.6E+00
642	EFWMVELEFW04A	M/V EFW04A EXTERNAL LEAK L	2.4E-08	1.1E-07	5.6E+00
643	EFWMVELEFW04C	M/V EFW04C EXTERNAL LEAK L	2.4E-08	1.1E-07	5.6E+00
644	EFWMVELEFW04D	M/V EFW04D EXTERNAL LEAK L	2.4E-08	1.1E-07	5.6E+00
645	RSSPMADCSPC	CS/RHR PUMP FAIL TO START (STANDBY)	1.4E-03	6.5E-03	5.6E+00
646	RWSSUPRST01C	CONTAINMENT SUMP ST01C PLUG	2.1E-04	9.6E-04	5.5E+00
647	RSSMVOD114C	M/V 114C FAIL TO OPEN	9.0E-04	4.1E-03	5.5E+00
648	RSSPMSRCSPC	CS/RHR PUMP-C FAIL TO RUN (STANDBY) (<1H)	3.8E-04	1.7E-03	5.5E+00
649	SGNST-CCWC	CCW-C START SIGNAL	4.3E-04	1.9E-03	5.5E+00
650	RSSPMLRCSPC	CS/RHR PUMP C FAIL TO RUN (STANDBY) (>1H)	1.3E-04	5.9E-04	5.5E+00
651	RSSMVCM114C	M/V 114C MIS-CLOSE	9.6E-07	4.3E-06	5.5E+00
652	RSSMVFC114C	M/V 114C FAIL TO CONTROL	7.2E-05	3.2E-04	5.5E+00
653	RSSMVPR114C	M/V 114C PLUG	2.4E-06	1.1E-05	5.5E+00
654	RSSORPR1242C	ORIFICE 1242C PLUG	2.4E-05	1.1E-04	5.5E+00
655	CIACVCDCIV12	C/V CIV12 FAIL TO CLOSE	1.0E-04	4.5E-04	5.5E+00
656	CIACVILCIV12	C/V CIV12 INTERNAL LEAK L	7.2E-07	3.2E-06	5.5E+00
657	SWSCF2PMYRSWPBD-ALL	ESW PUMP B,D FAIL TO RUN CCF	8.9E-06	4.0E-05	5.5E+00
658	RSSTMPICSPC	PUMP C OUTAGE	4.0E-03	1.8E-02	5.5E+00
659	RSSTMRPRHEXC	RHEXC OUTAGE	5.0E-03	2.2E-02	5.5E+00
660	RSSMVFC9011C	M/V 9011C FAIL TO CONTROL	7.2E-05	3.2E-04	5.5E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 23 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
661	RSSCVOD9008C	C/V 9008C FAIL TO OPEN	1.0E-05	4.6E-05	5.4E+00
662	RSSCVPR9008C	C/V 9008C PLUG	2.4E-06	1.1E-05	5.4E+00
663	RSSORPR006C	ORIFICE 006C PLUG	2.4E-05	1.1E-04	5.4E+00
664	RSSORPR007C	ORIFICE 007C PLUG	2.4E-05	1.1E-04	5.4E+00
665	RSSORPR908C	ORIFICE 908C PLUG	2.4E-05	1.1E-04	5.4E+00
666	RSSRHPRRHEXC	HEAT EXCHANGER CS/RHR C PLUG / FOUL	8.9E-06	4.0E-05	5.4E+00
667	RSSXVPRRHR04C	X/V RHR04C PLUG	2.4E-06	1.1E-05	5.4E+00
668	RSSORPR1244C	ORIFICE 1244C PLUG	2.4E-05	1.1E-04	5.4E+00
669	RSSORPR1246C	ORIFICE 1246C PLUG	2.4E-05	1.1E-04	5.4E+00
670	RSSXVPR183C	X/V 183C PLUG	2.4E-06	1.1E-05	5.4E+00
671	RSSXVPR187C	X/V 187C PLUG	2.4E-06	1.1E-05	5.4E+00
672	RSSXVPRCCW003C	X/V CCW003C PLUG	2.4E-06	1.1E-05	5.4E+00
673	EPSCF4DLLRDG-234	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN	2.5E-04	1.1E-03	5.4E+00
674	EPSCF4DLADDG-234	EPS GTG A,B,C,D FAIL TO START CCF	5.2E-05	2.3E-04	5.4E+00
675	EPSCF4DLSRDG-234	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	1.7E-04	5.4E+00
676	EPSCF4SEFFDG-234	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	5.5E-05	5.4E+00
677	EPSCF4CBTDDG-134	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	5.2E-06	2.3E-05	5.4E+00
678	EPSCF4CBWRDG-123	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	2.9E-08	1.3E-07	5.4E+00
679	RSSCF4MVOD114-23	CS/RHR M/V 114 FAIL TO OPEN CCF	5.7E-06	2.5E-05	5.4E+00
680	RSSCF4PMSRCSP-23	CS/RHR PUMP FAIL TO RUN (<1H) CCF	3.3E-06	1.4E-05	5.3E+00
681	CWSCF4MVCD043-134	CWS M/V 043 FAILTO CLOSE CCF	4.2E-06	1.8E-05	5.3E+00
682	CWSCF4MVCD056-234	CWS M/V 056 FAILTO CLOSE	4.2E-06	1.8E-05	5.3E+00
683	CWSCF4MVCD043-34	CWS M/V 043 FAILTO CLOSE CCF	8.3E-06	3.5E-05	5.2E+00
684	CWSCF4MVCD056-23	CWS M/V 056 FAILTO CLOSE	8.3E-06	3.5E-05	5.2E+00
685	EPSBSFFDCC	125V DC BUS-C FAILURE	5.8E-06	2.4E-05	5.2E+00
686	RSSCF4CVOD9012-134	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	9.3E-07	5.2E+00
687	RSSMVCM9007C	M/V 9007C MIS-CLOSE	9.6E-07	3.9E-06	5.1E+00
688	RSSMVPR9007C	M/V 9007C PLUG	2.4E-06	9.9E-06	5.1E+00
689	EPSBSFFDCA	125V DC BUS-A FAILURE	5.8E-06	2.4E-05	5.1E+00
690	CWSCF4MVCD043-234	CWS M/V 043 FAILTO CLOSE CCF	4.2E-06	1.7E-05	5.1E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 24 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
691	CWSCF4MVCD056-123	CWS M/V 056 FAILTO CLOSE	4.2E-06	1.7E-05	5.1E+00
692	RSSXVPR107C	X/V 107C PLUG	2.4E-06	9.6E-06	5.0E+00
693	RSSXVPR113C	X/V 113C PLUG	2.4E-06	9.6E-06	5.0E+00
694	CWSCF2PCBDCWPBD-	CWS PUMP B,D FAIL TO START CCF	7.5E-05	3.0E-04	5.0E+00
695	RSSCF4MVOD9011-124	CS/RHR M/V 9011 FAIL TO OPEN CCF	1.5E-06	5.8E-06	5.0E+00
696	SGNOO04ICVR12	CALIBRATION MISS (SGNICVRP10012A-D) (HE)	6.7E-05	2.6E-04	4.8E+00
697	CWSCF4CVOD052-R-	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	1.8E-07	4.7E+00
698	SWSCF4CVOD502-R-	ESW C/V 502 FAIL TO OPEN CCF	5.0E-08	1.8E-07	4.7E+00
699	SWSCF4CVOD602-R-	ESW C/V 602 FAIL TO OPEN CCF	5.0E-08	1.8E-07	4.7E+00
700	RSSCF4PMLRCSP-13	CS/RHR PUMP FAIL TO RUN (>1H) CCF	1.2E-06	4.2E-06	4.7E+00
701	RSSCF4PMLRCSP-23	CS/RHR PUMP FAIL TO RUN (>1H) CCF	1.2E-06	4.0E-06	4.5E+00
702	RSSCF4MVOD9011-13	CS/RHR M/V 9011 FAIL TO OPEN CCF	5.7E-06	1.9E-05	4.4E+00
703	EPSCF4CBTD6H-34	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	1.7E-05	4.4E+00
704	EPSTRFFMTF	MAIN TRANSFORMER MALFUNCTION	8.2E-06	2.8E-05	4.4E+00
705	RSSMVOD9011A	M/V 9011A FAIL TO OPEN	9.0E-04	3.0E-03	4.4E+00
706	CWSCF2PCYRCWPBD-	CWS PUMP B,D FAIL TO RUN CCF	5.0E-06	1.6E-05	4.3E+00
707	CFAFMPRFSF1	FLOW METER FSF1 PLUG	2.4E-05	8.0E-05	4.2E+00
708	CFAMVFCFSV2	FIRE WATER PUMP DISCHARGE M/V (FSV2) FAIL TO CONTROL	2.6E-02	8.7E-02	4.2E+00
709	CFAMVODFSV2	M/V FSV2 FAIL TO OPEN	1.0E-03	3.3E-03	4.2E+00
710	CFAMVPRFSV2	M/V FSV2 PLUG	2.4E-06	8.0E-06	4.2E+00
711	CFAXVPRFSV1	X/V FSV1 PLUG	2.4E-06	8.0E-06	4.2E+00
712	RSSMVFC9011A	M/V 9011A FAIL TO CONTROL	7.2E-05	2.3E-04	4.2E+00
713	CCWRSA	FAILURE OF CCW RECOVERY AFTER CORE MELT	1.6E-02	5.2E-02	4.2E+00
714	CFACVODFSV6	C/V FSV6 FAIL TO OPEN	1.2E-05	4.0E-05	4.2E+00
715	CFACVPRFSV6	C/V FSV6 Plug	2.4E-06	8.0E-06	4.2E+00
716	CFAMVFCFSV5	TIE LINE FROM FIRE SUPPRESSION SYSTEM TO CSS M/V MOV-011 (FSV5) FAIL TO CONTROL	2.6E-02	8.7E-02	4.2E+00
717	CFAMVODFSV5	M/V FSV5 FAIL TO OPEN	1.0E-03	3.3E-03	4.2E+00
718	CFAMVPRFSV5	M/V FSV5 PLUG	2.4E-06	8.0E-06	4.2E+00
719	CFAORPRFSO1	ORIFICE FSO1 PLUG	2.4E-05	8.0E-05	4.2E+00
720	RSAOO02FWP	OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)	4.2E-02	1.4E-01	4.2E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 25 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
721	RSSCF4CVOD9008-12	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.0E-07	6.3E-07	4.2E+00
722	RSSCF4CVOD9008-24	CS/RHR C/V 9008 FAIL TO OPEN CCF	2.0E-07	6.3E-07	4.2E+00
723	RSSCF4RHPRRHEX-13	CS/RHR HX PLUG CCF	1.7E-07	5.5E-07	4.2E+00
724	RSSCF4RHPRRHEX-23	CS/RHR HX PLUG CCF	1.7E-07	5.5E-07	4.2E+00
725	SGNCF4ICVR0012-123	CONTAINMENT PRESSURE SENSOR FAILURE CCF	6.6E-08	2.1E-07	4.1E+00
726	SGNCF4ICVR0012-124	CONTAINMENT PRESSURE SENSOR FAILURE CCF	6.6E-08	2.1E-07	4.1E+00
727	SGNCF4ICVR0012-134	CONTAINMENT PRESSURE SENSOR FAILURE CCF	6.6E-08	2.1E-07	4.1E+00
728	SGNCF4ICVR0012-234	CONTAINMENT PRESSURE SENSOR FAILURE CCF	6.6E-08	2.1E-07	4.1E+00
729	SGNCF4ICVR0012-ALL	CONTAINMENT PRESSURE SENSOR FAILURE CCF	2.0E-07	6.2E-07	4.1E+00
730	RSSCF4MVOD9011-234	CS/RHR M/V 9011 FAIL TO OPEN CCF	1.5E-06	4.5E-06	4.1E+00
731	RSSCVOD9012A	C/V 9012A FAIL TO OPEN	1.0E-05	3.1E-05	4.1E+00
732	RSSCVPR9012A	C/V 9012A PLUG	2.4E-06	7.3E-06	4.1E+00
733	SWSCF4PMBD-R-23	ESW PUMP FAIL TO RE-START CCF	7.1E-05	2.2E-04	4.0E+00
734	SWSCF4PMBD-R-14	ESW PUMP FAIL TO RE-START CCF	7.1E-05	2.1E-04	4.0E+00
735	RSSCF4MVOD9011-12	RSS M/V 9011 FAIL TO OPEN CCF	5.7E-06	1.7E-05	4.0E+00
736	RSSCF4MVOD9011-14	RSS M/V 9011 FAIL TO OPEN CCF	5.7E-06	1.7E-05	4.0E+00
737	MSRAVCD500A4	A/V 500A4 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
738	MSRAVCD500A5	A/V 500A5 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
739	MSRAVCD500B4	A/V 500B4 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
740	MSRAVCD500B5	A/V 500B5 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
741	MSRAVCD500C4	A/V 500C4 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
742	MSRAVCD500C5	A/V 500C5 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
743	MSRAVCD500A1	A/V 500A1 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
744	MSRAVCD500A2	A/V 500A2 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
745	MSRAVCD500A3	A/V 500A3 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
746	MSRAVCD500B1	A/V 500B1 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
747	MSRAVCD500B2	A/V 500B2 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
748	MSRAVCD500B3	A/V 500B3 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
749	MSRAVCD500C1	A/V 500C1 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
750	MSRAVCD500C2	A/V 500C2 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 26 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
751	MSRAVCD500C3	A/V 500C3 FAIL TO CLOSE	1.2E-03	3.6E-03	4.0E+00
752	EPSTRFFPTD	6.9kV-480V D CLASS 1E STATION SERVICE TRANSFORMER FAIL TO RUN	8.2E-06	2.4E-05	3.9E+00
753	EPSBSFF4ESBD	480V CLASS 1E BUS D FAIL	5.8E-06	1.7E-05	3.9E+00
754	CWSCF4PCBD-R-34	CWS PUMP FAIL TO RE-START CCF	3.9E-05	1.1E-04	3.9E+00
755	RSSMVCM9011A	M/V 9011A MIS-CLOSE	9.6E-07	2.7E-06	3.9E+00
756	RSSMVPR9011A	M/V 9011A PLUG	2.4E-06	6.9E-06	3.9E+00
757	EPSBSFF4MCCA1	480V MCC A1 BUS FAILURE	5.8E-06	1.6E-05	3.8E+00
758	RSSCF4CVOD9012-123	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	6.3E-07	3.8E+00
759	RSSCF4CVOD9012-124	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	6.3E-07	3.8E+00
760	RSSXVPR9009A	X/V 9009A PLUG	2.4E-06	6.7E-06	3.8E+00
761	CWSCF4PCBD-R-12	CWS PUMP FAIL TO RE-START CCF	3.9E-05	1.1E-04	3.8E+00
762	EPSCF4CBTD6H-13	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	1.4E-05	3.8E+00
763	EPSCBWR4JA	4JA BREAKER FAIL OPERATE (MALFUNCTION)	3.0E-06	8.3E-06	3.8E+00
764	EPSBSFF6ESBD	6.9KV SAFETY D BUS FAILURE	5.8E-06	1.6E-05	3.7E+00
765	EPSBSFF4MCCD1	480V MCC D1 BUS FAILURE	5.8E-06	1.6E-05	3.7E+00
766	EPSCBWR4JD	4JD BREAKER FAIL OPERATE (MALFUNCTION)	3.0E-06	8.1E-06	3.7E+00
767	SWSTMPESWPD	ESW PUMP-D OUTAGE	1.2E-02	3.1E-02	3.5E+00
768	CWSTMRCCWHXD	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE	7.0E-03	1.8E-02	3.5E+00
769	CWSTMPCCWPD	D-CCW PUMP OUTAGE	6.0E-03	1.5E-02	3.5E+00
770	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START	6.5E-03	1.7E-02	3.5E+00
771	EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)	2.4E-03	6.1E-03	3.5E+00
772	EFWPTLRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (>1H)	1.5E-03	3.9E-03	3.5E+00
773	EFWPTELFWP1A	T/P FWP1A EXTERNAL LEAK L	2.2E-07	5.5E-07	3.5E+00
774	EPSCBWR4ID	4ID BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	7.5E-06	3.5E+00
775	RSSXVEL183C	X/V 183C EXTERNAL LEAK LARGE	7.2E-08	1.8E-07	3.5E+00
776	RSSXVEL187C	X/V 187C EXTERNAL LEAK LARGE	7.2E-08	1.8E-07	3.5E+00
777	RSSXVELCCW0003C	X/V CCW0003C EXTERNAL LEAK LARGE	7.2E-08	1.8E-07	3.5E+00
778	SGNTMLGSD	ESFAS and SLS D MAINTENANCE	3.0E-04	7.5E-04	3.5E+00
779	EFWMVODTS1A	M/V TS1A FAIL TO OPEN	9.6E-04	2.3E-03	3.4E+00
780	CFAFMFFFSF1	FLOW METER FSF1 BROKEN	7.2E-07	1.7E-06	3.4E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 27 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
781	CFAMVELFSV2	M/V FSV2 EXTERNAL LEAK L	2.4E-08	5.8E-08	3.4E+00
782	CFAPNELPIPE4	From TANK to Tie line PIPING EXTERNAL LEAK L	6.0E-10	1.4E-09	3.4E+00
783	CFAXVELFSV1	X/V FSV1 EXTERNAL LEAK L	7.2E-08	1.7E-07	3.4E+00
784	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	4.9E-02	3.4E+00
785	SWSCVEL502D	C/V 502D EXTERNAL LEAK L	4.8E-08	1.1E-07	3.4E+00
786	SWSCVPR502D	C/V 502D PLUG	2.4E-06	5.7E-06	3.4E+00
787	SWSPEELSWPD1	ESW PIPE D1 LEAK	3.9E-06	9.2E-06	3.4E+00
788	SWSPMBDSWPD	ESW PUMP-D FAIL TO START (RUNNING)	1.9E-03	4.4E-03	3.4E+00
789	SWSSTPRST07	STRAINER ST07 PLUG	1.7E-04	4.0E-04	3.4E+00
790	SWSXVEL503D	X/V 503D EXTEANAL LEAK L	7.2E-08	1.7E-07	3.4E+00
791	SWSXVEL507D	X/V 507D EXTEANAL LEAK L	7.2E-08	1.7E-07	3.4E+00
792	SWSXVEL509D	X/V 509D EXTEANAL LEAK L	7.2E-08	1.7E-07	3.4E+00
793	SWSXVELESS0001D	X/V ESS0001D EXTEANAL LEAK L	7.2E-08	1.7E-07	3.4E+00
794	SWSXVELESS0002D	X/V ESS0002D EXTEANAL LEAK L	7.2E-08	1.7E-07	3.4E+00
795	SWSXVPR503D	X/V 503D PLUG	2.4E-06	5.7E-06	3.4E+00
796	SWSXVPR507D	X/V 507D PLUG	2.4E-06	5.7E-06	3.4E+00
797	SWSXVPR509D	X/V 509D PLUG	2.4E-06	5.7E-06	3.4E+00
798	CWSPCBDCWPD	CCW-D FAIL TO START (RUNNING)	1.0E-03	2.4E-03	3.4E+00
799	SGNST-EFWTDA	TURBIN SIGNAL-A FAIL	4.3E-04	1.0E-03	3.4E+00
800	SWSPMYRSWPD	ESW PUMP-D FAIL TO RUN (RUNNING)	1.1E-04	2.6E-04	3.3E+00
801	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	4.9E-02	3.3E+00
802	CWSCVPR052D	C/V 052D PLUG	2.4E-06	5.5E-06	3.3E+00
803	CWSORPR1230D	ORIFICE 1230D PLUG	2.4E-05	5.5E-05	3.3E+00
804	CWSXVPR014D	X/V 014D PLUG	2.4E-06	5.5E-06	3.3E+00
805	CWSXVPR045D	X/V 045D PLUG	2.4E-06	5.5E-06	3.3E+00
806	CWSXVPR055D	X/V 055D PLUG	2.4E-06	5.5E-06	3.3E+00
807	CWSXVPR101D	X/V 101D PLUG	2.4E-06	5.5E-06	3.3E+00
808	CWSXVPR103D	X/V 103D PLUG	2.4E-06	5.5E-06	3.3E+00
809	SWSORPROR04D	ORIFICE OR04D PLUG	2.4E-05	5.5E-05	3.3E+00
810	SWSORPROR24D	ORIFICE OR24D PLUG	2.4E-05	5.5E-05	3.3E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 28 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
811	SWSPMELSWPD	ESW PUMP-D EXTERNAL LEAK L	1.9E-07	4.4E-07	3.3E+00
812	SWSXVPR569D	X/V 569D PLUG	2.4E-06	5.5E-06	3.3E+00
813	SWSXVPR570D	X/V 570D PLUG	2.4E-06	5.5E-06	3.3E+00
814	SWSSTPRST02D	STRAINER ST02D PLUG	1.7E-04	3.8E-04	3.3E+00
815	HPICF4PMADSIP-134	HHI PUMP FAIL TO START (Standby) CCF	9.5E-06	2.1E-05	3.2E+00
816	RSSCF4MVOD9011-34	CS/RHR M/V 9011 FAIL TO OPEN CCF	5.7E-06	1.3E-05	3.2E+00
817	EPSCF4CBWR6H-ALL	EPS C/B 6HA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	3.5E-07	3.2E+00
818	CWSPCYRCWPD	CCWP-D FAIL TO RUN (RUNNING)	6.2E-05	1.4E-04	3.2E+00
819	SWSCVEL602D	C/V 602D EXTERNAL LEAK L	4.8E-08	1.1E-07	3.2E+00
820	SWSCVPR602D	C/V 602D PLUG	2.4E-06	5.3E-06	3.2E+00
821	SWSFMPR2055D	FM 2055D PLUG	2.4E-05	5.3E-05	3.2E+00
822	SWSORPRESS0003D	ORIFICE ESS0003D PLUG	2.4E-05	5.3E-05	3.2E+00
823	SWSPEELSWSD2	ESW PIPE D2 LEAK	3.8E-07	8.3E-07	3.2E+00
824	SWSXVEL601D	X/V 601D EXTEANAL LEAK L	7.2E-08	1.6E-07	3.2E+00
825	SWSXVPR601D	X/V 601D PLUG	2.4E-06	5.3E-06	3.2E+00
826	EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE	5.0E-03	1.1E-02	3.2E+00
827	EFWMVFCTS1A	M/V TS1A FAIL TO CONTROL	7.2E-05	1.5E-04	3.1E+00
828	EFWMVPRTS1A	M/V TS1A PLUG	2.4E-06	5.1E-06	3.1E+00
829	EFWMVCMTS1A	M/V TS1A MIS-CLOSE	9.6E-07	2.0E-06	3.1E+00
830	EFWMVELTS1A	M/V TS1A EXTERNAL LEAK L	2.4E-08	5.1E-08	3.1E+00
831	EFWPNELSTA	STEAM LINE A PIPE LEAK	6.0E-10	1.3E-09	3.1E+00
832	EPSCF4DLLRDG-14	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	5.4E-04	3.1E+00
833	EPSCF4DLADDG-14	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	9.0E-05	3.1E+00
834	EPSCF4DLSRDG-14	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	8.5E-05	3.1E+00
835	EPSCF4SEFFDG-14	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	5.3E-05	3.1E+00
836	EPSCF4CBTDDG-24	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	4.9E-06	1.0E-05	3.1E+00
837	EPSCF4CBWRDG-34	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	7.1E-08	3.1E+00
838	RSSCF4CVOD9012-234	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	4.6E-07	3.1E+00
839	CFACVELFSV6	C/V EXTERNAL LEAK L	4.8E-08	1.0E-07	3.1E+00
840	RSSCF4CVOD9012-12	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	4.2E-07	3.1E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 29 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
841	RSSCF4CVOD9012-13	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	4.2E-07	3.1E+00
842	RSSCF4CVOD9012-14	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	4.2E-07	3.1E+00
843	RSSCVEL9012A	C/V 9012A EXTERNAL LEAK L	4.8E-08	1.0E-07	3.1E+00
844	CWSORPR1224D	ORIFICE 1224D PLUG	2.4E-05	5.0E-05	3.1E+00
845	OPSRSB	FAILURE OF OFFSITE POWER RECOVERY AFTER CORE MELT WITHIN	8.3E-02	1.8E-01	3.0E+00
846	CWSCVOD052D	C/V 052D FAIL TO OPEN	1.1E-05	2.2E-05	2.9E+00
847	SWSCVOD502D	C/V 052D FAIL TO OPEN	1.1E-05	2.2E-05	2.9E+00
848	SWSCVOD602D	C/V 602D FAIL TO OPEN	1.1E-05	2.2E-05	2.9E+00
849	EPSCF4CBTD6H-12	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	9.3E-06	2.9E+00
850	EFWCF2PMADFWP2-	EFW M/D FWP2 FAIL TO START CCF	2.2E-04	4.1E-04	2.9E+00
851	HVACF2FAADDGF-ALL	M/D EFW PUMP ROOM HVAC FAN FAIL TO START (CCF)	1.4E-04	2.6E-04	2.8E+00
852	HVACF2FALRDGF-ALL	M/D EFW PUMP ROOM HVAC FAN FAIL TO RUN (>1H) (CCF)	1.3E-04	2.3E-04	2.8E+00
853	HVACF2FASRDGF-ALL	M/D EFW PUMP ROOM HVAC FAN FAIL TO RUN (<1H) (CCF)	9.4E-05	1.7E-04	2.8E+00
854	EFWCVODTW1A	C/V TW1A FAIL TO OPEN	9.5E-06	1.7E-05	2.8E+00
855	EFWXVPRTW4A	X/V TW4A PLUG	2.4E-06	4.3E-06	2.8E+00
856	EFWCVPRTW1A	C/V TW1A PLUG	2.4E-06	4.3E-06	2.8E+00
857	VCWCF4CHYR-ALL	SAFETY CHILLER UNIT A,B,C,D FAIL TO RUN (CCF)	2.7E-05	4.7E-05	2.7E+00
858	VCWCF4CHYR-23	SAFETY CHILLER UNIT FAIL TO RUN (CCF)	1.8E-05	3.1E-05	2.7E+00
859	VCWCF4CHYR-123	SAFETY CHILLER UNIT FAIL TO RUN (CCF)	9.0E-06	1.6E-05	2.7E+00
860	VCWCF4CHYR-234	SAFETY CHILLER UNIT FAIL TO RUN (CCF)	9.0E-06	1.6E-05	2.7E+00
861	SWSPEELSWSD3	ESW PIPE D3 LEAK	2.1E-07	3.7E-07	2.7E+00
862	SWSRIELSWHXD	HEAT EXCHANGER CCWHXD TUBE EXTERNAL LEAK L	7.2E-07	1.2E-06	2.7E+00
863	SWSXVEL561D	X/V 561D EXTEANAL LEAK L	7.2E-08	1.2E-07	2.7E+00
864	SWSXVEL562D	X/V 562D EXTEANAL LEAK L	7.2E-08	1.2E-07	2.7E+00
865	SWSXVPR561D	X/V 561D PLUG	2.4E-06	4.1E-06	2.7E+00
866	SWSXVPR562D	X/V 562D PLUG	2.4E-06	4.1E-06	2.7E+00
867	EPSBSFFVITA	120V BUS-A FAILURE	5.8E-06	9.8E-06	2.7E+00
868	EFWXVILTW6AA	X/V TW6AA INTERNAL LEAK L	1.1E-05	1.8E-05	2.7E+00
869	EFWXVELTW6AB	X/V TW6AB EXTEANAL LEAK L	7.2E-08	1.2E-07	2.7E+00
870	EFWXVELTW6AA	X/V TW6AA EXTEANAL LEAK L	7.2E-08	1.2E-07	2.7E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 30 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
871	EFWCVELTW7AB	C/V TW7AB EXTERNAL LEAK L	4.8E-08	8.2E-08	2.7E+00
872	EFWCVELTW7AA	C/V TW7AA EXTERNAL LEAK L	4.8E-08	8.2E-08	2.7E+00
873	HPICF4PMSRSIP-134	HHI PUMP FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	5.5E-06	2.7E+00
874	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START	6.5E-03	1.1E-02	2.7E+00
875	EFWPTSRFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO RUN (<1H)	2.4E-03	4.1E-03	2.7E+00
876	EFWPTLRFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO RUN (>1H)	1.5E-03	2.6E-03	2.7E+00
877	EFWPTELFWP1B	T/P FWP1B EXTERNAL LEAK L	2.2E-07	3.7E-07	2.7E+00
878	EPSCF4DLLRDG-13	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	4.3E-04	2.7E+00
879	EPSCF4DLADDG-13	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	7.2E-05	2.7E+00
880	EPSCF4DLSRDG-13	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	6.7E-05	2.7E+00
881	EPSCF4SEFFDG-13	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	4.2E-05	2.7E+00
882	EPSCF4CBTDDG-23	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	4.9E-06	8.2E-06	2.7E+00
883	EPSCF4CBWRDG-24	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	5.6E-08	2.7E+00
884	EPSCF4DLLRDG-34	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	4.2E-04	2.7E+00
885	EPSCF4DLADDG-34	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	7.1E-05	2.7E+00
886	EPSCF4DLSRDG-34	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	6.7E-05	2.7E+00
887	EPSCF4SEFFDG-34	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	4.2E-05	2.7E+00
888	EPSCF4CBTDDG-34	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	4.9E-06	8.2E-06	2.7E+00
889	EPSCF4CBWRDG-23	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	5.6E-08	2.7E+00
890	EFWMVODTS1B	M/V TS1B FAIL TO OPEN	9.6E-04	1.5E-03	2.6E+00
891	CWSCF2CVOD052BD-	CWS C/V 052B,D FAIL TO OPEN CCF	5.6E-07	8.9E-07	2.6E+00
892	SWSCF2CVOD602BD-	ESW C/V 602 FAIL TO OPEN CCF	5.6E-07	8.9E-07	2.6E+00
893	SWSCF2CVOD502BD-	ESW C/V 502 FAIL TO OPEN CCF	5.6E-07	8.9E-07	2.6E+00
894	SGNST-EFWTDB	TURBIN SIGNAL-B FAIL	4.3E-04	6.6E-04	2.5E+00
895	EFWCF2PMSRFWP2-	EFW FWP2 FAIL TO RUN (<1h) CCF	1.7E-05	2.6E-05	2.5E+00
896	CWSCVEL052D	C/V 052D EXTERNAL LEAK L	4.8E-08	6.9E-08	2.4E+00
897	CWSMVEL043D	M/V 043D EXTEANAL LEAK L	2.4E-08	3.4E-08	2.4E+00
898	CWSMVEL056D	M/V 056D EXTEANAL LEAK L	2.4E-08	3.4E-08	2.4E+00
899	CWSPMELCWPD	M/P CCWPD EXTERNAL LEAK L	1.9E-07	2.7E-07	2.4E+00
900	CWSPNELCWD	CWS TRAIN D PIPE LEAK	9.1E-07	1.3E-06	2.4E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 31 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
901	CWSRIELCWHXD	HEAT EXCHANGER CCWHXD TUBE EXTERNAL LEAK L	7.2E-07	1.0E-06	2.4E+00
902	CWSXVEL014D	X/V 014D EXTEANAL LEAK L	7.2E-08	1.0E-07	2.4E+00
903	CWSXVEL045D	X/V 045D EXTEANAL LEAK L	7.2E-08	1.0E-07	2.4E+00
904	CWSXVEL055D	X/V 055D EXTEANAL LEAK L	7.2E-08	1.0E-07	2.4E+00
905	CWSXVEL101D	X/V 101D EXTEANAL LEAK L	7.2E-08	1.0E-07	2.4E+00
906	CWSXVEL103D	X/V 103D EXTEANAL LEAK L	7.2E-08	1.0E-07	2.4E+00
907	HPIXVEL132D	X/V 132D EXTERNAL LEAK L	7.2E-08	1.0E-07	2.4E+00
908	HPIXVEL133D	X/V 133D EXTERNAL LEAK L	7.2E-08	1.0E-07	2.4E+00
909	HPIXVEL160D	X/V 160D EXTERNAL LEAK L	7.2E-08	1.0E-07	2.4E+00
910	HPIXVEL161D	X/V 161D EXTERNAL LEAK L	7.2E-08	1.0E-07	2.4E+00
911	HPIXVELCCW0002D	X/V CCW0002D EXTERNAL LEAK L	7.2E-08	1.0E-07	2.4E+00
912	EPSCF4CBTD6H-24	EPS C/B 6HA,B,C,D FAIL TO OPEN CCF	5.0E-06	7.0E-06	2.4E+00
913	EFMBTSWCCF	EFW MDP START SIGNAL SOFTWARE CCF	1.0E-05	1.4E-05	2.4E+00
914	EFWMVFCTS1B	M/V TS1B FAIL TO CONTROL	7.2E-05	1.0E-04	2.4E+00
915	EFWMVPRTS1B	M/V TS1B PLUG	2.4E-06	3.3E-06	2.4E+00
916	EFWMVCMTS1B	M/V TS1B MIS-CLOSE	9.6E-07	1.3E-06	2.4E+00
917	EFWMVELTS1B	M/V TS1B EXTERNAL LEAK L	2.4E-08	3.3E-08	2.4E+00
918	EFWPNELSTB	STEAM LINE B PIPE LEAK	6.0E-10	8.3E-10	2.4E+00
919	CWSRHPFCWHXD	HEAT EXCHANGER CCWHXD PLUG / FOUL (CCW OR RHR)	1.4E-06	1.9E-06	2.4E+00
920	SGNST-BOB	B.O-B SIGNAL LOW FAIL	4.3E-04	5.8E-04	2.4E+00
921	RSSCF4CVOD9012-34	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	2.7E-07	2.4E+00
922	EFWOO04LAAA	EFW PIT WATER LEVEL GAGE A CALIBRATION MISS (HE)	2.2E-04	3.0E-04	2.3E+00
923	EFWTMTAB	D-EMERGENCY FEED WATER PUMP(FWP1B) OUTAGE	5.0E-03	6.7E-03	2.3E+00
924	EFWCF2PMLRFWP2-	EFW FWP2 FAIL TO RUN (>1h) CCF	5.9E-06	7.3E-06	2.2E+00
925	SWSCF4PMBD-R-24	ESW PUMP FAIL TO RE-START CCF	7.1E-05	8.6E-05	2.2E+00
926	EFWCVODTW1B	C/V TW1B FAIL TO OPEN	9.5E-06	1.1E-05	2.2E+00
927	EFWXVPRTW4B	X/V TW4B PLUG	2.4E-06	2.8E-06	2.2E+00
928	EFWCVPRTW1B	C/V TW1B PLUG	2.4E-06	2.8E-06	2.2E+00
929	SWSCF4PMBD-R-34	ESW PUMP FAIL TO RE-START CCF	7.1E-05	8.3E-05	2.2E+00
930	SGNTMLGSB	ESFAS and SLS B MAINTENANCE	3.0E-04	3.5E-04	2.2E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-42 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 32 of 32)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
931	HPICF4PMADSIP-34	HHI PUMP FAIL TO START (Standby) CCF	2.2E-05	2.5E-05	2.1E+00
932	EPSCF4DLLRDG-23	EPS GTG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	2.9E-04	2.1E+00
933	EPSCF4DLADDG-23	EPS GTG A,B,C,D FAIL TO START CCF	4.3E-05	4.9E-05	2.1E+00
934	EPSCF4DLSRDG-23	EPS GTG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	4.6E-05	2.1E+00
935	EPSCF4SEFFDG-23	EPS SG SEQUENCER FAIL TO OPERATE CCF	2.5E-05	2.8E-05	2.1E+00
936	EPSCF4CBTDDG-13	EPS GTG C/B GTGBA,B,C,D Fail to Closed CCF	4.9E-06	5.6E-06	2.1E+00
937	EPSCF4CBWRDG-12	EPS GTG C/B GTGBA,B,C,D fail to remain closed CCF	3.4E-08	3.8E-08	2.1E+00
938	SWSCF4PMBD-R-12	ESW PUMP FAIL TO RE-START CCF	7.1E-05	8.0E-05	2.1E+00
939	EFWXVILTW6BA	X/V TW6BA INTERNAL LEAK L	1.1E-05	1.2E-05	2.1E+00
940	EFWXVELTW6BA	X/V TW6BA EXTEANAL LEAK L	7.2E-08	8.0E-08	2.1E+00
941	EFWXVELTW6BB	X/V TW6BB EXTEANAL LEAK L	7.2E-08	8.0E-08	2.1E+00
942	EFWCVELTW7BB	C/V TW7BB EXTERNAL LEAK L	4.8E-08	5.4E-08	2.1E+00
943	EFWCVELTW7BA	C/V TW7BA EXTERNAL LEAK L	4.8E-08	5.4E-08	2.1E+00
944	EFWXVPRTW3A	X/V TW3A PLUG	2.4E-06	2.6E-06	2.1E+00
945	ACWCF2MVODCH1-ALL	ACW M/V CH1 FAILTO OPEN CCF	4.7E-05	5.0E-05	2.1E+00
946	ACWCF2MVODCH3-ALL	ACW M/V CH3 FAILTO OPEN CCF	4.7E-05	5.0E-05	2.1E+00
947	MSRAVCD533A	A/V 533A FAIL TO CLOSE	7.9E-04	8.4E-04	2.1E+00
948	CWSCF4PCBD-R-13	CWS PUMP FAIL TO RE-START CCF	3.9E-05	4.1E-05	2.0E+00
949	CWSCF4PCBD-R-14	CWS PUMP FAIL TO RE-START CCF	3.9E-05	4.0E-05	2.0E+00
950	MSRAVIL533A	A/V 533A INTERNAL LEAK L	1.2E-07	1.2E-07	2.0E+00
951	MSRAVIL535A	A/V 535A INTERNAL LEAK L	1.2E-07	1.2E-07	2.0E+00
952	MSRAVOM533A	A/V 533A MIS-OPENING	4.8E-06	4.9E-06	2.0E+00
953	MSRAVOM535A	A/V 535A MIS-OPENING	4.8E-06	4.9E-06	2.0E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-43 Common Cause Failure FV Importance for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.5E-01	7.2E+03
2	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	8.1E-02	9.7E+02
3	EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	9.9E-04	5.1E-02	5.3E+01
4	SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF	4.8E-05	2.8E-02	5.8E+02
5	EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF	1.5E-03	1.9E-02	1.4E+01
6	RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF	1.9E-05	1.9E-02	9.9E+02
7	EFWCF2TPADFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO START CCF	4.5E-04	1.6E-02	3.6E+01
8	CWSCF4PCBD-R-ALL	CCW PUMP ALL FAIL TO RE-START CCF	2.6E-05	1.5E-02	5.8E+02
9	SGNBTSWCCF	S,P SIGNAL SOFTWARE CCF	1.0E-05	1.5E-02	1.5E+03
10	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	1.4E-02	1.5E+03

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 44 Common Cause Failure RAW for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	SWSCF4PMYR-FF	ESW PUMP A,B,C,D FAIL TO RUN CCF	1.2E-08	6.7E-04	5.6E+04
2	CWSCF4RHPR-FF	ALL COMPONENT COOLING HEAT EXCHANGERS PLUG/FOUL OR LARGE EXTERNAL LEAK CCF	3.6E-08	1.9E-03	5.1E+04
3	CWSCF4PCYR-FF	CCW PUMP ALL FAIL TO RUN CCF	6.7E-09	3.4E-04	5.1E+04
4	EPSCF4BYFF-234	EPS BATTERY A,C,D FAIL TO OPERATE CCF	1.2E-08	5.2E-04	4.2E+04
5	EPSCF4BYFF-124	EPS BATTERY A,B,D FAIL TO OPERATE CCF	1.2E-08	5.1E-04	4.1E+04
6	RTPBTSWCCF	SUPPORT SOFTWARE CCF	1.0E-07	2.6E-03	2.6E+04
7	EPSCF4BYFF-ALL	EPS BATTERY A,B,C,D FAIL TO OPERATE CCF	5.0E-08	1.0E-03	2.0E+04
8	EPSCF4BYFF-134	EPS BATTERY A,B,C FAIL TO OPERATE CCF	1.2E-08	1.0E-04	8.2E+03
9	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.5E-01	7.2E+03
10	EPSCF4BYFF-123	EPS BATTERY B,C,D FAIL TO OPERATE CCF	1.2E-08	8.6E-05	7.0E+03

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 45 Human Error FV Importance for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	3.2E-01	1.7E+01
2	ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	5.1E-01	3.1E-01	1.3E+00
3	NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)	2.5E-02	1.4E-01	6.4E+00
4	RSAOO02FWP	OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)	4.2E-02	1.4E-01	4.2E+00
5	MSROO02533A	OPERATOR FAILS TO CLOSE MAIN STEAM ISOLATION VALVES (HE)	2.6E-03	5.3E-02	2.1E+01
6	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	4.9E-02	3.3E+00
7	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	4.9E-02	3.4E+00
8	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	3.5E-02	1.5E+01
9	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.9E-02	6.0E+00
10	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	1.5E-02	6.9E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-46 Human Error RAW for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	MSROO02533A	OPERATOR FAILS TO CLOSE MAIN STEAM ISOLATION VALVES (HE)	2.6E-03	5.3E-02	2.1E+01
2	ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)	2.0E-02	3.2E-01	1.7E+01
3	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	3.5E-02	1.5E+01
4	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	1.5E-02	6.9E+00
5	NCCOO02CCW	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CONTAINMENT COOLING (HE)	2.5E-02	1.4E-01	6.4E+00
6	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.9E-02	6.0E+00
7	SGNOO04ICVR12	CALIBRATION MISS (SGNICVRP10012A-D) (HE)	6.7E-05	2.6E-04	4.8E+00
8	RSAOO02FWP	OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)	4.2E-02	1.4E-01	4.2E+00
9	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	4.9E-02	3.4E+00
10	EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)	2.1E-02	4.9E-02	3.3E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 47 Hardware Single Failure FV Importance for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	CFAMVFCFSV2	FIRE WATER PUMP DISCHARGE M/V (FSV2) FAIL TO CONTROL	2.6E-02	8.7E-02	4.2E+00
2	CFAMVFCFSV5	TIE LINE FROM FIRE SUPPRESSION SYSTEM TO CSS M/V MOV-011 (FSV5) FAIL TO CONTROL	2.6E-02	8.7E-02	4.2E+00
3	CHIPMBDCHPB-R	CHP-B FAIL TO START (RUNNING)	1.8E-03	2.4E-02	1.4E+01
4	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START	6.5E-03	1.7E-02	3.5E+00
5	EPSDLLRDGP1-L2	AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H)	1.8E-02	1.4E-02	1.8E+00
6	FDAMVFC58MC	DEPRESSURIZATION VALVE FOR SEVERE ACCIDENT M/V MOV-118 (58MC) FAIL TO CONTROL	2.6E-02	1.3E-02	1.5E+00
7	FDAMVFC58RC	DEPRESSURIZATION VALVE FOR SEVERE ACCIDENT M/V MOV-119(58RC) FAIL TO CONTROL	2.6E-02	1.3E-02	1.5E+00
8	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START	6.5E-03	1.1E-02	2.7E+00
9	EPSDLLRDGP2-L2	AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H)	1.8E-02	1.1E-02	1.6E+00
10	RSSPMADCSPC	CS/RHR PUMP FAIL TO START (STANDBY)	1.4E-03	6.5E-03	5.6E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-48 Hardware Single Failure RAW for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	1.1E-03	1.1E+04
2	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL LEAK	7.2E-08	1.0E-04	1.5E+03
3	RWSTNELRWSP	REFUELING WATER STORAGE PIT LARGE EXTERNAL LEAK	4.8E-08	7.0E-05	1.5E+03
4	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	3.5E-05	1.5E+03
5	HPIMVEL8820B	CONTAINMENT ISOLATION M/V MOV-001B(8820B) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
6	HPIMVEL8820C	CONTAINMENT ISOLATION M/V MOV-001C(8820C) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
7	HPIMVEL8820A	CONTAINMENT ISOLATION M/V MOV-001A(8820A) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
8	HPIMVEL8820D	CONTAINMENT ISOLATION M/V MOV-001D(8820D) LARGE LEAK	2.4E-08	3.5E-05	1.4E+03
9	RSSPNEL01B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	4.1E-05	1.4E+03
10	RSSPNEL01D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	4.1E-05	1.4E+03

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-49 Dominant Plant Damage States of LRF

No	PDS	Conditional Containment Failure Probability for each PDS	Percentage Contribution	Cumulative Percentage
1	3D	1.0E+00	38.0%	38.0%
2	4K	1.0E+00	17.3%	55.3%
3	4D	1.0E+00	14.9%	70.3%
4	3A	1.2E-02	6.3%	76.5%
5	4L	1.0E+00	5.7%	82.3%
6	4H	1.0E+00	5.1%	87.3%
7	9A	6.7E-01	2.7%	90.0%
8	6D	1.0E+00	2.3%	92.3%
9	1K	1.0E+00	1.5%	93.8%
10	5A	3.2E-03	1.2%	95.0%

Table19.1- 50 Key Sources of Uncertainty and Key Assumptions (Level 2 PRA for Internal Events at Power)

Key Sources of Uncertainty and Key Assumptions		Type (Note)	Summary Results of Qualitative Assessments	Quantitative Approach
Level1/Level2 Interface	Parametric uncertainty of core damage frequency	P	(Parametric uncertainty is considered)	Uncertainty Analysis
	ATWS scenarios are included in low RCS pressure state.	M	ATWS scenarios lead to LBLOCA due to primary system overpressurization. If these scenarios lead to SGTR, there is slightly increase LRF because these sequence have a few percent of CDF.	NA
	Reactor vessel rupture scenarios are included in low RCS pressure state.	M	It is assumed that Reactor vessel rupture is same as LBLOCA.	NA
Containment Event Tree Development	Reactor vessel is assumed to fail regardless of the status of water injection into reactor vessel.	M	It is conservatively assumed no in-vessel retention.	NA
Level 2 event sequence quantification	Parametric uncertainty of the systems in the CSET	P	(Parametric uncertainty is considered)	Uncertainty Analysis
	The mean time to repair for one train of the CCWS is set to 24 hours regardless of cause of failure.	M	Mean maintenance act duration time is 19 hours for the pumps and 21 hours for the Diesels (Ref. 19.1-25). It is assumed that 24hours for CCWS.	NA
	There are no dependencies of human errors between level 1 PRA event tree and containment system event tree.	M	In the case of core damage accident, procedure has changed and technical support team organized to support operators.	NA

Note - Uncertainty sources are categorized into three types, Parametric (P) or Modeling (M).

Table19.1- 51 HCLPF Values of Structures and Categories of Components (Sheet 1 of 4)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Building / Structure			
Reactor Building	Structural Failure	1.50	3
Safety Power Source Buildings	Structural Failure	0.50	2
PCCV	Structural Failure	1.11	3
EFW Pit	Structural Failure	1.50	3
Refueling Water Storage Pit	Structural Failure	1.11	3
Interior Containment Structure	Structural Failure	1.71	3
Essential Service Water Intake Structure	Structural Failure	0.50	2
Essential Service Water Pipe Tunnel	Structural Failure	0.50	2
Primary Components			
Fuel Assembly (Reactor Internals and Core Assembly)	Structural Failure	0.50	2
Control Rod Drive	Structural Failure	0.67	1
Reactor Vessel	Structural Failure	0.62	1
Reactor Coolant Pumps	Structural Failure	0.67	1
Pressurizer	Structural Failure	0.67	1
Steam Generator (including Steam Generator Tubes)	Structural Failure	0.67	1
Mechanical Equipment			
Cable Tray	Structural Failure	0.53	1
Accumulators Tanks	Structural Failure	0.75	1
CS/RHR Heat Exchangers	Structural Failure	0.58	1
Component Cooling Heat Exchangers	Structural Failure	0.58	1
CCW Surge Tank	Structural Failure	0.58	1
Chiller Water Expansion Tanks	Structural Failure	0.58	1
Air Conditioner Ducts	Structural Failure	0.53	1
High Head Injection System Piping	Structural Failure	0.80	1
Piping around Accumulators Tanks	Structural Failure	0.80	1
CS/RHR System Piping	Structural Failure	0.80	1
EFW System Piping	Structural Failure	0.80	1
HVAC Chiller System Piping	Structural Failure	0.80	1
Component Cooling Water System	Structural Failure	0.80	1
Essential Service Water System Piping	Structural Failure	0.80	1
RCS Piping	Structural Failure	0.80	1
DVI Piping	Structural Failure	0.80	1
CS/RHR Hotleg Injection Piping	Structural Failure	0.80	1
Main Steam Lines (The upstream side from Main Steam Isolation Valves)	Structural Failure	0.80	1
In-Core Instrumentation Tube	Structural Failure	0.80	1
Pressurizer Safety Valve Piping	Structural Failure	0.80	1
Pressurizer Safety Depressurization Valve Piping	Structural Failure	0.80	1
Pressurizer Spray Piping	Structural Failure	0.80	1
Emergency Letdown Piping	Structural Failure	0.80	1
RCS Instrumentation Letdown Piping	Structural Failure	0.80	1
Accumulator Coldleg Injection Piping	Structural Failure	0.80	1
High Head Injection System Hotleg	Structural Failure	0.80	1
Containment Spray Nozzles	Structural Failure	0.80	1

Table19.1- 51 HCLPF Values of Structures and Categories of Components

(Sheet 2 of 4)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Pumps and Electric motor			
High Head Injection Pumps	Functional	0.62	1
High Head Injection Pumps	Structural Failure	0.62	1
CS/RHR Pumps	Functional	0.62	1
CS/RHR Pumps	Structural Failure	0.62	1
Motor Driven EFW Pumps	Functional	0.62	1
Component Cooling Water Pumps	Structural/ Functional	0.62	1
Essential Service Water Pumps	Structural/ Functional	0.62	1
HVAC Chiller Pumps	Functional	0.62	1
Turbine Driven EFW Pumps	Functional	0.75	1
M/D EFW Pumps Areas Ventilation Fans	Functional	0.67	1
HVAC Chillers	Functional	0.50	2
HVAC Chillers	Structural Failure	0.50	2
Motor-Operated Valve			
CCW CS/RHR heat exchanger outlet	Functional	0.80	1
Containment Spray Header Containment Isolation Valves	Functional Failure	0.80	1
EFW Isolation Valves	Functional	0.80	1
T/D EFW Pump Supply Motor Operated Valves	Functional Failure	0.80	1
CCW Surge Tank side Tie line Motor-Operated Valves	Functional Failure	0.80	1
CCW Heat Exchanger side Tie line Motor-Operated Valves	Functional Failure	0.80	1
M/D EFW Pumps Areas Cooling Water Flow Control valves	Functional Failure	0.80	1
Main Feed Water Isolation Valves	Functional	0.80	1
Refueling water Recirculation Pump Lines Isolation Valve	Functional Failure	0.80	1
Refueling water Recirculation Pump Lines Isolation Valve	Functional Failure	0.80	1
Air-Operated Valve			
Main Steam Isolation Valves	Functional	0.80	1
Refueling water Auxiliary Tank Lines Isolation Valve	Functional Failure	0.80	1

Table19.1- 51 HCLPF Values of Structures and Categories of Components

(Sheet 3 of 4)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Electrical Equipment			
Ceramic Insulators (Offsite Power System)	Functional Failure	0.08	1
class 1E Gas Turbine Generators	Functional	0.50	2
Batteries and Racks	Functional	1.13	1
class 1E Station Service Transformers	Functional	0.72	1
class 1E I&C Power Transformers	Functional	0.72	1
class 1E 6.9kV Switchgears	Functional	0.96	1
class 1E 480V Load Centers	Functional	0.96	1
class 1E Motor Control Centers	Functional	0.96	1
class 1E Gas Turbine Generators Control Boards	Functional Failure	1.13	1
Gas Turbine Generators Control Centers	Functional	1.13	1
class 1E DC Switchboards	Functional	1.13	1
Solenoid Distribution Panels	Functional	1.13	1
SLS Cabinets	Functional	1.13	1
RPS Cabinets	Functional	1.13	1
Electrical Equipment (continue)			
ESFAS Cabinets	Functional	1.13	1
Safety Remote I/O Cabinets	Functional	1.13	1
Ventilation Chiller Control Cabinets	Functional	1.13	1
class 1E Battery Chargers	Functional	0.75	1
UPS Unit	Functional	0.75	1
class 1E UPS Unit	Functional	0.75	1
Emergency Feedwater Pump Actuation Cabinets	Functional Failure	1.13	1
Safety and Check Valves			
Pressurizer Safety Valves	Functional	0.80	1
HHI Pump outlet Check Valves	Functional	0.80	1
RV/Hotleg Injection Line Check Valves	Functional	0.80	1
RV Injection Line First Check Valves	Functional	0.80	1
RV Injection Line Second Check Valves	Functional	0.80	1
Accumulators Check Valves	Functional	0.80	1
Accumulators Check Valves	Functional	0.80	1
CS/RHR Pumps Suction side Line Check Valves	Functional Failure	0.80	1
Containment Spray Line Check Valves	Functional	0.80	1
EFW Isolation Check Valves	Functional	0.80	1
EFW Pit outlet Check Valves	Functional	0.80	1
M/D EFW Pump outlet Check Valves and T/D Pump outlet Check Valves	Functional Failure	0.80	1
SG outlet Line Check Valves	Functional	0.80	1

Table19.1- 51 HCLPF Values of Structures and Categories of Components

(Sheet 4 of 4)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Safety and Check Valves (continue)			
CCW Pump outlet Check Valves	Functional	0.80	1
Essential Service Water Pumps outlet Check Valves	Functional Failure	0.80	1
Essential Service Water Pumps Cooling line Check Valves	Functional Failure	0.80	1
Main Feed Water Isolation Check Valves	Functional	0.80	1
Refueling water Auxiliary Tank Lines Check Valve	Functional Failure	0.80	1
Containment Isolation Equipments			
RCP Seal Water Return Line CV Isolation Valves	Functional Failure	0.80	1
RCP Seal Water Return Line CV Isolation System Piping	Structural Failure	0.80	1
CV Sump Pump Outlet PIPE Line CV Isolation System Piping	Structural Failure	0.80	1
Instrument Air Pipe Line CV Isolation	Functional	0.80	1
Instrument Air Pipe Line CV Isolation	Functional	0.80	1
Instrument Air Pipe CV Isolation System Piping	Structural Failure	0.80	1
CV Clean up Pipe Line CV Isolation System Piping	Structural Failure	0.80	1
Penetrations	Structural Failure	0.50	2
Equipment hatches	Structural Failure	0.50	2
Other Equipments			
Spent Fuel Pit Heat Exchangers	Structural Failure	0.58	1
Spent Fuel Pit	Structural Failure	1.50	3
Spent Fuel Pit Pumps	Structural Failure	0.62	1
Spent Fuel Pit Pumps	Functional	0.62	1
Spent Fuel Pit Water Cooling System	Structural Failure	0.80	1

Notes:

1. HCLPF based on EPRI Utility Requirements Document (Reference 19.1-35)

2. HCLPF is assumed as 0.5g.

3. HCLPF based on EPRI TR-103959 methodology (Reference 19.1-36)

Table19.1-52 HCLPFs for Basic Events (Sheet 1 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Building / Structure						
Reactor building	Structural Failure	SE-GTSBDSFBLDGE	4.4	0.46	1.5	SE_GSTC
Safety power source buildings	Structural Failure	SE-GTSBDSFBLDGP	-	-	0.50	SE_GSTC
PCCV	Structural Failure	SE-GTSSRSFCVESS	3.2	0.46	1.1	SE_GSTC
EFW pit	Structural Failure	SE-EFWTNSFEFWP1AB	-	-	1.5	SE_GSTC
Refueling water storage pit	Structural Failure	SE-RWSTNSFRWSP	-	-	1.1	SE_GSTC
Interior containment structure	Structural Failure	SE-GTSSRSFCVINT	5.0	0.46	1.7	SE_GSTC
Essential service water intake Structure	Structural Failure	SE-SWSSRSFESWBAS	-	-	0.50	SE_CCW
Essential service water pipe tunnel	Structural Failure	SE-SWSSRSFESWTUN	-	-	0.50	SE_CCW
Primary Components						
Fuel assembly (Reactor internals and core assembly)	Structural Failure	SE-ELOSRSFFUEL	-	-	0.50	SE_ELOCA
Control rod drive	Structural Failure	SE-RTPSRSFCRD	2.2	0.51	0.67	SE-RTA
Reactor vessel	Structural Failure	SE-ELOSRSFRXVES	1.8	0.46	0.62	SE_ELOCA

Table19.1-52 HCLPFs for Basic Events (Sheet 2 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Primary Components (Continued)						
Reactor coolant pumps	Structural Failure	SE-ELOPMSFRCP	2.2	0.51	0.67	SE_ELOCA
Pressurizer	Structural Failure	SE-LLOPZSFPZR	2.2	0.51	0.67	SE_LLOCA
Steam generator (including steam generator tubes)	Structural Failure	SE-GTSSGSFSG	2.2	0.51	0.67	SE_GSTC
Mechanical Equipment						
Cable tray	Structural Failure	SE-GTSCASFCABLE	2.2	0.61	0.53	SE_GSTC
Accumulators tanks	Structural Failure	SE-ACCTKSFSIT1ABCD	2.2	0.46	0.75	SE-ACA-LLOCA SE-ACA-SLOCA
CS/RHR heat exchangers	Structural Failure	SE-RSSRISFRHEXABC D	1.7	0.46	0.58	SE_CCW
Component cooling heat exchangers	Structural Failure	SE-CWSRISFCCWHXA BCD	1.7	0.46	0.58	SE_CCW
CCW surge tank	Structural Failure	SE-CWSTNSFCW1TK	1.7	0.46	0.58	SE_CCW
Chiller water expansion tanks	Structural Failure	SE-HVATNSFCHTK	1.7	0.46	0.58	SE-HVA-MDPA(B)
Air conditioner ducts	Structural Failure	SE-HVAVDSFDUCT	2.2	0.61	0.53	SE-HVA-SA(B)(C)(D) SE-HVA-MDPA (B) SE-HVA-GTA(B)(C)(D)
High head injection system piping	Structural Failure	SE-HPIPNSFINJA	3.3	0.61	0.80	SE-HPI-LL SE-HIP-SL SE-RWS

Table19.1-52 HCLPFs for Basic Events (Sheet 3 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Mechanical Equipment (Continued)						
Piping around accumulators tanks	Structural Failure	SE-ACCPNSFINJA	3.3	0.61	0.80	SE-ACA-LLOCA SE-ACA-SLOCA
CS/RHR system piping	Structural Failure	SE-RSSPNSFPIPE	3.3	0.61	0.80	SE-RSS-CSS SE-RSS-CSS-HR SE-RWS
EFW system piping	Structural Failure	SE-EFWPNSFCSTA	3.3	0.61	0.80	SE-EFW-SL SE-EFW-LO1
HVAC chiller system piping	Structural Failure	SE-HVAPNSFCHPIPE	3.3	0.61	0.80	SE-HVA-MDPA(B)
Component cooling water system piping	Structural Failure	SE-CWSPNSFCCWA	3.3	0.61	0.80	SE_CCW
Essential service water system piping	Structural Failure	SE-SWSPNSFSWPA1	3.3	0.61	0.80	SE_CCW
RCS piping	Structural Failure	SE-ELOPNSFNPIP	3.3	0.61	0.80	SE_ELOCA
DVI piping	Structural Failure	SE-ELOPNSFDV	3.3	0.61	0.80	SE_ELOCA
CS/RHR hotleg injection piping	Structural Failure	SE-ELOPNSFCSHL	3.3	0.61	0.80	SE_ELOCA
Main steam lines (The upstream side from main steam isolation valves)	Structural Failure	SE-ELOPNSFMSIV	3.3	0.61	0.80	SE_ELOCA
In-core instrumentation tube	Structural Failure	SE-ELOPNSFINSTR	3.3	0.61	0.80	SE_ELOCA
Pressurizer safety valve piping	Structural Failure	SE-LLOPNSFPZRSV	3.3	0.61	0.80	SE_LLOCA

Table19.1-52 HCLPFs for Basic Events (Sheet 4 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Mechanical Equipment (Continued)						
Pressurizer Safety Depressurization Valve Piping	Structural Failure	SE-LLOPNSFPZRRV	3.3	0.61	0.80	SE_LLOCA
Pressurizer Spray Piping	Structural Failure	SE-LLOPNSFPZRSP	3.3	0.61	0.80	SE_LLOCA
Emergency Letdown Piping	Structural Failure	SE-LLOPNSFELD	3.3	0.61	0.80	SE_LLOCA
RCS Instrumentation Letdown Piping	Structural Failure	SE-SLOPNSFINST	3.3	0.61	0.80	SE_SLOCA
Accumulator Coldleg Injection Piping	Structural Failure	SE-ELOPNSFACCINJ	3.3	0.61	0.80	SE_ELOCA
High Head Injection System Hotleg Piping	Structural Failure	SE-ELOPNSFHPIINJ	3.3	0.61	0.80	SE_ELOCA
Containment Spray Nozzles	Structural Failure	SE-RSSSZSFNOZABCD	3.3	0.61	0.80	SE-RSS-CSS SE-RSS-CSS-HR
Pumps and Electric motor						
High Head Injection Pumps	Functional Failure	SE-HPIPMFFSIPABCD	1.8	0.46	0.62	SE-HPI-LL SE-HIP-SL
High Head Injection Pumps	Structural Failure	SE-HPIPMSFSIPABCD	1.8	0.46	0.62	SE_CCW
CS/RHR Pumps	Functional Failure	SE-RSSPMFFCSPABCD	1.8	0.46	0.62	SE-RSS-CSS SE-RSS-CSS-HR
CS/RHR Pumps	Structural Failure	SE-RSSPMSFCSPABCD	1.8	0.46	0.62	SE_CCW

Table19.1-52 HCLPFs for Basic Events (Sheet 5 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Pumps and Electric motor (Continued)						
Motor Driven EFW Pumps	Functional Failure	SE-EFWPMFFFWP2AB	1.8	0.46	0.62	SE-EFW-SL SE-EFW-LO1
Component Cooling Water Pumps	Structural/ Functional Failure	SE-CWSPMFFCCWPABCD	1.8	0.46	0.62	SE_CCW
Essential Service Water Pumps	Structural/ Functional Failure	SE-SWSPMFFSWPABCD	1.8	0.46	0.62	SE_CCW
HVAC Chiller Pumps	Functional Failure	SE-HVAPMFFHVPMABCD	1.8	0.46	0.62	SE-HVA-SA(B)(C)(D) SE-HVA-MDPA (B) SE-HVA-GTA(B)(C)(D)
Turbine Driven EFW Pumps	Functional Failure	SE-EFWPTFFFWP1AB	2.2	0.46	0.75	SE-EFW-SL SE-EFW-LO1
M/D EFW Pumps Areas Ventilation Fans	Functional Failure	SE-HVAFAFFEFFABC	2.2	0.51	0.67	SE-HVA-MDPA(B)
HVAC Chillers	Functional Failure	SE-HVACHFFCHLHX	-	-	0.50	SE-HVA-SA(B)(C)(D) SE-HVA-MDPA (B) SE-HVA-GTA(B)(C)(D)
HVAC Chillers	Structural Failure	SE-HVACHSFCHLHX	-	-	0.50	SE_CCW
Motor-Operated Valve						
CCW CS/RHR heat exchanger outlet valves	Functional Failure	SE-RSSMVFF114ABCD	3.3	0.61	0.80	SE-RSS-CSS-HR

Table19.1-52 HCLPFs for Basic Events (Sheet 6 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Motor-Operated Valve (Continued)						
Containment Spray Header Containment Isolation Valves	Functional Failure	SE-RSSMVFF9011ABCD	3.3	0.61	0.80	SE-RSS-CSS SE-RSS-CSS-HR
Containment Spray Header Containment Isolation Valves	Functional Failure	SE-RSSMVFF9011ABCD	3.3	0.61	0.80	SE-RSS-CSS SE-RSS-CSS-HR
EFW Isolation Valves	Functional Failure	SE-EFWMVFFAWABCDA	3.3	0.61	0.80	SE-EFW-SL SE-EFW-LO1
T/D EFW Pump Supply Motor Operated Valves	Functional Failure	SE-EFWMVFFTS1AB	3.3	0.61	0.80	SE-EFW-SL SE-EFW-LO1
CCW Surge Tank side Tie line Motor-Operated Valves	Functional Failure	SE-CWSMVFF043ABCD	3.3	0.61	0.80	SE_CCW
CCW Heat Exchanger side Tie line Motor-Operated Valves	Functional Failure	SE-CWSMVFF056ABCD	3.3	0.61	0.80	SE_CCW
M/D EFW Pumps Areas Cooling Water Flow Control valves	Functional Failure	SE-HVAMVFFEFWM32BC	3.3	0.61	0.80	SE-HVA-MDPA(B)
Main Feed Water Isolation Valves	Functional Failure	SE-MFWMVFF16GN37FJ	3.3	0.61	0.80	SE_ELOCA
Refueling water Recirculation Pump Lines Isolation Valve	Functional Failure	SE-RWSMVFF002	3.3	0.61	0.80	SE-RWS
Refueling water Recirculation Pump Lines Isolation Valve	Functional Failure	SE-RWSMVFF003	3.3	0.61	0.80	SE-RWS

Table19.1-52 HCLPFs for Basic Events (Sheet 7 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Air-Operated Valve						
Main Steam Isolation Valves	Functional Failure	SE-MSRAVFF533ABCD	3.3	0.61	0.80	SE_ELOCA
Refueling water Auxiliary Tank Lines Isolation Valve	Functional Failure	SE-RWSAVFF03	3.3	0.61	0.80	SE-RWS
Electrical Equipment						
Ceramic Insulators (Offsite Power System)	Functional Failure	SE-OPSTRFFRESERVE	0.30	0.55	0.08	SE_LOOP
Class 1E Emergency Gas Turbine Generators	Functional Failure	SE-EPSDLFFGTABCD	-	-	0.50	SE-OPS SE-EPS-69KA(B)(C)(D)
Batteries and Racks	Functional Failure	SE-EPSBYFFBYABCD	3.3	0.46	1.1	SE-OPS SE-EPS-69KA(B)(C)(D)
Class 1E Station Service Transformers	Functional Failure	SE-EPSTRFFPTABCD	2.1	0.46	0.72	SE-480A(B)(C)(D)
Class 1E I&C Power Transformers	Functional Failure	SE-EPSEPFFIBBABCD	2.1	0.46	0.72	SE-VITALA(B)(C)(D)
Class 1E 6.9kV Switchgears	Functional Failure	SE-EPSEPFFMCABCD	2.8	0.46	0.96	SE-OPS SE-EPS-69KA(B)(C)(D)
Class 1E 480V Load Centers	Functional Failure	SE-EPSEPFFPCABCD	2.8	0.46	0.96	SE-480A(B)(C)(D)(A1)(D1)
Class 1E Motor Control Centers	Functional Failure	SE-EPSEPFFMCCABCD	2.8	0.46	0.96	SE-EPS-MCA1(B1)(C1)(D1)(A2)(B2)(C2)(D2)
Class 1E Gas Turbine Generators Control Panels Boards	Functional Failure	SE-EPSEPFFEGBABCD	3.3	0.46	1.1	SE-OPS SE-EPS-69KA(B)(C)(D)

Table19.1-52 HCLPFs for Basic Events (Sheet 8 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Electrical Equipment (Continued)						
Gas Turbine Generators Control Centers	Functional Failure	SE-EPSEPFFGCCABCD	3.3	0.46	1.1	SE-OPS SE-EPS-69KA(B)(C)(D)
Class 1E DC Switchboards	Functional Failure	SE-EPSEPFFDCCABCD	3.3	0.46	1.1	SE-OPS SE-EPS-69KA(B)(C)(D) SE-EPS-DCA(B)(C)(D)
Solenoid Distribution Panels	Functional Failure	SE-EPSEPFFSDCABCD	3.3	0.46	1.1	SE_GSTC
SLS Cabinets	Functional Failure	SE-SGNEPFFSLCABCD	3.3	0.46	1.1	SE_GSTC
RPS Cabinets	Functional Failure	SE-SGNEPFFRPSABCD	3.3	0.46	1.1	SE_GSTC
ESFAS Cabinets	Functional Failure	SE-SGNEPFFEFCABCD	3.3	0.46	1.1	SE_GSTC
Safety Remote I/O Cabinets	Functional Failure	SE-SGNEPFFRIOABCD	3.3	0.46	1.1	SE_GSTC
Ventilation Chiller Control Cabinets	Functional Failure	SE-SGNEPFFVCPABCD	3.3	0.46	1.1	SE-HVA-SA(B)(C)(D) SE-HVA-MDPA (B) SE-HVA-GTA(B)(C)(D)
Class 1E Battery Charger Panels	Functional Failure	SE-EPSEPFFBCPABCD	2.2	0.46	0.75	SE-OPS SE-EPS-69KA(B)(C)(D) SE-EPS-DCA(B)(C)(D)

Table19.1-52 HCLPFs for Basic Events (Sheet 9 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Electrical Equipment (Continued)						
UPS Unit	Functional Failure	SE-EPSIVFFINVABCD	2.2	0.46	0.75	SE-VITALA(B)(C)(D)
Class 1E UPS Unit	Functional Failure	SE-EPSEPFFIBDABCD	2.2	0.46	0.75	SE-VITALA(B)(C)(D)
Emergency Feedwater Pump Actuation Cabinets	Functional Failure	SE-SGNEPFFTDFAD	3.3	0.46	1.1	SE-EFW-SL SE-EFW-LO1
Safety and Check Valves						
Pressurizer Safety Valves	Functional Failure	SE-PZRSVFF0055678	3.3	0.61	0.80	SE_LLOCA
HHI Pump outlet Check Valves	Functional Failure	SE-HPICVFF8804ABCD	3.3	0.61	0.80	SE-HPI-LL SE-HIP-SL
RV/Hotleg Injection Line Check Valves	Functional Failure	SE-HPICVFF8806ABCD	3.3	0.61	0.80	SE-HPI-LL SE-HIP-SL
RV Injection Line First Check Valves	Functional Failure	SE-HPICVFF8808ABCD	3.3	0.61	0.80	SE-HPI-LL SE-HIP-SL
RV Injection Line Second Check Valves	Functional Failure	SE-HPICVFF8809ABCD	3.3	0.61	0.80	SE-HPI-LL SE-HIP-SL
Accumulators Check Valves	Functional Failure	SE-ACCCVFF8948ABCD	3.3	0.61	0.80	SE-ACA-LLOCA SE-ACA-SLOCA
Accumulators Check Valves	Functional Failure	SE-ACCCVFF8956ABCD	3.3	0.61	0.80	SE-ACA-LLOCA SE-ACA-SLOCA
CS/RHR Pumps Suction side Line Check Valves	Functional Failure	SE-RSSCVFF9008ABCD	3.3	0.61	0.80	SE-RSS-CSS SE-RSS-CSS-HR

Table19.1-52 HCLPFs for Basic Events (Sheet 10 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Safety and Check Valves (Continued)						
Containment Spray Line Check Valves	Functional Failure	SE-RSSCVFF9012ABCD	3.3	0.61	0.80	SE-RSS-CSS SE-RSS-CSS-HR
EFW Isolation Check Valves	Functional Failure	SE-EFWCVFFAW1ABCD	3.3	0.61	0.80	SE-EFW-SL SE-EFW-LO1
EFW Pit outlet Check Valves	Functional Failure	SE-EFWCVFFEFW03AB	3.3	0.61	0.80	SE-EFW-SL SE-EFW-LO1
M/D EFW Pump outlet Check Valves and T/D Pump outlet Check Valves	Functional Failure	SE-EFWCVFFMWTW1AB	3.3	0.61	0.80	SE-EFW-SL SE-EFW-LO1
SG outlet Line Check Valves	Functional Failure	SE-EFWCVFFTS3ABCD	3.3	0.61	0.80	SE-EFW-SL SE-EFW-LO1
CCW Pump outlet Check Valves	Functional Failure	SE-CWSCVFF052ABCD	3.3	0.61	0.80	SE_CCW
Essential Service Water Pumps outlet Check Valves	Functional Failure	SE-SWSCVFF502ABCD	3.3	0.61	0.80	SE_CCW
Essential Service Water Pumps Cooling line Check Valves	Functional Failure	SE-SWSCVFF602ABCD	3.3	0.61	0.80	SE_CCW
Main Feed Water Isolation Check Valves	Functional Failure	SE-MFWCVFF16C37	3.3	0.61	0.80	SE_ELOCA
Refueling water Auxiliary Tank Lines Check Valve	Functional Failure	SE-RWSCVFF02	3.3	0.61	0.80	SE-RWS

Table19.1-52 HCLPFs for Basic Events (Sheet 11 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Containment Isolation Equipments						
RCP Seal Water Return Line CV Isolation Valves	Functional Failure	SE-CVIMVFFCIV12	3.3	0.61	0.80	CV ISOLATION
RCP Seal Water Return Line CV Isolation System Piping	Structural Failure	SE-CVIPNSFSEALPIPE	3.3	0.61	0.80	CV ISOLATION
CV Sump Pump Outlet PIPE Line CV Isolation System Piping	Structural Failure	SE-CVIPNSFSUMPPIPE	3.3	0.61	0.80	CV ISOLATION
Instrument Air Pipe Line CV Isolation Valve	Functional Failure	SE-CVICVFFCIV12	3.3	0.61	0.80	CV ISOLATION
Instrument Air Pipe Line CV Isolation Valve	Functional Failure	SE-CVIMVFFCIV13	3.3	0.61	0.80	CV ISOLATION
Instrument Air Pipe CV Isolation System Piping	Structural Failure	SE-CVIPNSFIAPIPE	3.3	0.61	0.80	CV ISOLATION
CV Clean up Pipe Line CV Isolation System Piping	Structural Failure	SE-CVIPNSFCVCLPIPE	3.3	0.61	0.80	CV ISOLATION
Penetrations	Structural Failure	SE-CVIPESFPENE	-	-	0.50	CV ISOLATION
Equipment hatches	Structural Failure	SE-CVIHCSFHATCH	-	-	0.50	CV ISOLATION

Table19.1-52 HCLPFs for Basic Events (Sheet 12 of 12)

EQUIPMENT NAME	FAILURE MODE	SEISMIC BASIC EVENT ID	MEDIAN PGA (g)	βc	HCLPF (g)	IMPACTS
Other Equipments						
Spent Fuel Pit Heat Exchangers	Structural Failure	SE-SFPRISFSFPHXAB	1.7	0.46	0.58	LPSD
Spent Fuel Pit	Structural Failure	SE-SFPTNSFSFPIT	-	-	1.5	LPSD
Spent Fuel Pit Pumps	Structural Failure	SE-SFPPMSFSFP1AB	1.8	0.46	0.62	LPSD
Spent Fuel Pit Pumps	Functional Failure	SE-SFPPMFFSFP1AB	1.8	0.46	0.62	LPSD
Spent Fuel Pit Water Cooling System Piping	Structural Failure	SE-SFPPNSFSFPPIPE	3.3	0.61	0.80	LPSD

Table19.1- 53 HCLPFs for Sequences and the Plant HCLPF

SEQUENCE ID	SEQUENCE CODE	INITIATING EVENT HCLPF (g)	SEQUENCE HCLPF (INITIATING EVENT IS NOT INCLUDED) (g)	SEQUENCE HCLPF (g)
SE_GTC-0001		0.50	NA	0.50
SE_ELOCA-0001		0.50	NA	0.50
SE_CCWS-0001		0.50	NA	0.50
SE_LLOCA-0002	SE_CXC	0.67	0.80	0.80
SE_LLOCA-0003	SE_CSA	0.67	0.62	0.67
SE_LLOCA-0004	SE_ACA	0.67	0.75	0.75
SE_LLOCA-0005	SE_ACA-SE_CXC	0.67	0.80	0.80
SE_LLOCA-0006	SE_ACA-SE_CSA	0.67	0.75	0.75
SE_LLOCA-0007	SE_HIA	0.67	0.62	0.67
SE_LLOCA-0008	SE_HIA-SE_CXC	0.67	0.80	0.80
SE_LLOCA-0009	SE_HIA-SE_CSA	0.67	0.50	0.67
SE_LLOCA-0010	SE_HIA-SE_ACA	0.67	0.75	0.75
SE_LLOCA-0011	SE_HIA-SE_ACA-SE_CXC	0.67	0.80	0.80
SE_LLOCA-0012	SE_HIA-SE_ACA-SE_CSA	0.67	0.75	0.75
SE_SLOCA-0002	SE_CXB	0.80	0.80	0.80
SE_SLOCA-0003	SE_CSA	0.80	0.62	0.80
SE_SLOCA-0004	SE_HIB	0.80	0.62	0.80
SE_SLOCA-0005	SE_HIB-SE_CXB	0.80	0.80	0.80
SE_SLOCA-0006	SE_HIB-SE_CSA	0.80	0.50	0.80
SE_SLOCA-0007	SE_HIB-SE_ACC	0.80	0.75	0.80
SE_SLOCA-0008	SE_HIB-SE_ACC-SE_CXB	0.80	0.80	0.80
SE_SLOCA-0009	SE_HIB-SE_ACC-SE_CSA	0.80	0.75	0.80
SE_SLOCA-0010	SE_EFA	0.80	0.75	0.80
SE_SLOCA-0011	SE_EFA-SE_CXB	0.80	0.80	0.80
SE_SLOCA-0012	SE_EFA-SE_CSA	0.80	0.75	0.80
SE_SLOCA-0013	SE_EFA-SE_HIB	0.80	0.75	0.80
SE_SLOCA-0014	SE_EFA-SE_HIB-SE_CXB	0.80	0.80	0.80
SE_SLOCA-0015	SE_EFA-SE_HIB-SE_CSA	0.80	0.75	0.80
SE_SLOCA-0016	SE_RTA	0.80	0.67	0.80
SE_LOOP-0014	SE_EFO	0.08	0.75	0.75
SE_LOOP-0015	SE_EFO-SE_CXB3	0.08	0.80	0.80
SE_LOOP-0016	SE_EFO-SE_CSA	0.08	0.75	0.75
SE_LOOP-0027	SE_OPS-SEL	0.08	0.50	0.50
SE_LOOP-0029	SE_RTA	0.08	0.67	0.67
			Plant HCLPF =	**0.50g**

Table19.1-54 Initiating Events Included/Excluded in the Internal Fire PRA

	Event description	Considered in Fire PRA MODEL
1	Large Loss-of-Coolant Accident	No, fire can not induce a pipe break
2	Medium Loss-of-Coolant Accident	No, fire can not induce a pipe break Yes, if fire can induce spurious opening of Emergency Let Down valve
3	Small Loss-of-Coolant Accident	No, fire can not induce a pipe break Yes, if the fire can induce spurious opening of safety depressurization valve
4	Very Small Loss-of-Coolant Accident	No, fire can not induce a pipe break Yes, if the fire can induce spurious opening of Reactor Vessel Top Vent line valve
5	Reactor Vessel Rupture	No, fire can not induce vessel rupture
6	Steam Generator Tube Rupture	No, fire can not induce SG tube rupture
7	Main Steam Line Break (Downstream MSIV: Turbine side)	No, fire can not induce a pipe break Yes, if the fire can induce spurious opening of secondary side power operated valve
8	Main Steam Line Break (Upstream MSIV: CV side)	No, Fire can not induce a pipe break Yes, if the fire can induce spurious opening of a Main Steam Power Operated Relief Valve
9	Feed Water Line Break	Fire can not induce a pipe break
10	General Transient	Yes
11	Loss of Main Feed Water	Yes
12	Total Loss of Component Cooling Water	No, fire cannot affect all four trains because of physiscal separation between trains
13	Partial Loss of Component Cooling Water	Yes
14	Loss of Offsite Power	Yes
15	Loss of Vital AC Bus	Yes
16	Loss of Vital DC Bus	Yes
17	ATWS	No, not likely for fires

Table19.1- 55 Fire Compartment Evaluation (Sheet 1 of 2)

Fire Compartment	Description	Fire Frequency [1/RY]	CDF [1/RY]	Remarks
YARD	Switchyard	2.0E-02	1.2E-06	
FA6-101-01	Turbine Building Other Floor	5.6E-02	1.0E-07	
FA6-101-04	FA6-101-04 Zone	1.4E-03	8.4E-08	
FA4-101	Auxiliary Building	2.5E-02	4.6E-08	
FA2-205	D Class 1E Electrical Room	2.3E-03	4.6E-08	
FA2-202	A Class 1E Electrical Room	2.3E-03	4.4E-08	
FA3-104	A-Class 1E GTG Room	5.4E-03	3.7E-08	
FA3-111	D-Class 1E GTG Room	5.4E-03	3.6E-08	
FA1-101-17	C/V 3F Northwestern Part Floor Zone	7.8E-04	2.3E-08	
FA2-309	D-Class 1E I&C Room	1.3E-03	1.2E-08	
FA2-304	A-Class 1E I&C Room	1.3E-03	1.1E-08	
FA2-308	Main Control Room	2.6E-03	1.0E-08	

Table19.1- 55 Fire Compartment Evaluation (Sheet 2 of 2)

Fire Compartment	Description	Fire Frequency [1/RY]	CDF [1/RY]	Remarks
FA1-101-24	C/V 4F Southwestern Part Floor Zone	3.4E-04	1.0E-08	
FA3-109	C-Class 1E GTG Room	5.1E-03	9.5E-09	
FA3-117	A-Class 1E Battery Charger Room	1.4E-03	9.5E-09	
FA3-123	D-Class 1E Battery Charger Room	1.4E-03	9.2E-09	

Table19.1-56 Screened Multiple Compartment Scenarios

Fire Scenario No.	Fire exposing Area	Fire exposed Area	CDF [1RY]
FA2-205-M-05	FA2-205	FA2-206	3.7E-08
FA2-202-M-04	FA2-202	FA2-201	3.1E-08
FA6-101-M-02	FA6-101-01	FA6-101-04	2.5E-08
FA2-206-M-06	FA2-206	FA2-201	9.8E-09

Table 19.1-57 Cutsets for Dominant Scenarios (YARD) (Sheet 1/ of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	4.2E-07	34.8	YARD-B29 EPSCF4DLLRDG-ALL EPSOO02RDG RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
2	4.1E-07	33.8	YARD-B29 EPSCF4CBTD6H-ALL RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) 6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF RCP SEAL LOCA
3	8.9E-08	7.4	YARD-B29 EPSCF4DLADDG-ALL EPSOO02RDG RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
4	6.6E-08	5.5	YARD-B29 EPSCF4DLSRDG-ALL EPSOO02RDG RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
5	2.9E-08	2.4	YARD-B29 EPSCF2SLLRDGP-ALL EPSCF4DLLRDG-ALL RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) AAC GAS TURBINE GENERATOR (GTG P1,P2) FAIL TO RUN (>1H) CCF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF RCP SEAL LOCA

Table 19.1-57 Cutsets for Dominant Scenarios (YARD) (Sheet 2 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	1.6E-08	1.3	YARD-B29 EPSCF4SEFFDG-ALL EPSOO02RDG RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) GAS TURBINE GENERATOR SEQUENCER FAIL TO OPERATE CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
7	9.7E-09	0.8	YARD-B29 ACWOO02CT-DP2 ACWOO02FS RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE) OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE) RCP SEAL LOCA
8	8.6E-09	0.7	YARD-B29 EPSCF4CBTDDG-ALL EPSOO02RDG RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO CLOSE CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
9	6.3E-09	0.5	YARD-B29 EPSCF2SLLRDGP-ALL EPSCF4DLADDG-ALL RCP----SEAL	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) AAC GAS TURBINE GENERATOR (GTG P1,P2) FAIL TO RUN (>1H) CCF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF RCP SEAL LOCA
10	6.1E-09	0.5	YARD-B29 EPSCF4DLLRDG-ALL EPSDLLRDGP1-L2 EPSDLLRDGP2-L2	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS) EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H) AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H)

Table 19.1-57 Cutsets for Dominant Scenarios (FA6-101-01) (Sheet 3 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	5.9E-09	5.8	FA6-101-B32	IGNITION SOURCE-MAIN FEEDWATER PUMPS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
2	4.3E-09	4.2	FA6-101-B35	IGNITION SOURCE-T/G OIL
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
3	3.4E-09	3.3	FA6-101-B36	IGNITION SOURCE-TRANSIENT COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
4	3.2E-09	3.2	FA6-101-B37	IGNITION SOURCE-TRANSIENT COMBUSTIBLES
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED

Table 19.1-57 Cutsets for Dominant Scenarios (FA6-101-01) (Sheet 4 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
5	2.9E-09	2.9	FA6-101-B34 HPIOO02FWBD-S MSRCF4AVCD533-ALL	IGNITION SOURCE-T/G Hydrogen OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
6	1.8E-09	1.7	FA6-101-B33 HPIOO02FWBD-S MSRCF4AVCD533-ALL	IGNITION SOURCE-Turbine GENERATOR (T/G) EXCITOR OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
7	1.7E-09	1.7	FA6-101-B32 HPIOO02FWBD-S MSRCF4AVCD533-24	IGNITION SOURCE-MAIN FEEDWATER PUMPS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515B,D(533B,D) FAIL TO CLOSED
8	1.7E-09	1.7	FA6-101-B32 HPIOO02FWBD-S MSRCF4AVCD533-34	IGNITION SOURCE-MAIN FEEDWATER PUMPS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515C,D(533C,D) FAIL TO CLOSED

Table 19.1-57 Cutsets for Dominant Scenarios (FA6-101-01) (Sheet 5 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
9	1.7E-09	1.7	FA6-101-B32	IGNITION SOURCE-MAIN FEEDWATER PUMPS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-13	MAIN STEAM ISOLATION VALVE AOV-515A,C(533A,C) FAIL TO CLOSED
10	1.7E-09	1.7	FA6-101-B32	IGNITION SOURCE-MAIN FEEDWATER PUMPS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-23	MAIN STEAM ISOLATION VALVE AOV-515B,C(533B,C) FAIL TO CLOSED

Table 19.1-57 Cutsets for Dominant Scenarios (FA6-101-04) (Sheet 6 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.5E-08	17.5	FA6-101-04-B36	IGNITION SOURCE—TRANSIENT COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
2	1.4E-08	17.0	FA6-101-04-B36	IGNITION SOURCE—TRANSIENT COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
			RCP----SEAL	RCP SEAL LOCA
3	1.4E-08	16.4	FA6-101-04-B37	IGNITION SOURCE-TRANSIENT COMBUSTIBLES COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-57 Cutsets for Dominant Scenarios (FA6-101-04) (Sheet 7 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
4	1.3E-08	15.9	FA6-101-04-B37	IGNITION SOURCE-TRANSIENT COMBUSTIBLES COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
			RCP----SEAL	RCP SEAL LOCA
5	3.2E-09	3.7	FA6-101-04-B36	IGNITION SOURCE－TRANSIENT COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
6	2.9E-09	3.5	FA6-101-04-B37	IGNITION SOURCE-TRANSIENT COMBUSTIBLES COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-57 Cutsets for Dominant Scenarios (FA6-101-04) (Sheet 8 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	2.3E-09	2.8	FA6-101-04-B36 EPSCF4DLSRDG-ALL EPSOO02RDG RCP----SEAL	IGNITION SOURCE－TRANSIENT COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
8	2.2E-09	2.6	FA6-101-04-B37 EPSCF4DLSRDG-ALL EPSOO02RDG RCP----SEAL	IGNITION SOURCE-TRANSIENT COMBUSTIBLES COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE) RCP SEAL LOCA
9	1.0E-09	1.2	FA6-101-04-B36 EPSCF2SLLRDGP-ALL EPSCF4DLLRDG-ALL RCP----SEAL	IGNITION SOURCE－TRANSIENT COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING AAC GAS TURBINE GENERATOR (GTG P1,P2) FAIL TO RUN (>1H) CCF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF RCP SEAL LOCA

Table 19.1-57 Cutsets for Dominant Scenarios (FA6-101-04) (Sheet 9 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	9.7E-10	1.2	FA6-101-04-B37	IGNITION SOURCE-TRANSIENT COMBUSTIBLES COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,P2) FAIL TO RUN (>1H) CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-57 Cutsets for Dominant Scenarios (FA4-101) (Sheet 10 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	5.8E-09	12.8	FA4-101-B15 HPIOO02FWBD-S MSRCF4AVCD533-ALL	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
2	3.1E-09	6.8	FA4-101-B21 HPIOO02FWBD-S MSRCF4AVCD533-ALL	IGNITION SOURCE-PUMPS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
3	1.7E-09	3.8	FA4-101-B15 HPIOO02FWBD-S MSRCF4AVCD533-34	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515C,D(533C,D) FAIL TO CLOSED
4	1.7E-09	3.8	FA4-101-B15 HPIOO02FWBD-S MSRCF4AVCD533-23	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515B,C(533B,C) FAIL TO CLOSED
5	1.7E-09	3.8	FA4-101-B15 HPIOO02FWBD-S MSRCF4AVCD533-12	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515A,B(533A,B) FAIL TO CLOSED

Table 19.1-57 Cutsets for Dominant Scenarios (FA4-101) (Sheet 11 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	1.7E-09	3.8	FA4-101-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-24	MAIN STEAM ISOLATION VALVE AOV-515B,D(533B,D) FAIL TO CLOSED
7	1.7E-09	3.8	FA4-101-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-13	MAIN STEAM ISOLATION VALVE AOV-515A,C(533A,C) FAIL TO CLOSED
8	1.7E-09	3.8	FA4-101-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-14	MAIN STEAM ISOLATION VALVE AOV-515A,D(533A,D) FAIL TO CLOSED
9	9.1E-10	2.0	FA4-101-B21	IGNITION SOURCE-PUMPS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-34	MAIN STEAM ISOLATION VALVE AOV-515C,D(533C,D) FAIL TO CLOSED

Table 19.1-57 Cutsets for Dominant Scenarios (FA4-101) (Sheet 12 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	9.1E-10	2.0	FA4-101-B21 HPIOO02FWBD-S MSRCF4AVCD533-23	IGNITION SOURCE-PUMPS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515B,C(533B,C) FAIL TO CLOSED

Table 19.1-57 Cutsets for Dominant Scenarios (FA2-205) (Sheet 13 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	4.3E-09	9.2	FA2-205-B15 HPIOO02FWBD-S MSRAVCD533B	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515B FAIL TO CLOSED
2	4.3E-09	9.2	FA2-205-B15 HPIOO02FWBD-S MSRAVCD533A	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515A FAIL TO CLOSED
3	2.3E-09	5.0	FA2-205-B15 HPIOO02FWBD-S SGNST-ISA	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM LINE ISOLATION VALVE AOV-515A(533A) ISOLATION SIGNAL TRAIN A FAIL
4	2.3E-09	5.0	FA2-205-B15 HPIOO02FWBD-S SGNST-ISB	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM LINE ISOLATION VALVE AOV-515B(533B) ISOLATION SIGNAL TRAIN B FAIL
5	1.5E-09	3.2	FA2-205-B15 MSRAVCD533A PZRMVOD58RA	IGNITION SOURCE-ELECTRICAL CABINETS MAIN STEAM ISOLATION VALVE AOV-515A FAIL TO CLOSED SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPENOF 32)
6	1.5E-09	3.2	FA2-205-B15 MSRAVCD533B PZRMVOD58RA	IGNITION SOURCE-ELECTRICAL CABINETS MAIN STEAM ISOLATION VALVE AOV-515B FAIL TO CLOSED SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPENOF 32)

Table 19.1-57 Cutsets for Dominant Scenarios (FA2-205) (Sheet 14 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	9.6E-10	2.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
8	7.9E-10	1.7	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPENOF 32)
			SGNST-ISB	MAIN STEAM LINE ISOLATION VALVE AOV-515B(533B) ISOLATION SIGNAL TRAIN B FAIL
9	7.9E-10	1.7	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPENOF 32)
			SGNST-ISA	MAIN STEAM LINE ISOLATION VALVE AOV-515A(533A) ISOLATION SIGNAL TRAIN A FAIL
10	4.3E-10	0.9	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAB	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Table 19.1-57 Cutsets for Dominant Scenarios (FA2-202) (Sheet 15 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	4.3E-09	9.9	FA2-202-B15 HPIOO02FWBD-S MSRAVCD533D	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM ISOLATION VALVE AOV-515C FAIL TO CLOSED
2	4.3E-09	9.9	FA2-202-B15 HPIOO02FWBD-S MSRAVCD533C	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) A/V 533C FAIL TO CLOSE
3	2.3E-09	5.3	FA2-202-B15 HPIOO02FWBD-S SGNST-ISD	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM LINE ISOLATION VALVE AOV-515D(533D) ISOLATION SIGNAL TRAIN D FAIL
4	2.3E-09	5.3	FA2-202-B15 HPIOO02FWBD-S SGNST-ISC	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) MAIN STEAM LINE ISOLATION VALVE AOV-515C(533C) ISOLATION SIGNAL TRAIN C FAIL
5	1.5E-09	3.4	FA2-202-B15 MSRAVCD533C PZRMVOD58RB	IGNITION SOURCE-ELECTRICAL CABINETS A/V 533C FAIL TO CLOSE SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
6	1.5E-09	3.4	FA2-202-B15 MSRAVCD533D PZRMVOD58RB	IGNITION SOURCE-ELECTRICAL CABINETS MAIN STEAM ISOLATION VALVE AOV-515C FAIL TO CLOSED SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Table 19.1-57 Cutsets for Dominant Scenarios (FA2-202) (Sheet 16 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.3E-09	3.0	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			SWSTMPESWPB	ESW PUMP-B OUTAGE
8	1.1E-09	2.5	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			VCWCHBDB	CHILLER FAIL TO START (RUNNING)
9	9.6E-10	2.2	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
10	7.9E-10	1.8	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
			SGNST-ISC	MAIN STEAM LINE ISOLATION VALVE AOV-515C(533C) ISOLATION SIGNAL TRAIN C FAIL

Table 19.1-57 Cutsets for Dominant Scenarios (FA3-104) (Sheet 17 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	3.2E-09	8.7	FA3-104-B8	IGNITION SOURCE－DIESEL GENERATORS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	ESW PUMP-B OUTAGE
2	2.6E-09	7.2	FA3-104-B8	IGNITION SOURCE－DIESEL GENERATORS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDB	CHILLER FAIL TO START (RUNNING)
3	1.1E-09	2.9	FA3-104-B8	IGNITION SOURCE－DIESEL GENERATORS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAA	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGEE
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
4	8.2E-10	2.3	FA3-104-B25	IGNITION SOURCE－TRANSIENT COMBUSTIBLE
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	ESW PUMP-B OUTAGE
5	7.6E-10	2.1	FA3-104-B8	IGNITION SOURCE－DIESEL GENERATORS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)

Table 19.1-57 Cutsets for Dominant Scenarios (FA3-104) (Sheet 18 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	7.3E-10	2.0	FA3-104-B8	IGNITION SOURCE－DIESEL GENERATORS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
			SWSTMPESWPB	ESW PUMP-B OUTAGE
7	7.0E-10	1.9	FA3-104-B8	IGNITION SOURCE－DIESEL GENERATORS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFALRDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)
8	6.9E-10	1.9	FA3-104-B25	IGNITION SOURCE－TRANSIENT COMBUSTIBLE
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDB	CHILLER FAIL TO START (RUNNING)
9	6.1E-10	1.7	FA3-104-B8	IGNITION SOURCE－DIESEL GENERATORS
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
			VCWCHBDB	CHILLER FAIL TO START (RUNNING)

Table 19.1-57 Cutsets for Dominant Scenarios (FA3-104) (Sheet 19 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	5.7E-10	1.6	FA3-104-B24	IGNITION SOURCE－TRANSIENT COMBUSTIBLE FIRE CAUSED BY WELDING AND CUTTING
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	ESW PUMP-B OUTAGE

Table 19.1-57 Cutsets for Dominant Scenarios (FA2-205-M-05) (Sheet 20 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.8E-09	4.8	FA2-205-B15 DR-FA2-205-M-10 HPICF4PMADSIP-ALL	IGNITION SOURCE-ELECTRICAL CABINETS FIRE RESISTANT DOOR FALIURE(FA2-205-M-10) SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF
2	1.3E-09	3.6	FA2-205-B15 DR-FA2-205-M-10 RSSCF4MVOD9011-ALL	IGNITION SOURCE-ELECTRICAL CABINETS FIRE RESISTANT DOOR FALIURE(FA2-205-M-10) RSS M/V 9011 FAIL TO OPEN CCF
3	1.3E-09	3.6	FA2-205-B15 DR-FA2-205-M-10 RSSCF4MVOD114-ALL	IGNITION SOURCE-ELECTRICAL CABINETS FIRE RESISTANT DOOR FALIURE(FA2-205-M-10) CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
4	9.5E-10	2.6	FA2-205-B15 DR-FA2-205-M-10 RSSTMRPRHEXA SWSTMPESWPB	IGNITION SOURCE-ELECTRICAL CABINETS FIRE RESISTANT DOOR FALIURE(FA2-205-M-10) A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE ESW PUMP-B OUTAGE
5	9.0E-10	2.5	FA2-205-B15 DR-FA2-205-M-10 HPILSFF8805A SWSTMPESWPB	IGNITION SOURCE-ELECTRICAL CABINETS FIRE RESISTANT DOOR FALIURE(FA2-205-M-10) CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009A(8805A) LIMIT SWITCH FAIL ESW PUMP-B OUTAGE

Table 19.1-57 Cutsets for Dominant Scenarios (FA2-205-M-05) (Sheet 21 of 21)

No.	Cut Set Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	9.0E-10	2.5	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(FA2-205-M-10)
			HPILSFF8820A	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001A(8820A) LIMIT SWITCH FAIL
			SWSTMPESWPB	ESW PUMP-B OUTAGE
7	9.0E-10	2.5	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(FA2-205-M-10)
			HPILSFF8807A	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011A(8807A) LIMIT SWITCH FAIL
			SWSTMPESWPB	ESW PUMP-B OUTAGE
8	8.0E-10	2.2	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(FA2-205-M-10)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	7.6E-10	2.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(FA2-205-M-10)
			HPITMPISIPA	A-SAFETY INJECTION PUMP OUTAGE
			SWSTMPESWPB	ESW PUMP-B OUTAGE
10	7.6E-10	2.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(FA2-205-M-10)
			RSSTMPICSPA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPB	ESW PUMP-B OUTAGE

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 1 of 9)

(YARD)

No.	Cutsets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
1	4.1E-08	68.0	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
			RCP----SEAL	RCP SEAL LOCA
			RSBRCB	OPERATOR FAILS TO OPEN 6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) MANUALY AFTER CORE MELT(HE)
2	4.2E-09	7.1	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSBTSWCCF	EPS SOFTWARE CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
3	1.3E-09	2.2	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			LR-5A	CCFP for Specific PDS
			RCP----SEAL	RCP SEAL LOCA
4	1.3E-09	2.2	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
			LR-5A	CCFP for Specific PDS
			RCP----SEAL	RCP SEAL LOCA

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 2 of 9) (YARD)

No.	Cutsets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
5	6.4E-10	1.1	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			EPSCF4IVFFINV-ALL	INVERTERS (INVA,B,C,D) FAIL TO OPERATE CFF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			RCP----SEAL	RCP SEAL LOCA
6	4.6E-10	0.8	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			RCP----SEAL	RCP SEAL LOCA
			RSBRGTG	FAILURE OF EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) RECOVERY AFTER CORE MELT
7	4.1E-10	0.7	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			ACWOO02CT-DP2	OPERATOR FAILS TO CONNECT COOLING TOWER SYSTEM TO CCWS FOR ALTERNATIVE CCW, UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			ACWOO02FS	OPERATOR FAILS TO CONNECT FIRE SERVICE WATER TO CCWS FOR ALTERNATIVE CCW (HE)
			RCP----SEAL	RCP SEAL LOCA
			RSAOO02FWP	OPERATOR FAILS TO OPERATE FIREWATER INJECTION INTO SPRAY HEADER FOR RECOVERY OF CONTAINMENT SPRAY(HE)
			SWSCF4PMBD-R-ALL	ESW PUMP A,B,C,D FAIL TO RE-START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 3 of 9)

(YARD)

No.	Cutsets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
8	3.9E-10	0.6	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF
			LR-5E	CCFP for Specific PDS
			RCP----SEAL	RCP SEAL LOCA
9	3.0E-10	0.5	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSBTSWCCF	EPS SOFTWARE CCF
			EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF
			RCP----SEAL	RCP SEAL LOCA
10	2.9E-10	0.5	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			1CF	REACTOR CAVITY FLOODING FAILS DUE TO LOSS OF POWER SUPPLY
			1FD	RCS DEPRESSURIZATION FAILS DUE TO LOSS OF POWER SUPPLY
			EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF
			EPSOO02RDG	OPERATOR FAILS TO CONNECT ALTERNATIVE GTG TO SAFETY BUS (HE)
			LR-5A	CCFP for Specific PDS
			RCP----SEAL	RCP SEAL LOCA

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 4 of 9) (FA1-101-17)

No.	Cutsets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
1	9.2E-10	5.7	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWCF2CVODEFW03-ALL	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN
			LR-9E	CCFP for Specific PDS
2	6.4E-10	4.0	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWCF4CVODAW1-ALL	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF
			LR-9E	CCFP for Specific PDS
3	6.4E-10	4.0	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWCF4CVODXW1-ALL	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF
			LR-9E	CCFP for Specific PDS
4	6.1E-10	3.8	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			LR-9E	CCFP for Specific PDS
			SWSTMPESWPB	ESW PUMP-B OUTAGE
5	5.0E-10	3.1	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			LR-9E	CCFP for Specific PDS
			VCWCHBDB	CHILLER FAIL TO START (RUNNING)

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 5 of 9) (FA1-101-17)

No.	Cutsets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
6	4.6E-10	2.9	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			LR-9E	CCFP for Specific PDS
			SWSTMPESWPB	ESW PUMP-B OUTAGE
7	3.9E-10	2.4	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			LR-9E	CCFP for Specific PDS
			VCWCHBDB	CHILLER FAIL TO START (RUNNING)
8	2.2E-10	1.4	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			LR-9E	CCFP for Specific PDS
			SWSTMPESWPB	ESW PUMP-B OUTAGE
9	2.0E-10	1.3	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START
			EFWTMPAB	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE
			LR-9E	CCFP for Specific PDS
10	2.0E-10	1.3	FA1-101-17-B23	IGNITION SOURCE-TRANSFORMERS(DRY)
			EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			EFWTMPAA	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE
			LR-9E	CCFP for Specific PDS

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 6 of 9)

(FA2-205-M-05)

No.	Cutsets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.3E-09	8.8	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSCF4MVOD9011-ALL	CONTAINMENT SPRAY HEADER CONTAINMENT ISOLATION VALVES MOV-004A,B,C,D(9011A,B,C,D) FAIL TO OPEN CCF
2	1.3E-09	8.8	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
3	9.5E-10	6.3	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSTMRPRHEXA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPB	ESW PUMP-B OUTAGE
4	7.6E-10	5.0	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSTMPICSPA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPB	ESW PUMP-B OUTAGE
5	5.5E-10	3.7	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			CWSTMRCCWHXB	B-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSTMRPRHEXA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
6	4.7E-10	3.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			CWSTMPCCWPB	B-CCW PUMP OUTAGE
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSTMRPRHEXA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 7 of 9) (FA2-205-M-05)

No.	Cutsets Freq.(/RY)	Percent (%)	Cutsets	Basic Event Name
7	4.4E-10	2.9	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			CWSTMRCCWHXB	B-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSTMPICSPA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
8	3.8E-10	2.5	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			CWSTMPCCWPB	B-CCW PUMP OUTAGE
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSTMPICSPA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
9	3.0E-10	2.0	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF
10	2.7E-10	1.8	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			DR-FA2-205-M-05	FIRE RESISTANT DOOR FALIURE(FA2-205-M-05)
			RSSPMADCSPA	A-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP FAIL TO START (STANDBY)
			SWSTMPESWPB	ESW PUMP-B OUTAGE

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 8 of 9)

(FA2-205)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	9.8E-10	7.8	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			LR-9A	CCFP for Specific PDS
			MSRAVCD533A	MAIN STEAM ISOLATION VALVE AOV-515A(533A) FAIL TO CLOSED
			PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPEN
2	9.8E-10	7.8	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			LR-9A	CCFP for Specific PDS
			MSRAVCD533B	MAIN STEAM ISOLATION VALVE AOV-515B(533B) FAIL TO CLOSED
			PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPEN
3	5.3E-10	4.2	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			LR-9A	CCFP for Specific PDS
			PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPEN
			SGNST-ISA	MAIN STEAM LINE ISOLATION VALVE AOV-515A(533A) ISOLATION SIGNAL TRAIN A FAIL
4	5.3E-10	4.2	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			LR-9A	CCFP for Specific PDS
			PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPEN
			SGNST-ISB	MAIN STEAM LINE ISOLATION VALVE AOV-515B(533B) ISOLATION SIGNAL TRAIN B FAIL
5	2.2E-10	1.7	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			LR-9A	CCFP for Specific PDS
			MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED
			PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPEN
6	2.1E-10	1.7	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			RTPBTSWCCF	SUPPORT SOFTWARE CCF

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1- 58 Cutsets for Dominant Scenarios for LRF (Sheet 9 of 9)

(FA2-205)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.4E-10	1.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			LR-9A	CCFP for Specific PDS
			MSRAVCD533B	MAIN STEAM ISOLATION VALVE AOV-515B(533B) FAIL TO CLOSED
			PZRCF2MVOD58R-ALL	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
8	1.4E-10	1.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			LR-9A	CCFP for Specific PDS
			MSRAVCD533A	MAIN STEAM ISOLATION VALVE AOV-515A(533A) FAIL TO CLOSED
			PZRCF2MVOD58R-ALL	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
9	1.4E-10	1.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			MSRAVCD533A	MAIN STEAM ISOLATION VALVE AOV-515A(533A) FAIL TO CLOSED
			RSSCF4MVOD9011-ALL	CONTAINMENT SPRAY HEADER CONTAINMENT ISOLATION VALVES MOV-004A,B,C,D(9011A,B,C,D) FAIL TO OPEN CCF
10	1.4E-10	1.1	FA2-205-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			MSRAVCD533A	MAIN STEAM ISOLATION VALVE AOV-515A(533A) FAIL TO CLOSED
			RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-59 Basic Events (Hardware Failure, Human Error) FV Importance for Fire (Sheet 1 of 3)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RCP----SEAL	SEAL LOCA	1.0E+00	7.4E-01	1.0E+00
2	EPSOO02RDG	(HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR	2.1E-02	3.9E-01	1.9E+01
3	EPSCF4DLLRDG-ALL	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	9.9E-04	3.1E-01	3.1E+02
4	EPSCF4CBTD6H-ALL	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	2.0E-05	2.5E-01	1.2E+04
5	HPIOO02FWBD-S	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	2.6E-03	1.1E-01	4.3E+01
6	EPSCF4DLADDG-ALL	EPS DG A,B,C,D FAIL TO START CCF	2.1E-04	6.5E-02	3.1E+02
7	EFWOO01PW2AB	SUPPLY WATER FROM ALTERNATIVE EFW PIT TO RECOVER LACK OF WATER VOLUME FOR CONTINUOUS SG FEED WATER	2.0E-02	6.1E-02	4.0E+00
8	EPSCF4DLSRDG-ALL	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	1.6E-04	4.8E-02	3.1E+02
9	HPIOO02FWBD	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	3.8E-03	4.7E-02	1.3E+01
10	EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,P2) FAIL TO RUN (>1H) CCF	1.5E-03	2.8E-02	2.0E+01
11	SWSTMPESWPB	SWP-B OUTAGE	1.2E-02	2.5E-02	3.1E+00
12	MSRCF4AVCD533-ALL	A/V 533 FAIL TO CLOSE CCF	1.8E-04	2.5E-02	1.4E+02
13	DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(DR-FA2-205-M-10)	7.4E-03	2.1E-02	3.8E+00
14	DR-FA2-202-M-07	FIRE RESISTANT DOOR FALIURE(DR-FA2-202-M-07)	7.4E-03	1.7E-02	3.3E+00
15	VCWCHBDB	CHILLER FAIL TO START (RUNNING)	1.0E-02	1.5E-02	2.5E+00

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-59 Basic Events (Hardware Failure, Human Error) FV Importance for Fire (Sheet 2 of 3)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
16	EFWPTADFWP1A	T/P FWP1A FAIL TO START	6.5E-03	1.5E-02	3.2E+00
17	EPSDLLRDGP1-L2	AAC P1 FAIL TO RUN (>1H)	1.8E-02	1.5E-02	1.8E+00
18	EPSDLLRDGP2-L2	AAC P2 FAIL TO RUN (>1H)	1.8E-02	1.4E-02	1.8E+00
19	DR-FA6-101-M-02	FIRE RESISTANT DOOR FALIURE(DR-FA6-101-M-02)	7.4E-03	1.4E-02	2.8E+00
20	ACWOO02FS	ALTERNATIVE CCW BY FIRE SERVICE WATER FAIL TO OPERATE (HE)	2.0E-02	1.3E-02	1.6E+00
21	EPSCF4SEFFDG-ALL	EPS SG SEQUENCER FAIL TO OPERATE CCF	3.8E-05	1.2E-02	3.1E+02
22	ACWOO02CT-DP2	ALTERNATIVE CCW BY COOLING TOWER FAIL TO OPERATE (HE)	5.1E-01	1.2E-02	1.0E+00
23	PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN	8.7E-04	1.1E-02	1.3E+01
24	EFWTMTAA	T/D-A OUTAGE	5.0E-03	9.8E-03	3.0E+00
25	PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPEN	8.7E-04	9.6E-03	1.2E+01
26	EFWPTADFWP1B	T/P FWP1B FAIL TO START	6.5E-03	8.3E-03	2.3E+00
27	HPICF4PMADSIP-ALL	M/P FAIL TO START (Standby) CCF	1.1E-04	8.0E-03	7.3E+01
28	SWSCF4PMBD-R-ALL	SWS PUMP FAIL TO RE-START CCF	4.8E-05	7.4E-03	1.6E+02
29	MSRCF4AVCD533-24	MAIN STEAM ISOLATION VALVE AOV-515B,D(533B,D) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
30	MSRCF4AVCD533-13	MAIN STEAM ISOLATION VALVE AOV-515A,C(533A,C) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02

Table 19.1-59 Basic Events (Hardware Failure, Human Error) FV Importance for Fire (Sheet 3 of 3)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
31	MSRCF4AVCD533-14	MAIN STEAM ISOLATION VALVE AOV-515A,D(533A,D) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
32	MSRCF4AVCD533-23	MAIN STEAM ISOLATION VALVE AOV-515B,C(533B,C) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
33	MSRCF4AVCD533-34	MAIN STEAM ISOLATION VALVE AOV-515C,D(533C,D) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
34	MSRCF4AVCD533-12	MAIN STEAM ISOLATION VALVE AOV-515A,B(533A,B) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
35	EPSTMDGP1	OUTAGE EMERGENCY DIESEL GENERATOR P1 (EPS)	1.2E-02	7.3E-03	1.6E+00
36	EPSTMDGP2	OUTAGE EMERGENCY DIESEL GENERATOR P2 (EPS)	1.2E-02	6.8E-03	1.6E+00
37	PZRCF2MVOD58R-ALL	PORV 58RA,58RB FAIL TO OPEN (CCF)	1.3E-04	6.7E-03	5.4E+01
38	EPSCF4CBTDDG-ALL	EPS DG C/B DGBA,B,C,D Fail to Closed CCF	2.0E-05	6.3E-03	3.1E+02
39	RSPEVA	FAIL TO EVACUATION TO RSP	2.1E-01	5.8E-03	1.0E+00
40	HPIOO02FWBD-R	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES TO RSP	1.0E-01	5.7E-03	1.1E+00
41	EPSCF2DLADDGP-ALL	EPS DG FAIL TO START CCF	3.1E-04	5.7E-03	2.0E+01
42	EPSCF4DLLRDG-134	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	5.5E-03	2.3E+01
43	EFWPTSRFWP1A	T/P FWP1A FAIL TO RUN (<1H)	2.4E-03	5.3E-03	3.2E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 1 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4BYFF-124	EPS BATTERY Fail to Operate CCF	1.2E-08	1.6E-04	1.3E+04
2	EPSCF4BYFF-234	EPS BATTERY Fail to Operate CCF	1.2E-08	1.6E-04	1.3E+04
3	EPSCF4CBTD6H-ALL	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	2.0E-05	2.5E-01	1.2E+04
4	RTPBTSWCCF	SOFTWARE CCF	1.0E-07	5.1E-04	5.1E+03
5	EPSCF4BYFF-24	EPS BATTERY Fail to Operate CCF	1.9E-08	3.6E-05	1.9E+03
6	EPSCF4DLADDG-ALL	EFW C/V EFW03 FAIL TO OPEN CCF	2.4E-06	2.2E-03	9.2E+02
7	EFWCF4CVODAW1-ALL	EFW C/V AW1 FAIL TO OPEN CCF	1.7E-06	1.5E-03	9.2E+02
8	EFWCF4CVODXW1-ALL	EFW C/V XW1 FAIL TO OPEN CCF	1.7E-06	1.5E-03	9.2E+02
9	EFWXVELPW2A	X/V PW2A EXTERNAL LEAK L	7.2E-08	6.4E-05	8.9E+02
10	EFWXVELPW2B	X/V PW2B EXTERNAL LEAK L	7.2E-08	6.4E-05	8.9E+02
11	EFWCF4CVODAW1-234	EFW C/V AW1 FAIL TO OPEN CCF	6.2E-08	5.5E-05	8.9E+02
12	EFWCF4CVODAW1-134	EFW C/V AW1 FAIL TO OPEN CCF	6.2E-08	5.5E-05	8.9E+02
13	EFWCF4CVODAW1-124	EFW C/V AW1 FAIL TO OPEN CCF	6.2E-08	5.5E-05	8.9E+02
14	EFWCF4CVODAW1-123	EFW C/V AW1 FAIL TO OPEN CCF	6.2E-08	5.5E-05	8.9E+02
15	EPSCF4BYFF-134	EPS BATTERY Fail to Operate CCF	1.2E-08	9.8E-06	7.9E+02
16	EPSCF4BYFF-ALL	EPS BATTERY Fail to Operate CCF	5.0E-08	3.3E-05	6.6E+02
17	EPSCF4CBTD6H-134	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.2E-06	2.9E-03	5.6E+02
18	EPSCF4CBWR4I-ALL	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	1.6E-07	8.7E-05	5.5E+02
19	EPSCF4CBTD6H-124	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.2E-06	2.8E-03	5.5E+02
20	EPSCF4BYFF-123	EPS BATTERY Fail to Operate CCF	1.2E-08	6.1E-06	5.0E+02
21	SWSCF4PMYR-FF	SWSP FAIL TO RUN (CCF) (Fleming factor)	1.2E-08	5.4E-06	4.5E+02
22	EPSBTSWCCF	EPS SOFTWARE CCF	1.0E-05	3.1E-03	3.1E+02
23	EPSCF4DLLRDG-ALL	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	9.9E-04	3.1E-01	3.1E+02
24	EPSCF4DLADDG-ALL	EPS DG A,B,C,D FAIL TO START CCF	2.1E-04	6.5E-02	3.1E+02

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 2 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
25	EPSCF4DLSRDG-ALL	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	1.6E-04	4.8E-02	3.1E+02
26	EPSCF4SEFFDG-ALL	EPS SG SEQUENCER FAIL TO OPERATE CCF	3.8E-05	1.2E-02	3.1E+02
27	EPSCF4CBTDDG-ALL	EPS DG C/B DGBA,B,C,D Fail to Closed CCF	2.0E-05	6.3E-03	3.1E+02
28	EPSCF4IVFFINV-ALL	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.5E-06	4.6E-04	3.1E+02
29	EPSCF4CBWRDG-ALL	EPS DG C/B DGBA,B,C,D fail to remain closed CCF	1.6E-07	4.8E-05	3.0E+02
30	EPSCF4CBWRVIT4-ALL	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	4.8E-05	3.0E+02
31	EPSCF4CBWR4I-134	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	6.0E-06	2.1E+02
32	EPSCF4CBWR4I-234	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	5.6E-06	1.9E+02
33	EPSCF4CBWR4I-124	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	5.4E-06	1.9E+02
34	EPSCF4CBWR4I-123	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	5.4E-06	1.8E+02
35	SWSCF4PMBD-R-ALL	SWS PUMP FAIL TO RE-START CCF	4.8E-05	7.4E-03	1.6E+02
36	CWSCF4PCBD-R-ALL	CWS PUMP FAIL TO RE-START CCF	2.6E-05	4.1E-03	1.6E+02
37	BOSBTSWCCF	B.O SIGNAL SOFTWARE CCF	1.0E-05	1.5E-03	1.5E+02
38	CWSCF4RHPR-FF	HEAT EXCHANGER CCWHX PLUG/FOUL EXTERNAL LEAK L (CCF) (Fleming factor)	3.6E-08	5.5E-06	1.5E+02
39	SGNBTSWCCF	S,P SIGNAL SOFTWARE CCF	1.0E-05	1.4E-03	1.4E+02
40	CWSCF4CVOD052-R-ALL	CWS C/V 052 FAIL TO RE-OPEN CCF	1.5E-07	2.1E-05	1.4E+02
41	SWSCF4CVOD502-R-ALL	SWS C/V 502 FAIL TO OPEN CCF	1.5E-07	2.1E-05	1.4E+02
42	SWSCF4CVOD602-R-ALL	SWS C/V 602 FAIL TO OPEN CCF	1.5E-07	2.1E-05	1.4E+02

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 3 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
43	MSRCF4AVCD533-ALL	A/V 533 FAIL TO CLOSE CCF	1.8E-04	2.5E-02	1.4E+02
44	MSRCF4AVCD533-24	MAIN STEAM ISOLATION VALVE AOV-515B,D(533B,D) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
45	MSRCF4AVCD533-13	MAIN STEAM ISOLATION VALVE AOV-515A,C(533A,C) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
46	MSRCF4AVCD533-14	MAIN STEAM ISOLATION VALVE AOV-515A,D(533A,D) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
47	MSRCF4AVCD533-23	MAIN STEAM ISOLATION VALVE AOV-515B,C(533B,C) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
48	MSRCF4AVCD533-34	MAIN STEAM ISOLATION VALVE AOV-515C,D(533C,D) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
49	MSRCF4AVCD533-12	MAIN STEAM ISOLATION VALVE AOV-515A,B(533A,B) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02
50	MSRCF4AVCD533-134	MAIN STEAM ISOLATION VALVE AOV-515A,C,D(533A,C,D) FAIL TO CLOSED	2.6E-05	3.6E-03	1.4E+02
51	MSRCF4AVCD533-123	MAIN STEAM ISOLATION VALVE AOV-515A,B,C(533A,B,C) FAIL TO CLOSED	2.6E-05	3.6E-03	1.4E+02
52	MSRCF4AVCD533-124	MAIN STEAM ISOLATION VALVE AOV-515A,B,D(533A,B,D) FAIL TO CLOSED	2.6E-05	3.6E-03	1.4E+02

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 4 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
53	MSRCF4AVCD533-234	MAIN STEAM ISOLATION VALVE AOV-515B,C,D(533B,C,D) FAIL TO CLOSED	2.6E-05	3.6E-03	1.4E+02
54	MSRBTSWCCF	MSR STEAM LINE ISORATION SIGNAL SOFTWARE CCF	1.0E-05	1.4E-03	1.4E+02
55	EPSCF4CBWR4I-34	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	3.8E-06	1.2E+02
56	EPSCF4CBWR4I-12	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	3.3E-06	1.0E+02
57	EPSCF4CBWR4I-13	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	2.9E-06	8.7E+01
58	EPSCF4CBWR4I-24	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	2.7E-06	8.0E+01
59	EFWCF4CVODXW1-124	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	4.7E-06	7.7E+01
60	EFWCF4CVODXW1-123	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	4.6E-06	7.6E+01
61	HPICF4PMADSIP-ALL	M/P FAIL TO START (Standby) CCF	1.1E-04	8.0E-03	7.3E+01
62	RWSCF4SUPRST01-ALL	SUMP STRAINER PLUG CCF	9.7E-06	6.9E-04	7.2E+01
63	EFWCF4CVODXW1-234	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	4.2E-06	6.9E+01
64	HPICF4PMSRSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO RUN (Standby) (<1h) CCF	8.5E-06	5.7E-04	6.8E+01
65	EFWCF4CVODXW1-134	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	4.1E-06	6.7E+01
66	HPICF4PMLRSIP-ALL	M/P FAIL TO RUN (Standby) (>1h) CCF	2.9E-06	1.9E-04	6.4E+01
67	HPICF4CVOD8804-ALL	C/V 8804 FAIL TO OPEN CCF	1.0E-06	5.8E-05	5.8E+01
68	HPICF4CVOD8808-ALL	C/V 8808 FAIL TO OPEN CCF	1.0E-06	5.8E-05	5.8E+01
69	HPICF4CVOD8809-ALL	C/V 8809 FAIL TO OPEN CCF	1.0E-06	5.8E-05	5.8E+01
70	HPICF4CVOD8806-ALL	C/V 8806 FAIL TO OPEN CCF	1.0E-06	5.8E-05	5.8E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 5 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
71	PZRCF2MVOD58R-ALL	PORV 58RA,58RB FAIL TO OPEN (CCF)	1.3E-04	6.7E-03	5.4E+01
72	EFWCVODEFW03B	EFW PIT-B DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	4.9E-04	5.2E+01
73	EFWCVPREFW03B	EFW PIT-B DISCHARGE LINE C/V PLUG	2.4E-06	1.2E-04	5.0E+01
74	EFWXVPRPW1B	EFW PIT-B DISCHARGE LINE MANUAL VALVE PLUG	2.4E-06	1.2E-04	5.0E+01
75	EPSCF4CBTD6H-14	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	2.4E-04	5.0E+01
76	EFWCVODEFW03A	EFW PIT-A DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	4.5E-04	4.8E+01
77	EFWCF4CVODAW1-23	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	1.1E-05	4.8E+01
78	EFWXVPRPW1A	EFW PIT-A DISCHARGE LINE MANUAL VALVE PLUG	2.4E-06	1.1E-04	4.7E+01
79	EFWCVPREFW03A	EFW PIT-A DISCHARGE LINE C/V PLUG	2.4E-06	1.1E-04	4.7E+01
80	EFWCF4CVODAW1-24	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	9.8E-06	4.5E+01
81	EFWCF4CVODXW1-24	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	9.8E-06	4.4E+01
82	EPSCF4CBTD6H-123	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.2E-06	2.2E-04	4.3E+01
83	HPIOO02FWBD-S	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	2.6E-03	1.1E-01	4.3E+01
84	EFWCF4CVODXW1-13	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	8.9E-06	4.0E+01
85	EPSCF4CBTD6H-234	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.2E-06	2.0E-04	4.0E+01
86	EFWXVELPW1B	EFW PIT-B DISCHARGE LINE X/V VLV-007B(PW1B) LARGE LEAK	7.2E-08	2.7E-06	3.8E+01
87	EFWXVELTW3B	X/V TW3B EXTEANAL LEAK L	7.2E-08	2.7E-06	3.8E+01
88	EFWXVELEFW01B	X/V EFW01B EXTERNAL LEAK L	7.2E-08	2.7E-06	3.8E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 6 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
89	EFWXVELMW3B	EFW PIT-B DISCHARGE LINE X/V VLV-009C(MW3B) LARGE LEAK	7.2E-08	2.7E-06	3.8E+01
90	EPSCF4CBWR4J-ALL	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	5.6E-06	3.7E+01
91	EFWXVELMW3A	X/V MW3A EXTEANAL LEAK L	7.2E-08	2.5E-06	3.6E+01
92	EFWXVELEFW01A	X/V EFW01A EXTERNAL LEAK L	7.2E-08	2.5E-06	3.6E+01
93	EFWXVELTW3A	X/V TW3A EXTEANAL LEAK L	7.2E-08	2.5E-06	3.6E+01
94	EFWXVELPW1A	X/V PW1A EXTERNAL LEAK L	7.2E-08	2.5E-06	3.6E+01
95	EFWCF4CVODAW1-12	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	7.5E-06	3.4E+01
96	EFWTNELEFWP1B	B-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
97	EFWCVELEFW03B	C/V EFW03B EXTERNAL LEAK L	4.8E-08	1.5E-06	3.2E+01
98	EFWCF4CVODAW1-13	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	6.7E-06	3.1E+01
99	EFWCVELEFW03A	C/V EFW03A EXTERNAL LEAK L	4.8E-08	1.4E-06	3.0E+01
100	EFWTNELEFWP1A	A-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	1.4E-06	3.0E+01
101	RWSXVEL001	X/V 001 EXTERNAL LEAK L	7.2E-08	2.0E-06	2.9E+01
102	EPSBSFFDCA	125V DC BUS-A FAILURE	5.8E-06	1.6E-04	2.9E+01
103	EFWCF4CVODAW1-14	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	6.0E-06	2.8E+01
104	EPSBSFFDCD	DC-D SWITCH BOARD FAILURE	5.8E-06	1.5E-04	2.8E+01
105	EFWCF4CVODAW1-34	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	5.8E-06	2.7E+01
106	EPSCF4IVFFINV-134	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	1.2E-05	2.5E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 7 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
107	RSSCF4MVOD9011-ALL	CONTAINMENT SPRAY HEADER CONTAINMENT ISOLATION VALVES MOV-004A,B,C,D(9011A,B,C,D) FAIL TO OPEN	8.4E-05	1.9E-03	2.4E+01
108	RSSCF4MVOD114-ALL	RSS M/V 114 FAIL TO OPEN CCF	8.4E-05	1.9E-03	2.4E+01
109	EPSCF4DLLRDG-134	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	5.5E-03	2.3E+01
110	EPSCF4DLADDG-134	EPS DG A,B,C,D FAIL TO START CCF	5.2E-05	1.1E-03	2.3E+01
111	EPSCF4DLSRDG-134	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	8.5E-04	2.3E+01
112	RSSCF4PMADCSP-ALL	RSS PUMP FAIL TO START CCF	1.9E-05	4.0E-04	2.2E+01
113	EPSCF4SEFFDG-134	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	2.6E-04	2.2E+01
114	EPSCF4BYFF-34	EPS BATTERY Fail to Operate CCF	1.9E-08	3.9E-07	2.2E+01
115	EPSCF4BYFF-12	EPS BATTERY Fail to Operate CCF	1.9E-08	3.9E-07	2.2E+01
116	EPSCF4BYFF-14	EPS BATTERY Fail to Operate CCF	1.9E-08	3.9E-07	2.2E+01
117	EPSCF4BYFF-23	EPS BATTERY Fail to Operate CCF	1.9E-08	3.9E-07	2.2E+01
118	CCWBTSWCCF	CCW SOFTWARE CCF	1.0E-05	2.0E-04	2.1E+01
119	RWSTNELRWSP	EPS BREAKER SWWA AND SWWD FAIL TO CLOS CCF	4.8E-08	9.8E-07	2.1E+01
120	EPSCF4CBTDDG-234	EPS DG C/B DGBA,B,C,D Fail to Closed CCF	5.2E-06	1.1E-04	2.1E+01
121	HPICF4PMADSIP-234	SAFETY INJECTION PUMP B,C,D FAIL TO START (Standby) CCF	9.5E-06	1.9E-04	2.1E+01
122	HPICF4PMADSIP-123	M/P FAIL TO START (Standby) CCF	9.5E-06	1.8E-04	2.0E+01
123	RSSCF4PMSRCSP-ALL	RSS PUMP FAIL TO RUN (<1H) CCF	5.0E-06	9.5E-05	2.0E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 8of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
124	RWSCF4SUPRST01-234	SUMP STRAINER PLUG CCF	3.7E-06	7.0E-05	2.0E+01
125	RSSCF4RHPRRHEX-ALL	RSS HX PLUG CCF	4.8E-06	9.1E-05	2.0E+01
126	HPICF4PMSRSIP-234	M/P FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	6.2E-05	2.0E+01
127	RSSCF4PMADCSP-123	RSS PUMP FAIL TO START CCF	6.3E-06	1.2E-04	2.0E+01
128	EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,P2) FAIL TO RUN (>1H) CCF	1.5E-03	2.8E-02	2.0E+01
129	EPSCF2DLADDGP-ALL	EPS DG FAIL TO START CCF	3.1E-04	5.7E-03	2.0E+01
130	EPSCF2DLSRDGP-ALL	EPS DG FAIL TO RUN (<1h) CCF	2.3E-04	4.3E-03	2.0E+01
131	EPSCF2SEFFDGP-ALL	SEQUENCER FAIL TO OPERATE CCF	1.4E-04	2.6E-03	2.0E+01
132	EPSCF2CBTDDGBP-ALL	EPS C/B DGBP1,2 FAIL TO CLOSED CCF	2.8E-05	5.2E-04	1.9E+01
133	EPSCF2CBTDSWW-ALL	EPS C/B SWWA,D FAIL TO CLOSED CCF	2.8E-05	5.2E-04	1.9E+01
134	EPSCF2CBTD4A-ALL	EPS TIELINE BREAKER 4AA,4AD FAIL TO CLOSED CCF	2.8E-05	5.2E-04	1.9E+01
135	EPSOO02RDG	(HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR	2.1E-02	3.9E-01	1.9E+01
136	EPPBTSWCCF	EPS P SOFTWARE CCF	1.0E-05	1.8E-04	1.9E+01
137	RWSCF4SUPRST01-123	SUMP STRAINER PLUG CCF	3.7E-06	6.7E-05	1.9E+01
138	EPSCF2IVFFINV-ALL	EPS INVP1,P2 FAIL TO OPERATE CCF	5.6E-06	1.0E-04	1.9E+01
139	HPICF4PMSRSIP-123	M/P FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	5.9E-05	1.9E+01
140	RSSPNEL01D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.9E-08	5.1E-07	1.9E+01
141	RSSPNEL01B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.9E-08	5.1E-07	1.9E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 9of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
142	RSSPNEL01A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.8E-08	5.1E-07	1.9E+01
143	RSSPNEL01C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.8E-08	5.1E-07	1.9E+01
144	HPIPNELSUCTSB	PIPE IN CV EXTERNAL LEAK L	2.8E-08	5.0E-07	1.9E+01
145	HPIPNELSUCTSA	PIPE IN CV EXTERNAL LEAK L	2.8E-08	5.0E-07	1.9E+01
146	HPIPNELSUCTSC	PIPE IN CV EXTERNAL LEAK L	2.8E-08	5.0E-07	1.9E+01
147	HPIPNELSUCTSD	PIPE IN CV EXTERNAL LEAK L	2.8E-08	5.0E-07	1.9E+01
148	RSSMVEL9007A	M/V 9007A EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
149	RSSMVEL9007D	M/V 9007D EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
150	RSSMVEL9007C	M/V 9007C EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
151	RSSMVEL9007B	M/V 9007B EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
152	HPIMVEL8820B	M/V 8820B EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
153	HPIMVEL8820A	M/V 8820A EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
154	RWSMVEL002	M/V 002 EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
155	HPIMVEL8820D	M/V 8820D EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
156	HPIMVEL8820C	M/V 8820C EXTERNAL LEAK L	2.4E-08	4.3E-07	1.9E+01
157	CWSCF4PCYR-FF	CCWP FAIL TO RUN (CCF) (Fleming factor)	6.7E-09	1.2E-07	1.9E+01
158	HPICF4PMLRSIP-134	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	2.0E-05	1.8E+01
159	RSSCF4PMLRCSP-ALL	RSS PUMP FAIL TO RUN (>1H) CCF	1.7E-06	2.9E-05	1.8E+01
160	EPSCF4CBWRVIT4P-ALL	EPS C/B VIT4P1,P2 FAIL TO REMAIN CLOSED CCF	2.8E-07	4.8E-06	1.8E+01
161	EPSCF2CBWRSWW-ALL	EPS BREAKER SWWA AND SWWD FAIL TO CLOS CCF	2.8E-07	4.8E-06	1.8E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 10of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
162	EPSCF2CBWR4A-ALL	EPS TIELINE BREAKER 4AA,4AD FAIL OPERATE	2.8E-07	4.8E-06	1.8E+01
163	EPSCF2CBWRDGBP-ALL	EPS C/B DGBP1,2 FAIL TO REMAIN CLOSED CCF	2.8E-07	4.8E-06	1.8E+01
164	RSSCF4PMSRCSP-123	RSS PUMP FAIL TO RUN (<1H) CCF	1.7E-06	2.8E-05	1.8E+01
165	RSSCF4MVOD114-123	RSS M/V 114 FAIL TO OPEN CCF	1.5E-06	2.4E-05	1.7E+01
166	RSSCF4MVOD9011-123	RSS M/V 9011 FAIL TO OPEN CCF	1.5E-06	2.4E-05	1.7E+01
167	HPICF4PMLRSIP-123	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	1.8E-05	1.7E+01
168	EPSCF2BYFFP-ALL	EPS BATTERY P1,P2 Fail to Operate CCF	8.4E-08	1.3E-06	1.7E+01
169	EPSCF4CBWR4J-34	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	5.2E-07	1.7E+01
170	EPSCF4CBWR4I-14	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	3.4E-08	5.2E-07	1.7E+01
171	EPSCF4IVFFINV-124	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	7.4E-06	1.6E+01
172	EPSBSFFDCC	DC-C SWITCH BOARD FAILURE	5.8E-06	8.5E-05	1.6E+01
173	EPSCF4DLLRDG-124	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	3.6E-03	1.5E+01
174	RSSRIELRHEXA	CS/RHR HEAT EXCHANGER A LEAK LARGE	7.2E-07	1.0E-05	1.5E+01
175	EPSCF4DLLRDG-123	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	3.6E-03	1.5E+01
176	EPSCF4DLADDG-124	EPS DG A,B,C,D FAIL TO START CCF	5.2E-05	7.4E-04	1.5E+01
177	HPICF4CVOD8804-234	C/V 8804 FAIL TO OPEN CCF	2.7E-07	3.8E-06	1.5E+01
178	HPICF4CVOD8809-234	C/V 8809 FAIL TO OPEN CCF	2.7E-07	3.8E-06	1.5E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 11of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
179	HPICF4CVOD8806-234	C/V 8806 FAIL TO OPEN CCF	2.7E-07	3.8E-06	1.5E+01
180	HPICF4CVOD8808-234	C/V 8808 FAIL TO OPEN CCF	2.7E-07	3.8E-06	1.5E+01
181	EPSCF4DLSRDG-124	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	5.5E-04	1.5E+01
182	EPSCF4DLADDG-123	EPS DG A,B,C,D FAIL TO START CCF	5.2E-05	7.3E-04	1.5E+01
183	RSSCF4PMLRCSP-123	RSS PUMP FAIL TO RUN (>1H) CCF	5.8E-07	8.0E-06	1.5E+01
184	RSSCF4CVOD9012-ALL	RSS C/V 9012 FAIL TO OPEN CCF	4.3E-07	5.9E-06	1.5E+01
185	EPSCF4DLSRDG-123	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	5.4E-04	1.5E+01
186	EPSCF4CBWR4J-134	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.0E-07	1.5E+01
187	EPSCF4CBWR4J-234	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.0E-07	1.5E+01
188	EPSCF4SEFFDG-124	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.7E-04	1.5E+01
189	RSSRIELRHEXD	CS/RHR HEAT EXCHANGER D LEAK LARGE	7.2E-07	9.8E-06	1.5E+01
190	RSSPNEL04A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.6E-07	3.5E-06	1.5E+01
191	EPSCF4DLLRDG-234	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	3.4E-03	1.4E+01
192	HPICF4PMADSIP-134	SAFETY INJECTION PUMP A,C,D FAIL TO START (Standby) CCF	9.5E-06	1.3E-04	1.4E+01
193	EPSCF4IVFFINV-123	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	6.7E-06	1.4E+01
194	RSSCF4CVOD9008-ALL	RSS C/V 9008 FAIL TO OPEN CCF	4.3E-07	5.7E-06	1.4E+01
195	EPSCF4SEFFDG-123	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.7E-04	1.4E+01
196	EPSCF4DLADDG-234	EPS DG A,B,C,D FAIL TO START CCF	5.2E-05	6.9E-04	1.4E+01
197	HPIPMELSIPA	M/P SIPA EXTERNAL LEAK L	1.9E-07	2.5E-06	1.4E+01
198	RSSPMELCSPA	CS/RHR PUMP A EXTERNAL LEAK L	1.9E-07	2.5E-06	1.4E+01
199	EPSCF4DLSRDG-234	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	3.9E-05	5.1E-04	1.4E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 12of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
200	EPSCF4CBTDDG-124	EPS DG C/B DGBA,B,C,D Fail to Closed CCF	5.2E-06	6.8E-05	1.4E+01
201	RSSPNEL04D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.5E-07	3.3E-06	1.4E+01
202	RSSPMELCSPD	CS/RHR PUMP D EXTERNAL LEAK L	1.9E-07	2.5E-06	1.4E+01
203	RWSCF4SUPRST01-134	SUMP STRAINER PLUG CCF	3.7E-06	4.7E-05	1.4E+01
204	EPSBYFFD	BATTERY-D FAIL TO OPERATE	3.8E-06	4.9E-05	1.4E+01
205	EPSCF4SEFFDG-234	EPS SG SEQUENCER FAIL TO OPERATE CCF	1.3E-05	1.6E-04	1.4E+01
206	HPICF4CVOD8806-123	C/V 8806 FAIL TO OPEN CCF	2.7E-07	3.4E-06	1.4E+01
207	HPICF4CVOD8809-123	C/V 8809 FAIL TO OPEN CCF	2.7E-07	3.4E-06	1.4E+01
208	HPICF4CVOD8808-123	C/V 8808 FAIL TO OPEN CCF	2.7E-07	3.4E-06	1.4E+01
209	HPICF4CVOD8804-123	C/V 8804 FAIL TO OPEN CCF	2.7E-07	3.4E-06	1.4E+01
210	HPICF4PMSRSIP-134	M/P FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	4.2E-05	1.4E+01
211	EPSCF4CBTDDG-123	EPS DG C/B DGBA,B,C,D Fail to Closed CCF	5.2E-06	6.6E-05	1.4E+01
212	EPSBYFFA	BATTERY A FAIL TO OPERATE	3.8E-06	4.8E-05	1.4E+01
213	RSSCF4CVOD9012-123	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	2.8E-06	1.4E+01
214	RSSCF4CVOD9008-124	RSS C/V 9008 FAIL TO OPEN CCF	2.2E-07	2.8E-06	1.4E+01
215	EFWXVELMW4A	X/V MW4A EXTERNAL LEAK L	7.2E-08	8.9E-07	1.3E+01
216	EFWXVELTW4B	X/V TW4B EXTERNAL LEAK L	7.2E-08	8.9E-07	1.3E+01
217	EFWXVELTW4A	X/V TW4A EXTERNAL LEAK L	7.2E-08	8.9E-07	1.3E+01
218	EFWXVELMW4B	X/V MW4B EXTERNAL LEAK L	7.2E-08	8.9E-07	1.3E+01
219	HPIOO02FWBD	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	3.8E-03	4.7E-02	1.3E+01
220	EPSCF4CBTDDG-134	EPS DG C/B DGBA,B,C,D Fail to Closed CCF	5.2E-06	6.4E-05	1.3E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 13of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
221	PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN	8.7E-04	1.1E-02	1.3E+01
222	HPICF4PMLRSIP-234	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	1.3E-05	1.3E+01
223	HPIPNELINJSA	PIPE OUT OF CV EXTERNAL LEAK L	9.2E-08	1.1E-06	1.3E+01
224	HPICF4PMADSIP-34	SAFETY INJECTION PUMP C,D FAIL TO START (Standby) CCF	2.2E-05	2.5E-04	1.2E+01
225	EFWCVELMW1A	C/V MW1A EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
226	EFWCVELTW1A	C/V TW1A EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
227	EFWCVELTW1B	C/V TW1B EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
228	EFWCVELMW1B	C/V MW1B EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
229	EFWCVELAW1A	C/V AW1A EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
230	EFWCVELAW1C	C/V AW1C EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
231	EFWCVELAW1D	C/V AW1D EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
232	EFWCVELAW1B	C/V AW1B EXTERNAL LEAK L	4.8E-08	5.4E-07	1.2E+01
233	HPICF4PMSRSIP-34	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	4.0E-05	1.2E+01
234	RWSCF4SUPRST01-34	SUMP STRAINER PLUG CCF	3.0E-06	3.4E-05	1.2E+01
235	HPICF4PMLRSIP-34	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	1.4E-05	1.2E+01
236	HPICF4PMADSIP-124	M/P FAIL TO START (Standby) CCF	9.5E-06	1.0E-04	1.2E+01
237	EPSBSFF6ESBD	6.9KV SAFETY D BUS FAILURE	5.8E-06	6.3E-05	1.2E+01
238	PZRMVOD58RA	SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPEN	8.7E-04	9.6E-03	1.2E+01
239	EPSTRFFPTD	4PTD TRANSFORMER FAIL TO RUN	8.2E-06	8.8E-05	1.2E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 14of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
240	RSSXVEL9009D	X/V 9009D EXTERNAL LEAK LARGE	7.2E-08	7.8E-07	1.2E+01
241	RSSXVELSFP01D	X/V SFP01D EXTERNAL LEAK L	7.2E-08	7.8E-07	1.2E+01
242	RSSXVELRHR04A	X/V RHR04A EXTERNAL LEAK LARGE	7.2E-08	7.8E-07	1.2E+01
243	RSSXVELRHR04D	X/V RHR04D EXTERNAL LEAK LARGE	7.2E-08	7.8E-07	1.2E+01
244	RSSXVELSFP02A	X/V SFP02A EXTERNAL LEAK L	7.2E-08	7.8E-07	1.2E+01
245	RSSXVELSFP02D	X/V SFP02D EXTERNAL LEAK L	7.2E-08	7.8E-07	1.2E+01
246	RSSXVEL9009A	X/V 9009A EXTERNAL LEAK LARGE	7.2E-08	7.8E-07	1.2E+01
247	RSSXVELSFP01A	X/V SFP01A EXTERNAL LEAK L	7.2E-08	7.8E-07	1.2E+01
248	RSSCF4RHPRRHEX-123	RSS HX PLUG CCF	6.4E-08	6.9E-07	1.2E+01
249	RSSPNEL05A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	5.7E-08	6.2E-07	1.2E+01
250	RWSCF4SUPRST01-124	SUMP STRAINER PLUG CCF	3.7E-06	4.0E-05	1.2E+01
251	HPICF4PMSRSIP-124	6.9kV-480V D CLASS 1E STATION SERVICE TRANSFORMER FAIL TO RUN	3.3E-06	3.5E-05	1.2E+01
252	EPSCF4IVFFINV-234	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	5.3E-06	1.2E+01
253	EPSBSFF4MCCD1	480V MCC D1 BUS FAILURE	5.8E-06	6.0E-05	1.1E+01
254	EPSBSFF4ESBD	480V CLASS 1E BUS D FAIL	5.8E-06	6.0E-05	1.1E+01
255	HPICF4CVOD8808-134	C/V 8808 FAIL TO OPEN CCF	2.7E-07	2.8E-06	1.1E+01
256	HPICF4CVOD8806-134	C/V 8806 FAIL TO OPEN CCF	2.7E-07	2.8E-06	1.1E+01
257	HPICF4CVOD8804-134	C/V 8804 FAIL TO OPEN CCF	2.7E-07	2.8E-06	1.1E+01
258	HPICF4CVOD8809-134	C/V 8809 FAIL TO OPEN CCF	2.7E-07	2.8E-06	1.1E+01
259	HPICF4PMLRSIP-124	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	1.2E-05	1.1E+01
260	SWSCF4PMBD-R-124	SWS PUMP FAIL TO RE-START CCF	1.5E-05	1.6E-04	1.1E+01
261	EPSTRFFPTA	4PTA TRANSFORMER FAIL TO RUN	8.2E-06	8.3E-05	1.1E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 15 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
262	EPSBSFFDCB	125V DC BUS-B FAILURE	5.8E-06	5.8E-05	1.1E+01
263	EPSBSFF6ESBA	6.9KV SAFETY A BUS FAILURE	5.8E-06	5.8E-05	1.1E+01
264	HPICF4CVOD8804-34	C/V 8804 FAIL TO OPEN CCF	1.6E-07	1.6E-06	1.1E+01
265	HPICF4CVOD8809-34	C/V 8809 FAIL TO OPEN CCF	1.6E-07	1.6E-06	1.1E+01
266	HPICF4CVOD8806-34	C/V 8806 FAIL TO OPEN CCF	1.6E-07	1.6E-06	1.1E+01
267	HPICF4CVOD8808-34	C/V 8808 FAIL TO OPEN CCF	1.6E-07	1.6E-06	1.1E+01
268	EPSBSFFVITD	120V BUS-D FAILURE	5.8E-06	5.7E-05	1.1E+01
269	CWSCF4PCBD-R-123	CWS PUMP FAIL TO RE-START CCF	8.4E-06	8.3E-05	1.1E+01
270	RSSCF4PMADCSP-124	RSS PUMP FAIL TO START CCF	6.3E-06	6.2E-05	1.1E+01
271	HPICF4CVOD8808-124	C/V 8808 FAIL TO OPEN CCF	2.7E-07	2.6E-06	1.1E+01
272	HPICF4CVOD8809-124	C/V 8809 FAIL TO OPEN CCF	2.7E-07	2.6E-06	1.1E+01
273	HPICF4CVOD8806-124	C/V 8806 FAIL TO OPEN CCF	2.7E-07	2.6E-06	1.1E+01
274	HPICF4CVOD8804-124	C/V 8804 FAIL TO OPEN CCF	2.7E-07	2.6E-06	1.1E+01
275	HPICF4PMADSIP-12	M/P FAIL TO START (Standby) CCF	2.2E-05	2.1E-04	1.1E+01
276	EPSCF4CBWRDG-234	EPS DG C/B DGBA,B,C,D fail to remain closed CCF	2.9E-08	2.8E-07	1.1E+01
277	EPSCF4CBWRVIT4-134	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.8E-07	1.1E+01
278	RSSCF4PMADCSP-12	RSS PUMP FAIL TO START CCF	1.3E-05	1.2E-04	1.1E+01
279	EPSCBWR4ID	4ID BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	2.9E-05	1.1E+01
280	EPSCBWR4JD	4JD BREAKER FAIL OPERATE (MALFUNCTION)	3.0E-06	2.9E-05	1.1E+01
281	RSSCF4MVOD9011-12	RSS M/V 9011 FAIL TO OPEN CCF	5.7E-06	5.5E-05	1.1E+01
282	RSSCF4MVOD114-12	RSS M/V 114 FAIL TO OPEN CCF	5.7E-06	5.5E-05	1.1E+01
283	HPICF4PMSRSIP-12	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	3.5E-05	1.1E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 16 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
284	RSSCF4PMSRCSP-12	RSS PUMP FAIL TO RUN (<1H) CCF	3.3E-06	3.2E-05	1.1E+01
285	RWSCF4SUPRST01-12	SUMP STRAINER PLUG CCF	3.0E-06	2.9E-05	1.1E+01
286	RSSCF4PMSRCSP-124	RSS PUMP FAIL TO RUN (<1H) CCF	1.7E-06	1.6E-05	1.1E+01
287	RSSCF4MVOD9011-124	RSS M/V 9011 FAIL TO OPEN CCF	1.5E-06	1.4E-05	1.1E+01
288	RSSCF4MVOD114-124	RSS M/V 114 FAIL TO OPEN CCF	1.5E-06	1.4E-05	1.1E+01
289	HPICF4PMLRSIP-12	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	1.2E-05	1.1E+01
290	RSSCF4PMLRCSP-12	RSS PUMP FAIL TO RUN (>1H) CCF	1.2E-06	1.1E-05	1.1E+01
291	EPSBSFF4ESBA	480V BUS A FAILURE	5.8E-06	5.6E-05	1.1E+01
292	SWSCF2PMYRSWPAC-ALL	SWS PUMP A,C FAIL TO RUN CCF	8.9E-06	8.5E-05	1.1E+01
293	RSSCF4PMLRCSP-124	RSS PUMP FAIL TO RUN (>1H) CCF	5.8E-07	5.5E-06	1.1E+01
294	RSSCF4CVOD9012-124	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	2.1E-06	1.1E+01
295	RSSCF4CVOD9008-134	RSS C/V 9008 FAIL TO OPEN CCF	2.2E-07	2.1E-06	1.1E+01
296	RSSCF4CVOD9012-12	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	1.9E-06	1.1E+01
297	RSSCF4CVOD9008-14	RSS C/V 9008 FAIL TO OPEN CCF	2.0E-07	1.9E-06	1.1E+01
298	RSSCF4RHPRRHEX-12	RSS HX PLUG CCF	1.7E-07	1.7E-06	1.1E+01
299	HPICF4CVOD8804-12	C/V 8804 FAIL TO OPEN CCF	1.6E-07	1.5E-06	1.1E+01
300	HPICF4CVOD8806-12	C/V 8806 FAIL TO OPEN CCF	1.6E-07	1.5E-06	1.1E+01
301	HPICF4CVOD8809-12	C/V 8809 FAIL TO OPEN CCF	1.6E-07	1.5E-06	1.1E+01
302	HPICF4CVOD8808-12	C/V 8808 FAIL TO OPEN CCF	1.6E-07	1.5E-06	1.1E+01
303	EFWMVFCAWCA	M/V AWCA FAIL TO CONTROL	7.2E-05	6.8E-04	1.0E+01
304	EFWMVFCAWDA	M/V AWDA FAIL TO CONTROL	7.2E-05	6.8E-04	1.0E+01
305	EFWMVFCAWAA	M/V AWAA FAIL TO CONTROL	7.2E-05	6.8E-04	1.0E+01
306	EFWMVFCAWBA	M/V AWBA FAIL TO CONTROL	7.2E-05	6.7E-04	1.0E+01
307	EPSBSFF4MCCA1	480V MCC A1 BUS FAILURE	5.8E-06	5.4E-05	1.0E+01

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 17 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
308	EFWORPRFEAW0C	ORIFICE FEAW0C PLUG	2.4E-05	2.2E-04	1.0E+01
309	EFWORPRFEAW0D	ORIFICE FEAW0D PLUG	2.4E-05	2.2E-04	1.0E+01
310	EFWORPRFEAW0A	ORIFICE FEAW0A PLUG	2.4E-05	2.2E-04	1.0E+01
311	EFWORPRFEAW0B	ORIFICE FEAW0B PLUG	2.4E-05	2.2E-04	1.0E+01
312	EFWCVODAW1B	C/V AW1B FAIL TO OPEN	9.5E-06	8.7E-05	1.0E+01
313	EFWCVODAW1A	C/V AW1A FAIL TO OPEN	9.5E-06	8.6E-05	1.0E+01
314	EFWCVODAW1C	C/V AW1C FAIL TO OPEN	9.5E-06	8.6E-05	1.0E+01
315	EFWCVODAW1D	C/V AW1D FAIL TO OPEN	9.5E-06	8.6E-05	1.0E+01
316	RSSCF4RHPRRHEX-124	RSS HX PLUG CCF	6.4E-08	5.7E-07	9.9E+00
317	HPICVEL8804A	C/V 8804A EXTERNAL LEAK L	4.8E-08	4.3E-07	9.9E+00
318	RSSCVEL9008D	C/V 9008D EXTERNAL LEAK L	4.8E-08	4.3E-07	9.9E+00
319	RSSCVEL9008A	C/V 9008A EXTERNAL LEAK L	4.8E-08	4.3E-07	9.9E+00
320	RSSPNEL05D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	4.7E-08	4.2E-07	9.9E+00
321	HPIPNELSUCTLA	PIPE OUT OF CV EXTERNAL LEAK L	3.3E-08	2.9E-07	9.9E+00
322	RSSMVEL9015A	M/V 9015A EXTERNAL LEAK L	2.4E-08	2.1E-07	9.9E+00
323	RSSMVEL9015D	M/V 9015D EXTERNAL LEAK L	2.4E-08	2.1E-07	9.9E+00
324	HPIMVEL8805A	M/V 8805A EXTERNAL LEAK L	2.4E-08	2.1E-07	9.9E+00
325	RSSMVEL9011D	M/V 9011D EXTERNAL LEAK L	2.4E-08	2.1E-07	9.9E+00
326	RSSMVEL9011A	M/V 9011A EXTERNAL LEAK L	2.4E-08	2.1E-07	9.9E+00
327	RSSPNEL11A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	1.7E-07	9.9E+00
328	RSSPNEL11D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	1.7E-07	9.9E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 18 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
329	RSSPNEL03A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.7E-09	6.0E-08	9.9E+00
330	RSSPNEL03D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.1E-09	5.4E-08	9.9E+00
331	EPSBSFFVITA	120V BUS-A FAILURE	5.8E-06	5.1E-05	9.8E+00
332	PZRMVPR58RB	M/V 58RB PLUG	2.4E-06	2.1E-05	9.8E+00
333	PZRMVPR58MB	M/V 58MB PLUG	2.4E-06	2.1E-05	9.8E+00
334	EPSCBWR4IA	4IA BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	2.7E-05	9.8E+00
335	EFWCVPRAW1B	C/V AW1B PLUG	2.4E-06	2.1E-05	9.8E+00
336	EFWCVPRAW1A	C/V AW1A PLUG	2.4E-06	2.1E-05	9.8E+00
337	EFWMVPRAWAA	M/V AWAA PLUG	2.4E-06	2.1E-05	9.8E+00
338	EFWMVPRAWBB	M/V AWBB PLUG	2.4E-06	2.1E-05	9.8E+00
339	EFWMVPRAWBA	M/V AWBA PLUG	2.4E-06	2.1E-05	9.8E+00
340	EFWMVPRAWAB	M/V AWAB PLUG	2.4E-06	2.1E-05	9.8E+00
341	EFWMVCMAWBB	M/V AWBB MIS-CLOSE	9.6E-07	8.3E-06	9.7E+00
342	EFWMVCMAWAB	M/V AWAB MIS-CLOSE	9.6E-07	8.3E-06	9.7E+00
343	EFWMVCMAWBA	M/V AWBA MIS-CLOSE	9.6E-07	8.3E-06	9.7E+00
344	EFWMVCMAWAA	M/V AWAA MIS-CLOSE	9.6E-07	8.3E-06	9.7E+00
345	EFWMVPRAWCB	M/V AWCB PLUG	2.4E-06	2.1E-05	9.6E+00
346	EFWMVPRAWDA	M/V AWDA PLUG	2.4E-06	2.1E-05	9.6E+00
347	EFWMVPRAWDB	M/V AWDB PLUG	2.4E-06	2.1E-05	9.6E+00
348	EFWCVPRAW1C	C/V AW1C PLUG	2.4E-06	2.1E-05	9.6E+00
349	EFWCVPRAW1D	C/V AW1D PLUG	2.4E-06	2.1E-05	9.6E+00
350	EFWMVPRAWCA	M/V AWCA PLUG	2.4E-06	2.1E-05	9.6E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 19 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
351	EFWMVCMAWDB	M/V AWDB MIS-CLOSE	9.6E-07	8.2E-06	9.5E+00
352	EFWMVCMAWDA	M/V AWDA MIS-CLOSE	9.6E-07	8.2E-06	9.5E+00
353	EFWMVCMAWCB	M/V AWCB MIS-CLOSE	9.6E-07	8.2E-06	9.5E+00
354	EFWMVCMAWCA	M/V AWCA MIS-CLOSE	9.6E-07	8.2E-06	9.5E+00
355	EPSCBWR4JA	4JA BREAKER FAIL OPERATE (MALFUNCTION)	3.0E-06	2.6E-05	9.5E+00
356	PZRMVPR58MA	M/V 58MA PLUG	2.4E-06	1.8E-05	8.6E+00
357	PZRMVPR58RA	M/V 58RA PLUG	2.4E-06	1.8E-05	8.6E+00
358	PZRMVCM58RB	M/V 58RB MIS-CLOSE	9.6E-07	6.9E-06	8.2E+00
359	PZRMVCM58MB	M/V 58MB MIS-CLOSE	9.6E-07	6.9E-06	8.2E+00
360	EFWCF2TPADFWP1-ALL	EMERGENCY FEED WATER PUMP A,D FAIL TO START CCF	4.5E-04	3.1E-03	7.9E+00
361	EPSCF4CBWRVIT4-124	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.0E-07	7.9E+00
362	EPSCF4CBWRDG-124	EPS DG C/B DGBA,B,C,D fail to remain closed CCF	2.9E-08	2.0E-07	7.9E+00
363	EPSCF4CBWRDG-123	EPS DG C/B DGBA,B,C,D fail to remain closed CCF	2.9E-08	2.0E-07	7.9E+00
364	EPSCF4CBWRVIT4-123	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.0E-07	7.9E+00
365	EPSCF4CBWRVIT4-234	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.0E-07	7.9E+00
366	EPSCF4CBWRDG-134	EPS DG C/B DGBA,B,C,D fail to remain closed CCF	2.9E-08	2.0E-07	7.9E+00
367	EFWMVILAWBA	M/V AWBA INTERNAL LEAK L	7.2E-08	4.9E-07	7.8E+00
368	EFWMVILAWCA	M/V AWCA INTERNAL LEAK L	7.2E-08	4.9E-07	7.8E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 20 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
369	EFWMVILAWDA	M/V AWDA INTERNAL LEAK L	7.2E-08	4.9E-07	7.8E+00
370	EFWMVILAWAA	M/V AWAA INTERNAL LEAK L	7.2E-08	4.9E-07	7.8E+00
371	SWSCF4PMBD-R-134	SWS PUMP FAIL TO RE-START CCF	1.5E-05	1.0E-04	7.7E+00
372	CWSCF4PCBD-R-124	CWS PUMP FAIL TO RE-START CCF	8.4E-06	5.4E-05	7.5E+00
373	SWSCF2PMBDSWPBD-ALL	SWS PUMP B,D FAIL TO START CCF	1.4E-04	8.8E-04	7.4E+00
374	EFWCF2PTSRFWP1-ALL	EFW T/D PUMP FAILTO RUN (<1H) CCF	1.1E-04	7.1E-04	7.3E+00
375	EFWCF2PTLRFWP1-ALL	EFW T/D PUMP FAILTO RUN (>1H) CCF	7.2E-05	4.4E-04	7.1E+00
376	MSRAVCD533A	MAIN STEAM ISOLATION VALVE AOV-515A FAIL TO CLOSED	7.9E-04	4.6E-03	6.8E+00
377	MSRAVCD533B	MAIN STEAM ISOLATION VALVE AOV-515B FAIL TO CLOSED	7.9E-04	4.6E-03	6.8E+00
378	SGNST-ISA	MAIN STEAM LINE ISOLATION VALVE AOV-515A(533A) ISOLATION SIGNAL TRAIN A FAIL	4.3E-04	2.5E-03	6.8E+00
379	SGNST-ISB	MAIN STEAM LINE ISOLATION VALVE AOV-515B(533B) ISOLATION SIGNAL TRAIN B FAIL	4.3E-04	2.5E-03	6.8E+00
380	EFWCF2MVODTS1-ALL	EFW M/V TS1 FAIL TO OPEN CCF	4.2E-05	2.4E-04	6.7E+00
381	EFWMVELAWCA	M/V AWCA EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00
382	EFWMVELAWAA	M/V AWAA EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00
383	EFWMVELAWCB	M/V AWCB EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00
384	EFWMVELAWBA	M/V AWBA EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00
385	EFWMVELAWBB	M/V AWBB EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 21 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
386	EFWMVELAWAB	M/V AWAB EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00
387	EFWMVELAWDA	M/V AWDA EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00
388	EFWMVELAWDB	M/V AWDB EXTERNAL LEAK L	2.4E-08	1.4E-07	6.7E+00
389	MSRAVIL535B	A/V 535B INTERNAL LEAK L	4.4E-05	2.5E-04	6.6E+00
390	PZRMVCM58MA	M/V 58MA MIS-CLOSE	9.6E-07	5.4E-06	6.6E+00
391	PZRMVCM58RA	M/V 58RA MIS-CLOSE	9.6E-07	5.4E-06	6.6E+00
392	MSRAVCD533D	MAIN STEAM ISOLATION VALVE AOV-515C FAIL TO CLOSED	7.9E-04	4.4E-03	6.5E+00
393	MSRAVCD533C	MAIN STEAM ISOLATION VALVE AOV-515D FAIL TO CLOSED	7.9E-04	4.4E-03	6.5E+00
394	SGNST-ISD	MAIN STEAM LINE ISOLATION VALVE AOV-515D(533D) ISOLATION SIGNAL TRAIN D FAIL	4.3E-04	2.3E-03	6.5E+00
395	SGNST-ISC	MAIN STEAM LINE ISOLATION VALVE AOV-515C(533C) ISOLATION SIGNAL TRAIN C FAIL	4.3E-04	2.3E-03	6.5E+00
396	MSRAVIL535C	A/V 535C INTERNAL LEAK L	4.4E-05	2.4E-04	6.4E+00
397	MSRAVIL535D	A/V 535D INTERNAL LEAK L	4.4E-05	2.4E-04	6.4E+00
398	SWSCF2PMYRSWPBD-ALL	SWS PUMP B,D FAIL TO RUN CCF	8.9E-06	4.8E-05	6.3E+00
399	MSRAVOM533A	MAIN STEAM ISOLATION VALVE AOV-515A MIS-OPENING	4.8E-06	2.5E-05	6.1E+00
400	MSRAVOM535A	A/V 535A MIS-OPENING	4.8E-06	2.5E-05	6.1E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 22 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
401	MSRAVOM533B	A/V 533B MIS-OPENING	4.8E-06	2.5E-05	6.1E+00
402	MSRAVOM535B	A/V 535B MIS-OPENING	4.8E-06	2.5E-05	6.1E+00
403	SWSCF4PMBD-R-234	SWS PUMP FAIL TO RE-START CCF	1.5E-05	7.6E-05	6.0E+00
404	MSRAVOM535D	A/V 535D MIS-OPENING	4.8E-06	2.3E-05	5.9E+00
405	MSRAVOM533D	MAIN STEAM ISOLATION VALVE AOV-515A MIS-OPENING	4.8E-06	2.3E-05	5.9E+00
406	MSRAVOM535C	A/V 535C MIS-OPENING	4.8E-06	2.3E-05	5.9E+00
407	MSRAVOM533C	MAIN STEAM ISOLATION VALVE AOV-515A MIS-OPENING	4.8E-06	2.3E-05	5.9E+00
408	CWSCF4PCBD-R-134	CWS PUMP FAIL TO RE-START CCF	8.4E-06	4.0E-05	5.8E+00
409	SWSCF4CVOD502-R-134	SWS C/V 502 FAIL TO OPEN CCF	5.0E-08	2.3E-07	5.7E+00
410	CWSCF4CVOD052-R-134	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	2.3E-07	5.7E+00
411	SWSCF4CVOD602-R-134	SWS C/V 602 FAIL TO OPEN CCF	5.0E-08	2.3E-07	5.7E+00
412	EFWCF2PMADFWP2-ALL	MOTOR-DRIVEN EMERGENCY FEED WATER PUMP FAIL TO START CCF	2.2E-04	9.6E-04	5.4E+00
413	HVACF2FAADDGF-ALL	FAN DGFAA AND DGFAB FAIL TO START (STANDBY) CCF	1.4E-04	6.0E-04	5.3E+00
414	HVACF2FALRDGF-ALL	FAN DGFAA AND DGFAB FAIL TO RUN (STANDBY) (>1H) CCF	1.3E-04	5.5E-04	5.3E+00
415	HVACF2FASRDGF-ALL	FAN DGFAA AND DGFAB FAIL TO RUN (<1H) CCF	9.4E-05	3.9E-04	5.2E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 23 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
416	MSRAVIL533C	MAIN STEAM ISOLATION VALVE AOV-515A LARGE LEAK	1.2E-07	5.0E-07	5.1E+00
417	MSRAVIL533B	MAIN STEAM ISOLATION VALVE AOV-515B LARGE LEAK	1.2E-07	5.0E-07	5.1E+00
418	MSRAVIL533A	MAIN STEAM ISOLATION VALVE AOV-515C LARGE LEAK	1.2E-07	5.0E-07	5.1E+00
419	MSRAVIL533D	MAIN STEAM ISOLATION VALVE AOV-515D LARGE LEAK	1.2E-07	5.0E-07	5.1E+00
420	MSRAVIL535A	A/V 535A INTERNAL LEAK L	1.2E-07	5.0E-07	5.1E+00
421	VCWCF4CHYR-ALL	CHILLER A, B, C AND D FAIL TO RUN CCF	2.7E-05	1.0E-04	4.8E+00
422	HPIPMELSIPD	M/P SIPD EXTERNAL LEAK L	1.9E-07	7.0E-07	4.6E+00
423	VCWCF4CHYR-23	CHILLER B AND C FAIL TO RUN CCF	1.8E-05	6.4E-05	4.5E+00
424	EFWCF2PMSRFWP2-ALL	EFW FWP2 FAIL TO RUN (<1h) CCF	1.7E-05	6.0E-05	4.5E+00
425	SWSCF4CVOD602-R-124	SWS C/V 602 FAIL TO OPEN CCF	5.0E-08	1.6E-07	4.3E+00
426	CWSCF4CVOD052-R-124	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	1.6E-07	4.3E+00
427	SWSCF4CVOD502-R-124	SWS C/V 502 FAIL TO OPEN CCF	5.0E-08	1.6E-07	4.3E+00
428	EFMBTSWCCF	EFW MDP START SIGNAL SOFTWARE CCF	1.0E-05	3.2E-05	4.2E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 24 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
429	VCWCF4CHYR-123	CHILLER A, B AND C FAIL TO RUN CCF	9.0E-06	2.8E-05	4.1E+00
430	VCWCF4CHYR-234	CHILLER B, C AND D FAIL TO RUN CCF	9.0E-06	2.8E-05	4.1E+00
431	EFWOO01PW2AB	SUPPLY WATER FROM ALTERNATIVE EFW PIT TO RECOVER LACK OF WATER VOLUME FOR CONTINUOUS SG FEED WATER	2.0E-02	6.1E-02	4.0E+00
432	EFWCF2PMLRFWP2-ALL	EFW FWP2 FAIL TO RUN (>1h) CCF	5.9E-06	1.7E-05	3.8E+00
433	DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(DR-FA2-205-M-10)	7.4E-03	2.1E-02	3.8E+00
434	EPSCF4CBTD6H-13	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	1.3E-05	3.7E+00
435	EPSCF4CBTD6H-34	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	1.3E-05	3.6E+00
436	EPSCF4CBTD6H-24	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	1.2E-05	3.5E+00
437	EPSCF4CBTD6H-12	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	1.2E-05	3.4E+00
438	HPICF4PMADSIP-13	M/P FAIL TO START (Standby) CCF	2.2E-05	5.1E-05	3.4E+00
439	DR-FA2-202-M-07	FIRE RESISTANT DOOR FALIURE(DR-FA2-202-M-07)	7.4E-03	1.7E-02	3.3E+00
440	SWSSTPRST05	STRAINER ST05 PLUG	1.7E-04	3.9E-04	3.3E+00
441	EFWPTADFWP1A	T/P FWP1A FAIL TO START	6.5E-03	1.5E-02	3.2E+00
442	CWSCF2PCYRCWPAC-ALL	CWS PUMP A,C FAIL TO RUN CCF	5.0E-06	1.1E-05	3.2E+00
443	SWSPMYRSWPC	SWP-C FAIL TO RUN (RUNNING)	1.1E-04	2.5E-04	3.2E+00
444	EFWPTSRFWP1A	T/P FWP1A FAIL TO RUN (<1H)	2.4E-03	5.3E-03	3.2E+00
445	SWSSTPRST02C	STRAINER ST02C PLUG	1.7E-04	3.7E-04	3.2E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 25 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
446	EFWPTLRFWP1A	T/P FWP1A FAIL TO RUN (>1H)	1.5E-03	3.4E-03	3.2E+00
447	EFWMVODTS1A	A-EMERGENCY FEED WATER PUMP STARTUP VALVE	9.6E-04	2.1E-03	3.2E+00
448	SGNST-EFWTDA	TURBIN SIGNAL-A FAIL	4.3E-04	8.9E-04	3.1E+00
449	SWSTMPESWPB	SWP-B OUTAGE	1.2E-02	2.5E-02	3.1E+00
450	SWSCF4PMBD-R-123	SWS PUMP FAIL TO RE-START CCF	1.5E-05	3.2E-05	3.1E+00
451	PZRSVCD0057	S/V 0057 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.4E-04	3.0E+00
452	PZRSVCD0055	S/V 0055 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.4E-04	3.0E+00
453	PZRSVCD0056	S/V 0056 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.4E-04	3.0E+00
454	PZRSVCD0058	S/V 0058 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.4E-04	3.0E+00
455	SWSPMBDSWPB	B-ESSENTIAL SERVICE WATER PUMP FAIL TO START (RUNNING)	1.9E-03	3.7E-03	3.0E+00
456	RSSCF4PMADCSP-134	RSS PUMP FAIL TO START CCF	6.3E-06	1.2E-05	3.0E+00
457	SGNTMLGSB	ESFAS and SLS B MAINTENANCE	3.0E-04	6.0E-04	3.0E+00
458	RSSCF4PMADCSP-13	RSS PUMP FAIL TO START CCF	1.3E-05	2.4E-05	3.0E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 26 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
459	EFWTMTAA	T/D-A OUTAGE	5.0E-03	9.8E-03	3.0E+00
460	CWSCF4MVCD043-ALL	CWS M/V 043 FAILTO CLOSE CCF	1.3E-05	2.4E-05	2.9E+00
461	CWSCF4MVCD056-ALL	CWS M/V 056 FAILTO CLOSE	1.3E-05	2.4E-05	2.9E+00
462	SWSSTPRST03	STRAINER ST03 PLUG	1.7E-04	3.2E-04	2.9E+00
463	HPIPNELINJSD	PIPE OUT OF CV EXTERNAL LEAK L	9.0E-08	1.7E-07	2.9E+00
464	RSSCF4MVOD9011-134	RSS M/V 9011 FAIL TO OPEN CCF	1.5E-06	2.7E-06	2.9E+00
465	SWSCF2CVOD602BD-ALL	SWS C/V 602 FAIL TO OPEN CCF	5.6E-07	1.1E-06	2.9E+00
466	SWSCF2CVOD502BD-ALL	SWS C/V 502 FAIL TO OPEN CCF	5.6E-07	1.1E-06	2.9E+00
467	EFWMVFCTS1A	M/V TS1A FAIL TO CONTROL	7.2E-05	1.3E-04	2.9E+00
468	CWSCF4PCBD-R-234	CWS PUMP FAIL TO RE-START CCF	8.4E-06	1.6E-05	2.9E+00
469	SWSPMYRSWPB	SWP-B FAIL TO RUN (RUNNING)	1.1E-04	2.1E-04	2.9E+00
470	SWSORPRESS0003C	ORIFICE ESS0003C PLUG	2.4E-05	4.4E-05	2.8E+00
471	SWSFMPR2055C	FM 2055C PLUG	2.4E-05	4.4E-05	2.8E+00
472	SWSORPROR24C	ORIFICE OR24C PLUG	2.4E-05	4.4E-05	2.8E+00
473	SWSORPROR04C	ORIFICE OR04C PLUG	2.4E-05	4.4E-05	2.8E+00
474	RWSCF4SUPRST01-13	SUMP STRAINER PLUG CCF	3.0E-06	5.5E-06	2.8E+00
475	DR-FA6-101-M-02	FIRE RESISTANT DOOR FALIURE(DR-FA6-101-M-02)	7.4E-03	1.4E-02	2.8E+00
476	SWSSTPRST02B	STRAINER ST02B PLUG	1.7E-04	3.0E-04	2.8E+00
477	HPICF4PMSRSIP-13	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	6.4E-06	2.8E+00
478	EFWOO04LAAA	WATER LEVEL A CALIBRATION MISS	2.2E-04	3.9E-04	2.8E+00
479	RSSCF4MVOD114-13	RSS M/V 114 FAIL TO OPEN CCF	5.7E-06	9.7E-06	2.7E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 27 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
480	RSSCF4MVOD9011-13	RSS M/V 9011 FAIL TO OPEN CCF	5.7E-06	9.7E-06	2.7E+00
481	VCWCF4PMYR-ALL	M/P A, B, C AND D FAIL TO RUN (Running)	1.5E-06	2.5E-06	2.7E+00
482	SWSORPROR04B	ORIFICE OR04B PLUG	2.4E-05	3.8E-05	2.6E+00
483	SWSORPRESS0003B	ORIFICE ESS0003B PLUG	2.4E-05	3.8E-05	2.6E+00
484	SWSFMPR2055B	FM 2055B PLUG	2.4E-05	3.8E-05	2.6E+00
485	SWSORPROR24B	ORIFICE OR24B PLUG	2.4E-05	3.8E-05	2.6E+00
486	RSSCF4PMSRCSP-13	RSS PUMP FAIL TO RUN (<1H) CCF	3.3E-06	5.1E-06	2.5E+00
487	RSSCF4PMSRCSP-134	RSS PUMP FAIL TO RUN (<1H) CCF	1.7E-06	2.5E-06	2.5E+00
488	HVAFAADDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)	2.9E-03	4.2E-03	2.5E+00
489	HVAFALRDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)	2.6E-03	3.9E-03	2.5E+00
490	VCWCHBDB	CHILLER FAIL TO START (RUNNING)	1.0E-02	1.5E-02	2.5E+00
491	VCWCHYRC	C-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)	2.1E-03	3.0E-03	2.5E+00
492	HVAFASRDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)	1.9E-03	2.8E-03	2.5E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 28 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
493	HVAFAADDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)	2.9E-03	4.2E-03	2.5E+00
494	HVAFALRDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)	2.6E-03	3.9E-03	2.5E+00
495	EFWPMADFWP2B	M/P FWP2B FAIL TO START (STANDBY)	1.3E-03	1.9E-03	2.5E+00
496	VCWCHYRB	B-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)	2.1E-03	3.0E-03	2.5E+00
497	VCWPMBDB	B-SAFETY CHILLER PUMP FAIL TO START (Running)	2.0E-03	2.9E-03	2.5E+00
498	HVAFASRDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)	1.9E-03	2.8E-03	2.5E+00
499	EFWPMADFWP2A	B-EMERGENCY FEED WATER PUMP FAIL TO START (STANDBY)	1.3E-03	1.9E-03	2.5E+00
500	EPSBSFF6ESBC	6.9KV SAFETY C BUS FAILURE	5.8E-06	8.4E-06	2.5E+00
501	SGNST-SIMDB	MDP-B START SIGNAL	4.3E-04	6.1E-04	2.4E+00
502	EFWPMSRFWP2B	M/P FWP2B FAIL TO RUN (STANDBY) (<1H)	3.8E-04	5.4E-04	2.4E+00
503	SGNST-SIMDA	MDP-A START SIGNAL	4.3E-04	6.0E-04	2.4E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 29 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
504	EFWPMSRFWP2A	M/P FWP2A FAIL TO RUN (STANDBY) (<1H)	3.8E-04	5.4E-04	2.4E+00
505	RSSCF4MVOD114-134	RSS M/V 114 FAIL TO OPEN CCF	1.5E-06	2.0E-06	2.4E+00
506	SWSCF4CVOD602-R-123	SWS C/V 602 FAIL TO OPEN CCF	5.0E-08	6.9E-08	2.4E+00
507	CWSCF4CVOD052-R-123	CWS C/V 052 FAIL TO RE-OPEN CCF	5.0E-08	6.9E-08	2.4E+00
508	SWSCF4CVOD502-R-123	SWS C/V 502 FAIL TO OPEN CCF	5.0E-08	6.9E-08	2.4E+00
509	EFWPMLRFWP2B	M/P FWP2B FAIL TO RUN (STANDBY) (>1H)	1.3E-04	1.8E-04	2.4E+00
510	EFWPMLRFWP2A	M/P FWP2A FAIL TO RUN (STANDBY) (>1H)	1.3E-04	1.8E-04	2.4E+00
511	EFWXVILTW6AA	X/V TW6AA INTERNAL LEAK L	1.1E-05	1.4E-05	2.4E+00
512	VCWPMYRB	M/P FAIL TO RUN (Running)	1.1E-04	1.5E-04	2.3E+00
513	VCWPMYRC	M/P FAIL TO RUN (Running)	1.1E-04	1.5E-04	2.3E+00
514	EFWCVODTW1A	C/V TW1A FAIL TO OPEN	9.5E-06	1.2E-05	2.3E+00
515	SWSCVOD602B	C/V 602B FAIL TO OPEN	1.1E-05	1.5E-05	2.3E+00
516	SWSCVOD502B	C/V 052B FAIL TO OPEN	1.1E-05	1.5E-05	2.3E+00
517	CWSCF4MVCD056-124	CWS M/V 056 FAILTO CLOSE	4.2E-06	5.3E-06	2.3E+00
518	CWSCF4MVCD043-123	CWS M/V 043 FAILTO CLOSE CCF	4.2E-06	5.3E-06	2.3E+00
519	EPSBSFF6ESBB	6.9KV SAFETY B BUS FAILURE	5.8E-06	7.3E-06	2.3E+00
520	EFWPTADFWP1B	T/P FWP1B FAIL TO START	6.5E-03	8.3E-03	2.3E+00
521	EFWPTSRFWP1B	T/P FWP1B FAIL TO RUN (<1H)	2.4E-03	2.9E-03	2.2E+00
522	EPSCBTD6HD	6HD BREAKER FAIL TO OPEN	3.5E-04	4.3E-04	2.2E+00
523	EPSCBTD6HA	6HA BREAKER FAIL TO OPEN	3.5E-04	4.3E-04	2.2E+00
524	EFWPTLRFWP1B	T/P FWP1B FAIL TO RUN (>1H)	1.5E-03	1.9E-03	2.2E+00
525	SWSPEELSWPC1	SWS PIPE C1 LEAK	3.9E-06	4.7E-06	2.2E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 30 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
526	EFWMVODTS1B	M/V TS1B FAIL TO OPEN	9.6E-04	1.1E-03	2.2E+00
527	EPSCF4DLLRDG-13	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	3.0E-04	2.2E+00
528	EPSCF4DLLRDG-14	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	3.0E-04	2.2E+00
529	EFWTMPAA	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE	4.0E-03	4.7E-03	2.2E+00
530	EPSCF4DLLRDG-34	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	2.9E-04	2.2E+00
531	SGNST-EFWTDB	TURBIN SIGNAL-B FAIL	4.3E-04	4.9E-04	2.2E+00
532	EFWTMPAB	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE	4.0E-03	4.6E-03	2.1E+00
533	EPSTRFFPTC	4PTC TRANSFORMER FAIL TO RUN	8.2E-06	9.3E-06	2.1E+00
534	CHICF2PMBD-ALL	CHARGING PUMP A,B FAIL TO START CCF	2.0E-04	2.3E-04	2.1E+00
535	VCWCF4CHYR-24	CHILLER B,D FAIL TO RUN (RUNNING) CCF	1.8E-05	2.0E-05	2.1E+00
536	VCWCF4CHYR-12	CHILLER A,B FAIL TO RUN (RUNNING) CCF	1.8E-05	2.0E-05	2.1E+00
537	VCWCF4PMYR-23	M/P B AND C FAIL TO RUN (Running)	1.0E-06	1.1E-06	2.1E+00
538	EPSCF4DLLRDG-23	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	2.5E-04	2.8E-04	2.1E+00
539	ACWCF2MVODCH4-ALL	ACW M/V CH4 FAILTO OPEN CCF	4.7E-05	5.0E-05	2.1E+00
540	ACWCF2MVODCH2-ALL	ACW M/V CH2 FAILTO OPEN CCF	4.7E-05	5.0E-05	2.1E+00
541	ACWCF2MVODCH6-ALL	ACW M/V CH6 FAILTO OPEN CCF	4.7E-05	5.0E-05	2.1E+00
542	VCWCF4CHYR-13	CHILLER A, C FAIL TO RUN (RUNNING) CCF	1.8E-05	1.9E-05	2.1E+00
543	VCWCF4CHYR-34	CHILLER C,D FAIL TO RUN (RUNNING) CCF	1.8E-05	1.9E-05	2.1E+00
544	HPICF4PMLRSIP-23	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	1.3E-06	2.1E+00
545	RSSCF4PMLRCSP-13	RSS PUMP FAIL TO RUN (>1H) CCF	1.2E-06	1.2E-06	2.1E+00
546	SWSXVPR507C	X/V 507C PLUG	2.4E-06	2.5E-06	2.1E+00
547	SWSXVPR503C	X/V 503C PLUG	2.4E-06	2.5E-06	2.1E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 31 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
548	SWSXVPR601C	X/V 601C PLUG	2.4E-06	2.5E-06	2.1E+00
549	SWSXVPR569C	X/V 569C PLUG	2.4E-06	2.5E-06	2.1E+00
550	SWSCVPR502C	C/V 502C PLUG	2.4E-06	2.5E-06	2.1E+00
551	SWSXVPR561C	X/V 561C PLUG	2.4E-06	2.5E-06	2.1E+00
552	SWSXVPR509C	X/V 509C PLUG	2.4E-06	2.5E-06	2.1E+00
553	SWSXVPR570C	X/V 570C PLUG	2.4E-06	2.5E-06	2.1E+00
554	SWSXVPR562C	X/V 562C PLUG	2.4E-06	2.5E-06	2.1E+00
555	SWSCVPR602C	C/V 602C PLUG	2.4E-06	2.5E-06	2.1E+00
556	EPSTRFFPTB	4PTB TRANSFORMER FAIL TO RUN	8.2E-06	8.5E-06	2.0E+00
557	CHIORPRRC1B	ORIFICE PLUG	2.4E-05	2.5E-05	2.0E+00
558	CHIORPRRC1A	ORIFICE PLUG	2.4E-05	2.5E-05	2.0E+00
559	CHIORPRFE138	ORIFICE FE138 PLUG	2.4E-05	2.5E-05	2.0E+00
560	CHIORPROR02	ORIFICE OR02 PLUG	2.4E-05	2.5E-05	2.0E+00
561	CHIORPRRC1D	ORIFICE PLUG	2.4E-05	2.5E-05	2.0E+00
562	CHIORPRRC1C	ORIFICE PLUG	2.4E-05	2.5E-05	2.0E+00
563	EPSBSFF4ESBC	480V BUS C FAILURE	5.8E-06	6.0E-06	2.0E+00
564	CHICVODRC7D	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
565	CHICVODRC7B	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
566	CHICVODRC4D	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
567	CHICVODRC7C	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
568	CHICVODRC4B	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
569	CHICVODRC4C	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00

Table 19.1-60 Basic Events (Hardware Failure, Human Error) RAW for Fire (Sheet 32 of 32)

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
570	CHICVOD169	C/V 169 FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
571	CHICVODRC6A	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
572	CHICVODRC6B	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
573	CHICVODRC6C	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
574	CHICVODRC4A	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
575	CHICVODRC7A	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
576	CHICVODRC6D	C/V FAIL TO OPEN	1.2E-05	1.2E-05	2.0E+00
577	SWSPEELSWPB1	SWS PIPE B1 LEAK	3.9E-06	3.9E-06	2.0E+00
578	CHICF2PMYR-R-ALL	CHI PUMP FAIL TO RUN CCF	5.0E-06	5.0E-06	2.0E+00
579	CHIAVCM236	A/V 236 MIS-CLOSE	4.8E-06	4.8E-06	2.0E+00
580	CHIAVCMCVC03	A/V Mis-Close	4.8E-06	4.8E-06	2.0E+00
581	CHIAVCMCVC04	A/V Mis-Close	4.8E-06	4.8E-06	2.0E+00
582	CHIAVCM138	A/V 138 MIS-CLOSE	4.8E-06	4.8E-06	2.0E+00
583	CHIAVCM215	A/V 215 MIS-CLOSE	4.8E-06	4.8E-06	2.0E+00
584	ACWCF2CVCDCH5-ALL	ACW C/V CH5 FAIL TO CLOSE CCF	4.7E-06	4.7E-06	2.0E+00
585	EPSCF4DLADDG-13	EPS DG A,B,C,D FAIL TO START CCF	4.3E-05	4.3E-05	2.0E+00
586	EPSCF4DLADDG-14	EPS DG A,B,C,D FAIL TO START CCF	4.3E-05	4.3E-05	2.0E+00
587	EPSCF4DLSRDG-14	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	4.0E-05	2.0E+00
588	EFWXVILMW6AA	X/V MW6AA INTERNAL LEAK L	1.1E-05	1.0E-05	2.0E+00
589	EFWMVFCTS1B	M/V TS1B FAIL TO CONTROL	7.2E-05	7.2E-05	2.0E+00
590	EPSCF4DLSRDG-13	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	4.0E-05	4.0E-05	2.0E+00

Table 19.1-61 Common Cause Failure FV Importance for Fire

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4DLLRDG-ALL	EPS DG A,B,C,D FAIL TO RUN (>1h) CCF	9.9E-04	3.1E-01	3.1E+02
2	EPSCF4CBTD6H-ALL	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	2.0E-05	2.5E-01	1.2E+04
3	EPSCF4DLADDG-ALL	EPS DG A,B,C,D FAIL TO START CCF	2.1E-04	6.5E-02	3.1E+02
4	EPSCF4DLSRDG-ALL	EPS DG A,B,C,D FAIL TO RUN (<1h) CCF	1.6E-04	4.8E-02	3.1E+02
5	EPSCF2SLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,P2) FAIL TO RUN (>1H) CCF	1.5E-03	2.8E-02	2.0E+01
6	EPSCF4DLADDG-ALL	A/V 533 FAIL TO CLOSE CCF	1.8E-04	2.5E-02	1.4E+02
7	EPSCF4SEFFDG-ALL	EPS SG SEQUENCER FAIL TO OPERATE CCF	3.8E-05	1.2E-02	3.1E+02
8	HPICF4PMADSIP-ALL	M/P FAIL TO START (Standby) CCF	1.1E-04	8.0E-03	7.3E+01
9	SWSCF4PMBD-R-ALL	SWS PUMP FAIL TO RE-START CCF	4.8E-05	7.4E-03	1.6E+02
10	MSRCF4AVCD533-24	MAIN STEAM ISOLATION VALVE AOV-515B,D(533B,D) FAIL TO CLOSED	5.2E-05	7.3E-03	1.4E+02

Table 19.1-62 Common Cause Failure RAW for Fire

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4BYFF-124	EPS BATTERY Fail to Operate CCF	1.2E-08	1.6E-04	1.3E+04
2	EPSCF4BYFF-234	EPS BATTERY Fail to Operate CCF	1.2E-08	1.6E-04	1.3E+04
3	EPSCF4CBTD6H-ALL	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	2.0E-05	2.5E-01	1.2E+04
4	RTPBTSWCCF	SOFTWARE CCF	1.0E-07	5.1E-04	5.1E+03
5	EPSCF4BYFF-24	EPS BATTERY Fail to Operate CCF	1.9E-08	3.6E-05	1.9E+03
6	EPSCF4DLADDG-ALL	EFW C/V EFW03 FAIL TO OPEN CCF	2.4E-06	2.2E-03	9.2E+02
7	EFWCF4CVODAW1-ALL	EFW C/V AW1 FAIL TO OPEN CCF	1.7E-06	1.5E-03	9.2E+02
8	EFWCF4CVODXW1-ALL	EFW C/V XW1 FAIL TO OPEN CCF	1.7E-06	1.5E-03	9.2E+02
9	EFWCF4CVODAW1-234	EFW C/V AW1 FAIL TO OPEN CCF	6.2E-08	5.5E-05	8.9E+02
10	EFWCF4CVODAW1-134	EFW C/V AW1 FAIL TO OPEN CCF	6.2E-08	5.5E-05	8.9E+02

Table 19.1-63 Human Error FV Importance for Fire

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSOO02RDG	(HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR	2.1E-02	3.9E-01	1.9E+01
2	HPIOO02FWBD-S	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	2.6E-03	1.1E-01	4.3E+01
3	EFWOO01PW2AB	SUPPLY WATER FROM ALTERNATIVE EFW PIT TO RECOVER LACK OF WATER VOLUME FOR CONTINUOUS SG FEED WATER	2.0E-02	6.1E-02	4.0E+00
4	HPIOO02FWBD	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	3.8E-03	4.7E-02	1.3E+01
5	ACWOO02FS	ALTERNATIVE CCW BY FIRE SERVICE WATER FAIL TO OPERATE (HE)	2.0E-02	1.3E-02	1.6E+00
6	EPSCF4DLADDG-ALL	ALTERNATIVE CCW BY COOLING TOWER FAIL TO OPERATE (HE)	5.1E-01	1.2E-02	1.0E+00
7	HPIOO02FWBD-R	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES TO RSP	1.0E-01	5.7E-03	1.1E+00
8	EFWOO01PW2AB-R	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) TO RSP	1.0E-01	3.3E-03	1.0E+00
9	MFWOO02R	MAIN FEED WATER RECOVER HUMAN ERROR	3.8E-03	2.3E-03	1.6E+00
10	HPIOO02FWBD-DP2	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	5.4E-02	2.3E-03	1.0E+00

Table 19.1-64 Human Error RAW for Fire

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	HPIOO02FWBD-S	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	2.6E-03	1.1E-01	4.3E+01
2	EPSOO02RDG	(HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR	2.1E-02	3.9E-01	1.9E+01
3	HPIOO02FWBD	HUMAN ERROR (TYPE C-P) OPERATOR FAIL TO OPEN RELIEF VALVES	3.8E-03	4.7E-02	1.3E+01
4	EFWOO01PW2AB	SUPPLY WATER FROM ALTERNATIVE EFW PIT TO RECOVER LACK OF WATER VOLUME FOR CONTINUOUS SG FEED WATER	2.0E-02	6.1E-02	4.0E+00
5	EFWOO04LAAA	WATER LEVEL A CALIBRATION MISS	2.2E-04	3.9E-04	2.8E+00
6	EPSCF4DLADDG-ALL	WATER LEVEL B CALIBRATION MISS	2.2E-04	1.8E-04	1.8E+00
7	ACWOO02FS	ALTERNATIVE CCW BY FIRE SERVICE WATER FAIL TO OPERATE (HE)	2.0E-02	1.3E-02	1.6E+00
8	MFWOO02R	MAIN FEED WATER RECOVER HUMAN ERROR	3.8E-03	2.3E-03	1.6E+00
9	EFWOO01EFW04-SB	PUMP OUTLET TIE LINE FAIL TO OPEN HUMAN ERROR (SB)	3.8E-03	1.6E-03	1.4E+00
10	EFWOO01EFW04	PUMP OUTLET TIE LINE FAIL TO OPEN HUMAN ERROR	2.6E-03	1.0E-03	1.4E+00

Table 19.1-65 Hardware Single Failure FV Importance for Fire

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RCP----SEAL	SEAL LOCA	1.0E+00	7.4E-01	1.0E+00
2	SWSTMPESWPB	SWP-B OUTAGE	1.2E-02	2.5E-02	3.1E+00
3	DR-FA2-205-M-10	FIRE RESISTANT DOOR FALIURE(DR-FA2-205-M-10)	7.4E-03	2.1E-02	3.8E+00
4	DR-FA2-202-M-07	FIRE RESISTANT DOOR FALIURE(DR-FA2-202-M-07)	7.4E-03	1.7E-02	3.3E+00
5	VCWCHBDDB	CHILLER FAIL TO START (RUNNING)	1.0E-02	1.5E-02	2.5E+00
6	EFWPTADFWP1A	T/P FWP1A FAIL TO START	6.5E-03	1.5E-02	3.2E+00
7	EPSDLLRDGP1-L2	AAC P1 FAIL TO RUN (>1H)	1.8E-02	1.5E-02	1.8E+00
8	EPSDLLRDGP2-L2	AAC P2 FAIL TO RUN (>1H)	1.8E-02	1.4E-02	1.8E+00
9	DR-FA6-101-M-02	FIRE RESISTANT DOOR FALIURE(DR-FA6-101-M-02)	7.4E-03	1.4E-02	2.8E+00
10	PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN	8.7E-04	1.1E-02	1.3E+01

Table 19.1-66 Hardware Single Failure RAW for Fire

Rank	BASIC EVENT ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EFWXVELPW2A	X/V PW2A EXTERNAL LEAK L	7.2E-08	6.4E-05	8.9E+02
2	EFWXVELPW2B	X/V PW2B EXTERNAL LEAK L	7.2E-08	6.4E-05	8.9E+02
3	EFWCVODEFW03B	EFW PIT-B DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	4.9E-04	5.2E+01
4	EFWCVPREFW03B	EFW PIT-B DISCHARGE LINE C/V PLUG	2.4E-06	1.2E-04	5.0E+01
5	EFWXVPRPW1B	EFW PIT-B DISCHARGE LINE MANUAL VALVE PLUG	2.4E-06	1.2E-04	5.0E+01
6	EFWCVODEFW03A	EFW PIT-A DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	4.5E-04	4.8E+01
7	EFWXVPRPW1A	EFW PIT-A DISCHARGE LINE MANUAL VALVE PLUG	2.4E-06	1.1E-04	4.7E+01
8	EFWCVPREFW03A	EFW PIT-A DISCHARGE LINE C/V PLUG	2.4E-06	1.1E-04	4.7E+01
9	EFWXVELPW1B	EFW PIT-B DISCHARGE LINE X/V VLV-007B(PW1B) LARGE LEAK	7.2E-08	2.7E-06	3.8E+01
10	EFWXVELTW3B	X/V TW3B EXTEANAL LEAK L	7.2E-08	2.7E-06	3.8E+01

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 1 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	50.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	2.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	2.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 2 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.2E-06	1.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8807C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8811C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8805C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 3 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8820C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
9	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPITMPISIPC	4.0E-03	C-SAFETY INJECTION PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 4 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	7.0E-07	0.7	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 5 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	45.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	2.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	2.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 6 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.7E-06	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSCF4MVOD9011-ALL	8.4E-05	RSS M/V 9011 FAIL TO OPEN CCF
5	1.7E-06	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
6	1.2E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 7 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8820C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8807C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8811C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
9	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8805C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 8 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 9 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	50.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	2.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	2.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 10 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.2E-06	1.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8807C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8811C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8805C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 11 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8820C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
9	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPITMPISIPC	4.0E-03	C-SAFETY INJECTION PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 12 of 116)

Flood Source : FA2-102-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	7.0E-07	0.7	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 13 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	45.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	2.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	2.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 14 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.7E-06	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSCF4MVOD9011-ALL	8.4E-05	RSS M/V 9011 FAIL TO OPEN CCF
5	1.7E-06	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
6	1.2E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 15 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8820C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8807C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8807C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
9	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8805C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 16 of 116)

Flood Source : FA2-108-01 Arrival to the duct : Y

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 17 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	75.2	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	3.7	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	3.3	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 18 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.8E-06	2.6	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWXVODPW3XV	7.0E-04	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE MANUAL VALVE XLV-004(PW3XV) FAIL TO OPEN
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
5	9.1E-07	1.3	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	1.2E-02	ESW PUMP-B OUTAGE
6	9.1E-07	1.3	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	1.2E-02	ESW PUMP-B OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 19 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	7.6E-07	1.1	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDB	1.0E-02	CHILLER FAIL TO START (RUNNING)
8	7.6E-07	1.1	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDB	1.0E-02	CHILLER FAIL TO START (RUNNING)
9	3.0E-07	0.4	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAA	4.0E-03	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 20 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	3.0E-07	0.4	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAA	4.0E-03	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 21 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	80.5	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	3.9	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	3.5	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 22 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.8E-06	2.8	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			EFWXVODPW3XV	7.0E-04	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE MANUAL VALVE XLV-004(PW3XV) FAIL TO OPEN
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
5	3.0E-07	0.5	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAB	4.0E-03	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
6	3.0E-07	0.5	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAB	4.0E-03	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 23 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	2.6E-07	0.4	!11SLBI_IF	1.0E+00	STEAM LINE BREAK/LEAK (CV SIDE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRCVCD536A	1.0E-04	MAIN STEAM ISORATION CHECK VALVE VLV-516A(536A) FAIL TO CLOSE
8	2.2E-07	0.3	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAB	2.9E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)
9	2.2E-07	0.3	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAB	2.9E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 24 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	2.0E-07	0.3	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFALRDGFAB	2.6E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 25 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	9.1E-07	11.6	!13TRANS_IF EFWOO01PW2AB HPIOO02FWBD SWSTMPESWPB	1.0E+00 2.0E-02 3.8E-03 1.2E-02	GENERAL TRANSIENT OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) OPERATOR FAILS BLEED AND FEED OPERATION (HE) ESW PUMP-B OUTAGE
2	9.1E-07	11.6	!14LOFF_IF EFWOO01PW2AB HPIOO02FWBD SWSTMPESWPB	1.0E+00 2.0E-02 3.8E-03 1.2E-02	LOSS OF FEED WATER FLOW OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) OPERATOR FAILS BLEED AND FEED OPERATION (HE) ESW PUMP-B OUTAGE
3	7.6E-07	9.6	!14LOFF_IF EFWOO01PW2AB HPIOO02FWBD VCWCHBDB	1.0E+00 2.0E-02 3.8E-03 1.0E-02	LOSS OF FEED WATER FLOW OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) OPERATOR FAILS BLEED AND FEED OPERATION (HE) CHILLER FAIL TO START (RUNNING)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 26 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	7.6E-07	9.6	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDB	1.0E-02	CHILLER FAIL TO START (RUNNING)
5	3.0E-07	3.9	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAA	4.0E-03	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
6	3.0E-07	3.9	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAA	4.0E-03	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 27 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	2.2E-07	2.8	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAA	2.9E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)
8	2.2E-07	2.8	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAA	2.9E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)
9	2.0E-07	2.5	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFALRDGFAA	2.6E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 28 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	2.0E-07	2.5	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFALRDGFAA	2.6E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 29 of 116)

Flood Source : FA2-501-03 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 30 of 116)

Flood Source : FA2-501-03 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 31 of 116)

Flood Source : FA2-501-03 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 32 of 116)

Flood Source : FA2-501-03 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 33 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 34 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 35 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 36 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 37 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.0E-07	8.8	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAB	4.0E-03	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
2	3.0E-07	8.8	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAB	4.0E-03	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
3	2.2E-07	6.3	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAB	2.9E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 38 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.2E-07	6.3	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAB	2.9E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)
5	2.0E-07	5.8	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFALRDGFAB	2.6E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)
6	2.0E-07	5.8	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFALRDGFAB	2.6E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 39 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.6E-07	4.5	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHYRC	2.1E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)
8	1.6E-07	4.5	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHYRC	2.1E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)
9	1.4E-07	4.2	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFASRDGFAB	1.9E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 40 of 116)

Flood Source : FA2-415-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	1.4E-07	4.2	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFASRDGFAB	1.9E-03	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 41 of 116)

Flood Source : FA2-102-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	48.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	2.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	2.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 42 of 116)

Flood Source : FA2-102-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.2E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8807C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8807C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8805C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 43 of 116)

Flood Source : FA2-102-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8820C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
9	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPITMPISIPC	4.0E-03	C-SAFETY INJECTION PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 44 of 116)

Flood Source : FA2-102-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.1E-07	0.9	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	1.2E-02	ESW PUMP-B OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 45 of 116)

Flood Source : FA2-108-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	5.1E-05	45.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.5E-06	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			PZRCF2MVOD58R-ALL	1.3E-04	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF
3	2.2E-06	2.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPICF4PMADSIP-ALL	1.1E-04	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 46 of 116)

Flood Source : FA2-108-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.7E-06	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSCF4MVOD9011-ALL	8.4E-05	RSS M/V 9011 FAIL TO OPEN CCF
5	1.7E-06	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
6	1.2E-06	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 47 of 116)

Flood Source : FA2-108-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8820C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8805C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
9	1.1E-06	1.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPILSFF8807C	4.8E-03	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8811C) LIMIT SWITCH FAIL
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 48 of 116)

Flood Source : FA2-108-01 Arrival to the duct : N

Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.6E-07	0.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPITMPISIPC	4.0E-03	C-SAFETY INJECTION PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 49 of 116)

Flood Source : FA2-112-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 50 of 116)

Flood Source : FA2-112-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 51 of 116)

Flood Source : FA2-112-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 52 of 116)

Flood Source : FA2-112-01 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 53 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N
Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 54 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N
Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 55 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N
Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 56 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N
Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 57 of 116)

Flood Source : FA2-206-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 58 of 116)

Flood Source : FA2-206-02 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 59 of 116)

Flood Source : FA2-206-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 60 of 116)

Flood Source : FA2-206-02 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 61 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 62 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 63 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N
Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 64 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N
Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 65 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 66 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 67 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 68 of 116)

Flood Source : FA2-501-11 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 69 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N
Categories of loss-of-fluid events : Major Flood

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 70 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N
Categories of loss-of-fluid events : Major Flood

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 71 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N
Categories of loss-of-fluid events : Major Flood

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 72 of 116)

Flood Source : FA2-407-04 Arrival to the duct : N
Categories of loss-of-fluid events : Major Flood

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 73 of 116)

Flood Source : FA2-201-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 74 of 116)

Flood Source : FA2-201-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 75 of 116)

Flood Source : FA2-201-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 76 of 116)

Flood Source : FA2-201-02 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 77 of 116)

Flood Source : FA2-407-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 78 of 116)

Flood Source : FA2-407-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 79 of 116)

Flood Source : FA2-407-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 80 of 116)

Flood Source : FA2-407-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 81 of 116)

Flood Source : FA2-111-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 82 of 116)

Flood Source : FA2-111-01 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 83 of 116)

Flood Source : FA2-111-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 84 of 116)

Flood Source : FA2-111-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 85 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 86 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 87 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 88 of 116)

Flood Source : FA2-501-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 89 of 116)

Flood Source : FA2-206-01 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 90 of 116)

Flood Source : FA2-206-01 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 91 of 116)

Flood Source : FA2-206-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 92 of 116)

Flood Source : FA2-206-01 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 93 of 116)

Flood Source : FA2-201-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 94 of 116)

Flood Source : FA2-201-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 95 of 116)

Flood Source : FA2-201-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 96 of 116)

Flood Source : FA2-201-01 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 97 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones
Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	9.1E-07	22.7	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	1.2E-02	ESW PUMP-B OUTAGE
2	7.6E-07	18.9	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDB	1.0E-02	CHILLER FAIL TO START (RUNNING)
3	3.0E-07	7.6	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMPAA	4.0E-03	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 98 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.2E-07	5.4	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFAADDGFAA	2.9E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)
5	2.0E-07	5.0	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFALRDGFAA	2.6E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)
6	1.6E-07	3.9	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHYRB	2.1E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 99 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.5E-07	3.8	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWPMBDB	2.0E-03	B-SAFETY CHILLER PUMP FAIL TO START (Running)
8	1.4E-07	3.6	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			HVAFASRDGFAA	1.9E-03	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)
9	1.4E-07	3.5	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSPMBDSWPB	1.9E-03	B-ESSENTIAL SERVICE WATER PUMP FAIL TO START (RUNNING)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 100 of 116)

Flood Source : FA2-414-01 Arrival to the duct : This zone is a pressure tight compartment and the flood is not propagated to the other zones

Categories of loss-of-fluid events : Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.7E-08	2.4	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPMADFWP2A	1.3E-03	B-EMERGENCY FEED WATER PUMP FAIL TO START (STANDBY)
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 101 of 116)

Flood Source : FA2-501-08 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 102 of 116)

Flood Source : FA2-501-08 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 103 of 116)

Flood Source : FA2-501-08 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 104 of 116)

Flood Source : FA2-501-08 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 105 of 116)

Flood Source : FA6-101-01 Arrival to the duct : -
Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	9.0E-09	3.7	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWCF2CVODEFW03-ALL	2.4E-06	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
2	9.0E-09	3.7	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWCF2CVODEFW03-ALL	2.4E-06	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
3	6.3E-09	2.6	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWCF4CVODXW1-ALL	1.7E-06	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 106 of 116)

Flood Source : FA6-101-01 Arrival to the duct : -
Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	6.3E-09	2.6	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWCF4CVODAW1-ALL	1.7E-06	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
5	6.3E-09	2.6	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWCF4CVODXW1-ALL	1.7E-06	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
6	6.3E-09	2.6	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWCF4CVODAW1-ALL	1.7E-06	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 107 of 116)

Flood Source : FA6-101-01 Arrival to the duct : -
Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	5.9E-09	2.4	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	1.2E-02	ESW PUMP-B OUTAGE
8	5.9E-09	2.4	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			SWSTMPESWPB	1.2E-02	ESW PUMP-B OUTAGE
9	5.0E-09	2.0	!14LOFF_IF	1.0E+00	LOSS OF FEED WATER FLOW
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDDB	1.0E-02	CHILLER FAIL TO START (RUNNING)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 108 of 116)

Flood Source : FA6-101-01 Arrival to the duct : -
Categories of loss-of-fluid events : Spray

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	5.0E-09	2.0	!13TRANS_IF	1.0E+00	GENERAL TRANSIENT
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD	3.8E-03	OPERATOR FAILS BLEED AND FEED OPERATION (HE)
			VCWCHBDB	1.0E-02	CHILLER FAIL TO START (RUNNING)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 109 of 116)

Flood Source : FA2-109-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	3.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.2	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 110 of 116)

Flood Source : FA2-109-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	2.1E-07	2.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF
5	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.5E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSCF4MVOD114-ALL	8.4E-05	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 111 of 116)

Flood Source : FA2-109-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	1.2E-07	1.5	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
9	1.1E-07	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 112 of 116)

Flood Source : FA2-109-01 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	9.2E-08	1.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 113 of 116)

Flood Source : FA2-501-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
1	3.3E-07	5.0	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTADFWP1A	6.6E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWTMTAA	5.0E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 114 of 116)

Flood Source : FA2-501-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
4	1.5E-07	2.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
5	1.2E-07	1.9	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
6	1.2E-07	1.8	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			EFWPTSRFWP1A	2.4E-03	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)
			HPIOO02FWBD-S	2.6E-03	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 115 of 116)

Flood Source : FA2-501-02 Arrival to the duct : N
Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
7	1.1E-07	1.6	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE
8	9.2E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01PW2AB	2.0E-02	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)
			OPSLOOP	5.3E-03	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			PZRMVOD58RB	8.7E-04	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
9	9.0E-08	1.4	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIOO01CHIB	2.6E-03	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)
			CWSTMRCCWHXD	7.0E-03	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMRPRHEXC	5.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-67 Internal Flood PRA Dominant Cutsets (Sheet 116 of 116)

Flood Source : FA2-501-02 Arrival to the duct : N

Categories of loss-of-fluid events : Major Floods

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Description
10	8.6E-08	1.3	!16PLOCW_IF	1.0E+00	PARTIAL LOSS OF COMPONENT COOLING WATER
			CHIPMBDCHPB-R	1.8E-03	B-CHARGING PUMP FAIL TO START
			RCP----SEAL	1.0E+00	RCP SEAL LOCA
			RSSTMPICSPC	4.0E-03	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE
			SWSTMPESWPD	1.2E-02	ESW PUMP-D OUTAGE

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-68 Basic Events (Hardware Failure, Human Error) FV Importance for Flood (Sheet 1 of 5)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	8.2E-01	4.1E+01
2	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	4.6E-01	1.8E+02
3	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.3E-01	3.6E+01
4	RCP----SEAL	RCP SEAL LOCA	1.0E+00	1.1E-01	1.0E+00
5	SWSTMPESWPD	ESW PUMP-D OUTAGE	1.2E-02	8.3E-02	7.8E+00
6	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	6.7E-02	2.7E+01
7	CWSTMRCCWHXD	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE	7.0E-03	4.8E-02	7.8E+00
8	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	4.8E-02	1.0E+01
9	CHIPMBDCHPB-R	B-CHARGING PUMP FAIL TO START	1.8E-03	4.2E-02	2.4E+01
10	CWSTMPCCWPD	D-CCW PUMP OUTAGE	6.0E-03	4.1E-02	7.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-68 Basic Events (Hardware Failure, Human Error) FV Importance for Flood (Sheet 2 of 5)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
11	RSSTMRPRHEXC	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE	5.0E-03	3.8E-02	8.5E+00
12	HPILSFF8807C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8807C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
13	HPILSFF8805C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
14	HPILSFF8820C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
15	RSSTMPICSPC	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE	4.0E-03	3.0E-02	8.5E+00
16	SWSTMPESWPB	ESW PUMP-B OUTAGE	1.2E-02	2.9E-02	3.3E+00
17	HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF	1.1E-04	2.8E-02	2.5E+02
18	PZRCF2MVOD58R-ALL	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF	1.3E-04	2.7E-02	2.1E+02
19	HPITMPISIPC	C-SAFETY INJECTION PUMP OUTAGE	4.0E-03	2.6E-02	7.6E+00
20	VCWCHBDB	CHILLER FAIL TO START (RUNNING)	1.0E-02	2.4E-02	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-68 Basic Events (Hardware Failure, Human Error) FV Importance for Flood (Sheet 3 of 5)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
21	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START	6.5E-03	1.8E-02	3.7E+00
22	HPILSFF8820D	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001D(8820D) LIMIT SWITCH FAIL	4.8E-03	1.7E-02	4.5E+00
23	HPILSFF8807D	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011D(8807D) LIMIT SWITCH FAIL	4.8E-03	1.7E-02	4.5E+00
24	HPILSFF8805D	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009D(8805D) LIMIT SWITCH FAIL	4.8E-03	1.7E-02	4.5E+00
25	EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE	5.0E-03	1.3E-02	3.6E+00
26	SWSPMBDSWPD	D-ESSENTIAL SERVICE WATER PUMP FAIL TO START (RUNNING)	1.9E-03	1.3E-02	7.7E+00
27	RSSPMADCSPC	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP FAIL TO START (STANDBY)	1.4E-03	1.2E-02	9.3E+00
28	HPITMPISIPD	D-SAFETY INJECTION PUMP OUTAGE	4.0E-03	1.2E-02	3.9E+00
29	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START	6.5E-03	1.1E-02	2.7E+00
30	EFWTMPAB	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE	4.0E-03	1.1E-02	3.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-68 Basic Events (Hardware Failure, Human Error) FV Importance for Flood (Sheet 4 of 5)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
31	HVAFAADDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)	2.9E-03	9.4E-03	4.2E+00
32	HPIPMADSIPC	C-SAFETY INJECTION PUMP FAIL TO START (STANDBY)	1.3E-03	9.3E-03	8.1E+00
33	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	9.1E-03	1.1E+02
34	EFWTMPAA	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE	4.0E-03	9.1E-03	3.3E+00
35	HVAFALRDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)	2.6E-03	8.6E-03	4.2E+00
36	EPSDLLRDGC	EMERGENCY GAS TURBINE GENERATOR (GTG C) FAIL TO RUN (>1H)	1.7E-02	7.7E-03	1.5E+00
37	RSSMVOD114C	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145C(114C) FAIL TO OPEN	9.0E-04	7.5E-03	9.3E+00
38	CWSPCBDCWPD	D-COMPONENT COOLING WATER PUMP FAIL TO START (RUNNING)	1.0E-03	6.9E-03	7.7E+00
39	HVAFAADDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)	2.9E-03	6.8E-03	3.3E+00
40	VCWCHYRC	C-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)	2.1E-03	6.7E-03	4.2E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-68 Basic Events (Hardware Failure, Human Error) FV Importance for Flood (Sheet 5 of 5)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
41	EFWTMTAB	D-EMERGENCY FEED WATER PUMP(FWP1B) OUTAGE	5.0E-03	6.7E-03	2.3E+00
42	EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)	2.4E-03	6.5E-03	3.7E+00
43	EFWOO04LAAA	EFW PIT WATER LEVEL GAGE A CALIBRATION MISS (HE)	2.2E-04	6.5E-03	3.0E+01
44	EFWXVODPW3XV	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE MANUAL VALVE XLV-004(PW3XV) FAIL TO OPEN	7.0E-04	6.4E-03	1.0E+01
45	RSSCF4MVOD9011-ALL	CONTAINMENT SPRAY HEADER CONTAINMENT ISOLATION VALVES MOV-004A,B,C,D(9011A,B,C,D) FAIL TO OPEN CCF	8.4E-05	6.3E-03	7.6E+01
46	HVAFASRDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)	1.9E-03	6.2E-03	4.2E+00
47	HVAFALRDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)	2.6E-03	6.2E-03	3.3E+00
48	EPSTMDGC	EMERGENCY GAS TURBINE GENERATOR (GTG C) OUTAGE	1.2E-02	5.5E-03	1.5E+00
49	RSSTMRPRHEXD	RHEXD OUTAGE	5.0E-03	5.0E-03	2.0E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 1 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4CBWR4I-ALL	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	5.4E-04	3.4E+03
2	SWSCF4PMYR-FF	ESW PUMP A,B,C,D FAIL TO RUN CCF	1.2E-08	2.7E-05	2.2E+03
3	EPSCF4CBWR4I-124	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	2.9E-08	4.9E-05	1.7E+03
4	EPSCF4CBWR4I-134	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	2.9E-08	3.2E-05	1.1E+03
5	EPSCF4BYFF-ALL	EPS BATTERY A,B,C,D FAIL TO OPERATE CCF	5.0E-08	4.1E-05	8.2E+02
6	EPSCF4BYFF-234	EPS BATTERY A,C,D FAIL TO OPERATE CCF	1.2E-08	9.0E-06	7.3E+02
7	EPSCF4BYFF-124	EPS BATTERY A,B,D FAIL TO OPERATE CCF	1.2E-08	9.0E-06	7.3E+02
8	EFWCF2CVODEFW03-ALL	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN	2.4E-06	1.5E-03	6.4E+02
9	EFWCF4CVODXW1-ALL	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF	1.7E-06	1.0E-03	6.3E+02
10	EFWCF4CVODAW1-ALL	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	1.7E-06	1.0E-03	6.3E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 2 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
11	EPSCF4CBWR4I-14	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	3.4E-08	2.0E-05	6.0E+02
12	EFWXVELPW2B	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006B(PW2B) LARGE LEAK	7.2E-08	4.0E-05	5.6E+02
13	EFWXVELPW2A	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006A(PW2A) LARGE LEAK	7.2E-08	4.0E-05	5.6E+02
14	EFWCF4CVODAW1-134	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	3.5E-05	5.6E+02
15	EFWCF4CVODAW1-234	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	3.5E-05	5.6E+02
16	EFWCF4CVODAW1-124	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	3.5E-05	5.6E+02
17	EFWCF4CVODAW1-123	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	6.2E-08	3.5E-05	5.6E+02
18	EPSBSFFDCD	DC-D SWITCH BOARD FAILURE	5.8E-06	2.1E-03	3.7E+02
19	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	3.3E-03	3.4E+02
20	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL LEAK	7.2E-08	2.1E-05	2.9E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 3 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
21	RWSTNELRWSP	REFUELING WATER STORAGE PIT LARGE EXTERNAL LEAK	4.8E-08	1.4E-05	2.9E+02
22	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	7.0E-06	2.9E+02
23	HPIMVEL8820D	CONTAINMENT ISOLATION M/V MOV-001D(8820D) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02
24	HPIMVEL8820A	CONTAINMENT ISOLATION M/V MOV-001A(8820A) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02
25	HPIMVEL8820C	CONTAINMENT ISOLATION M/V MOV-001C(8820C) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02
26	HPIMVEL8820B	CONTAINMENT ISOLATION M/V MOV-001B(8820B) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02
27	EPSBSFFDCC	DC-C SWITCH BOARD FAILURE	5.8E-06	1.7E-03	2.8E+02
28	CWSCF4RHPR-FF	ALL COMPONENT COOLING HEAT EXCHANGERS PLUG/FOUL OR LARGE EXTERNAL LEAK CCF	3.6E-08	9.1E-06	2.5E+02
29	CWSCF4PCYR-FF	CCW PUMP ALL FAIL TO RUN CCF	6.7E-09	1.7E-06	2.5E+02
30	RWSCF4SUPRST01-134	RWSP SUMP STRAINER PLUG CCF	3.7E-06	9.2E-04	2.5E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 4 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
31	HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF	1.1E-04	2.8E-02	2.5E+02
32	HPICF4PMSRSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO RUN (Standby) (<1h) CCF	8.5E-06	2.1E-03	2.5E+02
33	HPICF4PMLRSIP-ALL	M/P FAIL TO RUN (Standby) (>1h) CCF	2.9E-06	7.3E-04	2.5E+02
34	HPICF4CVOD8809-ALL	C/V 8809 FAIL TO OPEN CCF	1.0E-06	2.5E-04	2.5E+02
35	HPICF4CVOD8804-ALL	C/V 8804 FAIL TO OPEN CCF	1.0E-06	2.5E-04	2.5E+02
36	HPICF4CVOD8808-ALL	C/V 8808 FAIL TO OPEN CCF	1.0E-06	2.5E-04	2.5E+02
37	HPICF4CVOD8806-ALL	C/V 8806 FAIL TO OPEN CCF	1.0E-06	2.5E-04	2.5E+02
38	RWSCF4SUPRST01-234	RWSP SUMP STRAINER PLUG CCF	3.7E-06	8.8E-04	2.4E+02
39	RWSCF4SUPRST01-34	SUMP STRAINER PLUG CCF	3.0E-06	7.1E-04	2.4E+02
40	RSSPNEL01B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	6.5E-06	2.3E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 5 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
41	RSSPNEL01D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.9E-08	6.5E-06	2.3E+02
42	RSSPNEL01A	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	6.4E-06	2.3E+02
43	RSSPNEL01C	CS/RHR PIPING LARGE EXTERNAL LEAK	2.8E-08	6.4E-06	2.3E+02
44	HPIPNELSUCTSB	SAFETY INJECTION SYSTEM B TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	6.2E-06	2.2E+02
45	HPIPNELSUCTSD	SAFETY INJECTION SYSTEM D TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	6.2E-06	2.2E+02
46	HPIPNELSUCTSC	SAFETY INJECTION SYSTEM C TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	6.2E-06	2.2E+02
47	HPIPNELSUCTSA	SAFETY INJECTION SYSTEM A TRAIN PIPE INSIDE CV LARGE EXTERNAL LEAK	2.8E-08	6.2E-06	2.2E+02
48	RTPBTSWCCF	SUPPORT SOFTWARE CCF	1.0E-07	2.2E-05	2.2E+02
49	PZRCF2MVOD58R-ALL	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF	1.3E-04	2.7E-02	2.1E+02
50	RSSMVEL9007B	RWSP DISCHARGE LINE ISOLATION VALVE (9007B) LARGE EXTERNAL LEAK	2.4E-08	4.9E-06	2.1E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 6 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
51	RSSMVEL9007A	RWSP DISCHARGE LINE ISOLATION VALVE (9007A) LARGE EXTERNAL LEAK	2.4E-08	4.9E-06	2.1E+02
52	RSSMVEL9007D	RWSP DISCHARGE LINE ISOLATION VALVE (9007D) LARGE EXTERNAL LEAK	2.4E-08	4.9E-06	2.1E+02
53	RSSMVEL9007C	RWSP DISCHARGE LINE ISOLATION VALVE (9007C) LARGE EXTERNAL LEAK	2.4E-08	4.9E-06	2.1E+02
54	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	4.6E-01	1.8E+02
55	EPSCF4CBWR4J-ALL	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	2.8E-05	1.8E+02
56	EPSCF4BYFF-24	EPS BATTERY A,D FAIL TO OPERATE CCF	1.9E-08	3.0E-06	1.6E+02
57	EPSCF4CBWR4J-34	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	5.3E-06	1.6E+02
58	EPSCF4CBWR4J-134	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.6E-06	1.6E+02
59	EPSCF4CBWR4J-234	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.6E-06	1.6E+02
60	HPICF4PMADSIP-134	SAFETY INJECTION PUMP A,C,D FAIL TO START (Standby) CCF	9.5E-06	1.5E-03	1.5E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 7 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
61	HPICF4PMSRSIP-134	M/P FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	5.0E-04	1.5E+02
62	HPICF4PMLRSIP-234	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	1.7E-04	1.5E+02
63	HPICF4CVOD8808-134	C/V 8808 FAIL TO OPEN CCF	2.7E-07	4.1E-05	1.5E+02
64	HPICF4CVOD8804-134	C/V 8804 FAIL TO OPEN CCF	2.7E-07	4.1E-05	1.5E+02
65	HPICF4CVOD8806-134	C/V 8806 FAIL TO OPEN CCF	2.7E-07	4.1E-05	1.5E+02
66	HPICF4CVOD8809-134	C/V 8809 FAIL TO OPEN CCF	2.7E-07	4.1E-05	1.5E+02
67	SGNBTSWCCF	S,P SIGNAL SOFTWARE CCF	1.0E-05	1.5E-03	1.5E+02
68	EPSBYFFD	BATTERY-D FAIL TO OPERATE	3.8E-06	5.5E-04	1.5E+02
69	HPICF4PMADSIP-34	SAFETY INJECTION PUMP C,D FAIL TO START (Standby) CCF	2.2E-05	3.1E-03	1.4E+02
70	HPICF4PMADSIP-234	SAFETY INJECTION PUMP B,C,D FAIL TO START (Standby) CCF	9.5E-06	1.4E-03	1.4E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 8 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
71	HPICF4PMSRSIP-34	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	5.2E-04	1.4E+02
72	HPICF4PMSRSIP-234	M/P FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	4.7E-04	1.4E+02
73	HPICF4PMLRSIP-34	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	1.8E-04	1.4E+02
74	HPICF4PMLRSIP-134	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	1.6E-04	1.4E+02
75	HPICF4CVOD8804-234	C/V 8804 FAIL TO OPEN CCF	2.7E-07	3.9E-05	1.4E+02
76	HPICF4CVOD8809-234	C/V 8809 FAIL TO OPEN CCF	2.7E-07	3.9E-05	1.4E+02
77	HPICF4CVOD8806-234	C/V 8806 FAIL TO OPEN CCF	2.7E-07	3.9E-05	1.4E+02
78	HPICF4CVOD8808-234	C/V 8808 FAIL TO OPEN CCF	2.7E-07	3.9E-05	1.4E+02
79	HPICF4CVOD8809-34	C/V 8809 FAIL TO OPEN CCF	1.6E-07	2.3E-05	1.4E+02
80	HPICF4CVOD8806-34	C/V 8806 FAIL TO OPEN CCF	1.6E-07	2.3E-05	1.4E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 9 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
81	HPICF4CVOD8808-34	C/V 8808 FAIL TO OPEN CCF	1.6E-07	2.3E-05	1.4E+02
82	HPICF4CVOD8804-34	C/V 8804 FAIL TO OPEN CCF	1.6E-07	2.3E-05	1.4E+02
83	EPSCF4BYFF-12	EPS BATTERY Fail to Operate CCF	1.9E-08	2.7E-06	1.4E+02
84	EPSCF4BYFF-23	EPS BATTERY Fail to Operate CCF	1.9E-08	2.7E-06	1.4E+02
85	EFWCF4CVODXW1-234	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	7.3E-06	1.2E+02
86	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	9.1E-03	1.1E+02
87	RSSCF4PMADCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO START CCF	1.9E-05	2.0E-03	1.1E+02
88	RSSCF4PMSRCSP-ALL	CS/RHR PUMP A,B,C,D FAIL TO RUN (<1H) CCF	5.0E-06	5.4E-04	1.1E+02
89	RSSCF4PMLRCSP-ALL	RSS PUMP FAIL TO RUN (>1H) CCF	1.7E-06	1.9E-04	1.1E+02
90	CCWBTSWCCF	CCW SOFTWARE CCF	1.0E-05	1.1E-03	1.1E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 10 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
91	EPSCF4CBWR4I-24	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	3.4E-08	3.6E-06	1.1E+02
92	RSSCF4RHPRRHEX-ALL	CS/RHR HEAT EXCHANGER PLUG CCF	4.8E-06	5.1E-04	1.1E+02
93	RSSCF4CVOD9008-ALL	CS/RHR PUMP SUCTION LINE C/V VLV004A,B,C,D(9008A,B,C,D) FAIL TO OPEN CCF	4.3E-07	4.5E-05	1.1E+02
94	EPSCF4CBWR4I-234	EPS C/B 4IA,B,C,D Fail TO REMAIN CLOSED CCF	2.9E-08	3.1E-06	1.0E+02
95	EFWCF4CVODAW1-34	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	2.3E-05	1.0E+02
96	RSSCF4PMADCSP-34	RSS PUMP FAIL TO START CCF	1.3E-05	1.3E-03	1.0E+02
97	RSSCF4PMSRCSP-34	RSS PUMP FAIL TO RUN (<1H) CCF	3.3E-06	3.4E-04	1.0E+02
98	RSSCF4PMLRCSP-34	RSS PUMP FAIL TO RUN (>1H) CCF	1.2E-06	1.2E-04	1.0E+02
99	RSSCF4PMADCSP-134	RSS PUMP FAIL TO START CCF	6.3E-06	6.4E-04	1.0E+02
100	RSSCF4PMSRCSP-134	RSS PUMP FAIL TO RUN (<1H) CCF	1.7E-06	1.7E-04	1.0E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 11 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
101	RSSCF4PMLRCSP-134	RSS PUMP FAIL TO RUN (>1H) CCF	5.8E-07	5.9E-05	1.0E+02
102	RSSCF4PMADCSP-234	RSS PUMP FAIL TO START CCF	6.3E-06	6.4E-04	1.0E+02
103	RSSCF4PMSRCSP-234	RSS PUMP FAIL TO RUN (<1H) CCF	1.7E-06	1.7E-04	1.0E+02
104	RSSCF4PMLRCSP-234	RSS PUMP FAIL TO RUN (>1H) CCF	5.8E-07	5.9E-05	1.0E+02
105	RSSCF4MVOD114-34	RSS M/V 114 FAIL TO OPEN CCF	5.7E-06	5.7E-04	1.0E+02
106	RSSCF4MVOD114-234	RSS M/V 114 FAIL TO OPEN CCF	1.5E-06	1.4E-04	9.9E+01
107	RSSCF4MVOD114-134	RSS M/V 114 FAIL TO OPEN CCF	1.5E-06	1.4E-04	9.9E+01
108	EFWCF4CVODXW1-134	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	6.0E-06	9.7E+01
109	EFWCF4CVODAW1-13	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	2.1E-05	9.2E+01
110	RSSCF4CVOD9008-123	RSS C/V 9008 FAIL TO OPEN CCF	2.2E-07	1.9E-05	8.7E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 12 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
111	RSSCF4CVOD9008-234	RSS C/V 9008 FAIL TO OPEN CCF	2.2E-07	1.9E-05	8.7E+01
112	RSSCF4CVOD9008-23	RSS C/V 9008 FAIL TO OPEN CCF	2.0E-07	1.7E-05	8.7E+01
113	RSSCF4RHPRRHEX-34	RSS HX PLUG CCF	1.7E-07	1.5E-05	8.7E+01
114	RSSCF4RHPRRHEX-134	RSS HX PLUG CCF	6.4E-08	5.5E-06	8.7E+01
115	RSSCF4RHPRRHEX-234	RSS HX PLUG CCF	6.4E-08	5.5E-06	8.7E+01
116	EFWCF4CVODXW1-124	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF	6.2E-08	4.9E-06	7.9E+01
117	RSSCF4MVOD9011-ALL	RSS M/V 9011 FAIL TO OPEN CCF	8.4E-05	6.3E-03	7.6E+01
118	RSSCF4CVOD9012-ALL	RSS C/V 9012 FAIL TO OPEN CCF	4.3E-07	3.2E-05	7.6E+01
119	EPSCF4BYFF-123	EPS BATTERY B,C,D FAIL TO OPERATE CCF	1.2E-08	9.2E-07	7.6E+01
120	EFWCF4CVODAW1-14	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	1.6E-05	7.1E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 13 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
121	RSSCF4MVOD9011-34	RSS M/V 9011 FAIL TO OPEN CCF	5.7E-06	3.8E-04	6.8E+01
122	RSSCF4CVOD9012-34	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	1.3E-05	6.8E+01
123	EFWCF4CVODAW1-23	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	1.5E-05	6.6E+01
124	RSSCF4MVOD9011-234	RSS M/V 9011 FAIL TO OPEN CCF	1.5E-06	9.3E-05	6.5E+01
125	RSSCF4MVOD9011-134	RSS M/V 9011 FAIL TO OPEN CCF	1.5E-06	9.3E-05	6.5E+01
126	RSSCF4CVOD9012-234	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	1.4E-05	6.5E+01
127	RSSCF4CVOD9012-134	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	1.4E-05	6.5E+01
128	EFWCVODEFW03B	EFW PIT-B DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	4.5E-04	4.8E+01
129	EFWCVPREFW03B	EFW PIT-B DISCHARGE LINE C/V PLUG	2.4E-06	1.1E-04	4.8E+01
130	EFWCVELEFW03B	C/V EFW03B EXTERNAL LEAK L	4.8E-08	2.3E-06	4.8E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 14 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
131	EFWCF4CVODAW1-24	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	1.0E-05	4.5E+01
132	EFWXVPRPW1B	EFW PIT-B DISCHARGE LINE MANUAL VALVE PLUG	2.4E-06	9.9E-05	4.2E+01
133	EFWXVELPW1B	EFW PIT-B DISCHARGE LINE X/V VLV-007B(PW1B) LARGE LEAK	7.2E-08	3.0E-06	4.2E+01
134	EFWXVELMW3B	EFW PIT-B DISCHARGE LINE X/V VLV-009C(MW3B) LARGE LEAK	7.2E-08	3.0E-06	4.2E+01
135	EFWXVELTW3B	X/V TW3B EXTEANAL LEAK L	7.2E-08	3.0E-06	4.2E+01
136	EFWTNELEFWP1B	B-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	2.0E-06	4.2E+01
137	EFWPNELCSTB	LINE EXTERNAL LEAK FROM B-EMERGENCY FEED WATER PIT TO B-TRAIN 2 PUMP	6.0E-10	2.5E-08	4.2E+01
138	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	8.2E-01	4.1E+01
139	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.3E-01	3.6E+01
140	EFWXVPRPW2B	X/V PW2B PLUG	2.4E-06	7.2E-05	3.1E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 15 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
141	EFWOO04LAAA	EFW PIT WATER LEVEL GAGE A CALIBRATION MISS (HE)	2.2E-04	6.5E-03	3.0E+01
142	EFWCF4CVODXW1-24	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	6.0E-06	2.8E+01
143	EFWXVELEFW01B	X/V EFW01B EXTERNAL LEAK L	7.2E-08	1.9E-06	2.8E+01
144	EFWPNELTESTB	TEST LINE B PIPE LEAK	6.0E-10	1.6E-08	2.8E+01
145	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	6.7E-02	2.7E+01
146	SWSSTPRST02C	STRAINER ST02C PLUG	1.7E-04	4.3E-03	2.7E+01
147	SWSSTPRST05	STRAINER ST05 PLUG	1.7E-04	4.3E-03	2.7E+01
148	SWSPMYRSWPC	SWP-C FAIL TO RUN (RUNNING)	1.1E-04	2.9E-03	2.7E+01
149	SWSORPROR24C	ORIFICE OR24C PLUG	2.4E-05	6.2E-04	2.7E+01
150	SWSORPROR04C	ORIFICE OR04C PLUG	2.4E-05	6.2E-04	2.7E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 16 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
151	SWSFMPR2055C	FM 2055C PLUG	2.4E-05	6.2E-04	2.7E+01
152	SWSORPRESS0003C	ORIFICE ESS0003C PLUG	2.4E-05	6.2E-04	2.7E+01
153	SWSPEELSWPC1	SWS PIPE C1 LEAK	3.9E-06	1.0E-04	2.7E+01
154	SWSXVPR570C	X/V 570C PLUG	2.4E-06	6.2E-05	2.7E+01
155	SWSXVPR561C	X/V 561C PLUG	2.4E-06	6.2E-05	2.7E+01
156	SWSCVPR502C	C/V 502C PLUG	2.4E-06	6.2E-05	2.7E+01
157	SWSXVPR562C	X/V 562C PLUG	2.4E-06	6.2E-05	2.7E+01
158	SWSCVPR602C	C/V 602C PLUG	2.4E-06	6.2E-05	2.7E+01
159	SWSXVPR601C	X/V 601C PLUG	2.4E-06	6.2E-05	2.7E+01
160	SWSXVPR569C	X/V 569C PLUG	2.4E-06	6.2E-05	2.7E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 17 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
161	SWSXVPR507C	X/V 507C PLUG	2.4E-06	6.2E-05	2.7E+01
162	SWSXVPR503C	X/V 503C PLUG	2.4E-06	6.2E-05	2.7E+01
163	SWSXVPR509C	X/V 509C PLUG	2.4E-06	6.2E-05	2.7E+01
164	SWSRIELSWHXC	HEAT EXCHANGER CCWHXC TUBE EXTERNAL LEAK L	7.2E-07	1.8E-05	2.7E+01
165	SWSPEELSWSC2	SWS PIPE C2 LEAK	3.8E-07	9.6E-06	2.7E+01
166	SWSPEELSWSC3	SWS PIPE C3 LEAK	2.1E-07	5.5E-06	2.7E+01
167	SWSPMELSWPC	M/P SWPC EXTERNAL LEAK L	1.9E-07	4.9E-06	2.7E+01
168	SWSXVEL509C	X/V 509C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01
169	SWSXVEL561C	X/V 561C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01
170	SWSXVELESS0001C	X/V ESS0001C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 18 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
171	SWSXVEL507C	X/V 507C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01
172	SWSXVEL601C	X/V 601C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01
173	SWSXVEL503C	X/V 503C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01
174	SWSXVELESS0002C	X/V ESS0002C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01
175	SWSXVEL562C	X/V 562C EXTEANAL LEAK L	7.2E-08	1.8E-06	2.7E+01
176	SWSCVEL602C	C/V 602C EXTERNAL LEAK L	4.8E-08	1.2E-06	2.7E+01
177	SWSCVEL502C	C/V 502C EXTERNAL LEAK L	4.8E-08	1.2E-06	2.7E+01
178	CHIPMBDCHPB-R	B-CHARGING PUMP FAIL TO START	1.8E-03	4.2E-02	2.4E+01
179	CHICF2PMBD-ALL	CHARGING PUMP A,B FAIL TO START CCF	2.0E-04	4.7E-03	2.4E+01
180	EFWMVFCAWCA	M/V AWCA FAIL TO CONTROL	7.2E-05	1.6E-03	2.3E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 19 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
181	EFWMVFCAWDA	M/V AWDA FAIL TO CONTROL	7.2E-05	1.6E-03	2.3E+01
182	EFWORPRFEAW0C	ORIFICE FEAW0C PLUG	2.4E-05	5.3E-04	2.3E+01
183	EFWORPRFEAW0D	ORIFICE FEAW0D PLUG	2.4E-05	5.3E-04	2.3E+01
184	EFWCVODAW1C	C/V AW1C FAIL TO OPEN	9.5E-06	2.1E-04	2.3E+01
185	EFWCVODAW1D	C/V AW1D FAIL TO OPEN	9.5E-06	2.1E-04	2.3E+01
186	EFWMVPRAWCB	M/V AWCB PLUG	2.4E-06	5.3E-05	2.3E+01
187	EFWMVPRAWCA	M/V AWCA PLUG	2.4E-06	5.3E-05	2.3E+01
188	EFWCVPRAW1C	C/V AW1C PLUG	2.4E-06	5.3E-05	2.3E+01
189	EFWMVPRAWDA	M/V AWDA PLUG	2.4E-06	5.3E-05	2.3E+01
190	EFWMVPRAWDB	M/V AWDB PLUG	2.4E-06	5.3E-05	2.3E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 20 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
191	EFWCVPRAW1D	C/V AW1D PLUG	2.4E-06	5.3E-05	2.3E+01
192	EFWMVCMAWCA	M/V AWCA MIS-CLOSE	9.6E-07	2.1E-05	2.3E+01
193	EFWMVCMAWCB	M/V AWCB MIS-CLOSE	9.6E-07	2.1E-05	2.3E+01
194	EFWMVCMAWDA	M/V AWDA MIS-CLOSE	9.6E-07	2.1E-05	2.3E+01
195	EFWMVCMAWDB	M/V AWDB MIS-CLOSE	9.6E-07	2.1E-05	2.3E+01
196	SWSCF2PMYRSWPAC-ALL	SWS PUMP A,C FAIL TO RUN CCF	8.9E-06	1.8E-04	2.2E+01
197	EFWCF4CVODAW1-12	EFW C/V AW1 FAIL TO OPEN CCF	2.3E-07	4.7E-06	2.2E+01
198	EFWXVELTW4B	X/V TW4B EXTERNAL LEAK L	7.2E-08	1.5E-06	2.1E+01
199	EFWXVELMW4B	X/V MW4B EXTERNAL LEAK L	7.2E-08	1.5E-06	2.1E+01
200	EFWCVELPW3	C/V PW3 EXTERNAL LEAK L	4.8E-08	9.8E-07	2.1E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 21 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
201	EFWCVELAW1C	C/V AW1C EXTERNAL LEAK L	4.8E-08	9.8E-07	2.1E+01
202	EFWCVELAW1D	C/V AW1D EXTERNAL LEAK L	4.8E-08	9.8E-07	2.1E+01
203	EFWCVELTW1B	C/V TW1B EXTERNAL LEAK L	4.8E-08	9.8E-07	2.1E+01
204	EFWCVELMW1B	C/V MW1B EXTERNAL LEAK L	4.8E-08	9.8E-07	2.1E+01
205	EFWPNELPITAB	EFW PIT TIE LINE LEAK	6.0E-10	1.2E-08	2.1E+01
206	EFWPNELSGC	SG-C LINE EXTERNAL LEAK L	6.0E-10	1.2E-08	2.1E+01
207	EFWPNELSGD	SG-D LINE EXTERNAL LEAK L	6.0E-10	1.2E-08	2.1E+01
208	EFWPNELEFWMB	B-M/D PUMP LINE EXTERNAL LEAK L	6.0E-10	1.2E-08	2.1E+01
209	EFWPNELEFWTB	B-T/D PUMP LINE EXTERNAL LEAK L	6.0E-10	1.2E-08	2.1E+01
210	PZRSVCD0056	S/V 0056 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.4E-03	2.1E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 22 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
211	PZRSVCD0055	S/V 0055 FAIL TO CLOSE (RECLOSE)	7.0E-05	1.4E-03	2.1E+01
212	PZRSVCD0058	PRESSURIZER SAFETY VALV VLV-120(0058)	7.0E-05	1.4E-03	2.1E+01
213	PZRSVCD0057	PRESSURIZER SAFETY VALV VLV-121(0057)	7.0E-05	1.4E-03	2.1E+01
214	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	3.7E-04	2.0E+01
215	EPSBSFF6ESBC	6.9KV SAFETY C BUS FAILURE	5.8E-06	1.1E-04	1.9E+01
216	EPSBTSWCCF	EPS SOFTWARE CCF	1.0E-05	1.8E-04	1.9E+01
217	EPSCF4IVFFINV-ALL	INVERTERS (INVA,B,C,D) FAIL TO OPERATE CFF	1.5E-06	2.1E-05	1.5E+01
218	EFWCVODEFW03A	EFW PIT-A DISCHARGE LINE C/V FAIL TO OPEN	9.6E-06	1.3E-04	1.4E+01
219	EFWCVPREFW03A	EFW PIT-A DISCHARGE LINE C/V PLUG	2.4E-06	3.2E-05	1.4E+01
220	EFWCVELEFW03A	C/V EFW03A EXTERNAL LEAK L	4.8E-08	6.5E-07	1.4E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 23 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
221	EPSTRFFPTC	4PTC TRANSFORMER FAIL TO RUN	8.2E-06	1.0E-04	1.3E+01
222	EPSBSFF4ESBC	480V BUS C FAILURE	5.8E-06	7.1E-05	1.3E+01
223	EPSCBWR4IC	4IC BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	3.7E-05	1.3E+01
224	EFWMVILAWCA	M/V AWCA INTERNAL LEAK L	7.2E-08	8.7E-07	1.3E+01
225	EFWMVILAWDA	M/V AWDA INTERNAL LEAK L	7.2E-08	8.7E-07	1.3E+01
226	EFWCL3SAWCA	LOGIC 3ERROR	0.0E+00	0.0E+00	1.3E+01
227	EFWCL3SAWDA	LOGIC 3ERROR	0.0E+00	0.0E+00	1.3E+01
228	EFWXVPRPW1A	EFW PIT-A DISCHARGE LINE MANUAL VALVE PLUG	2.4E-06	2.9E-05	1.3E+01
229	EFWXVELPW1A	X/V PW1A EXTERNAL LEAK L	7.2E-08	8.6E-07	1.3E+01
230	EFWXVELMW3A	X/V MW3A EXTEANAL LEAK L	7.2E-08	8.6E-07	1.3E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 24 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
231	EFWXVELTW3A	X/V TW3A EXTEANAL LEAK L	7.2E-08	8.6E-07	1.3E+01
232	EFWTNELEFWP1A	A-EMERGENCY FEED WATER PIT EXTERNAL LEAK L	4.8E-08	5.7E-07	1.3E+01
233	EFWPNELCSTA	LINE EXTERNAL LEAK FROM A-EMERGENCY FEED WATER PIT TO A-TRAIN 2 PUMP	6.0E-10	7.2E-09	1.3E+01
234	CWSPCYRCWPC	CCWP-C FAIL TO RUN (RUNNING)	6.2E-05	7.4E-04	1.3E+01
235	CWSORPR1230C	ORIFICE 1230C PLUG	2.4E-05	2.8E-04	1.3E+01
236	CWSORPR1224C	ORIFICE 1224C PLUG	2.4E-05	2.8E-04	1.3E+01
237	CWSXVPR055C	X/V 055C PLUG	2.4E-06	2.8E-05	1.3E+01
238	CWSXVPR045C	X/V 045C PLUG	2.4E-06	2.8E-05	1.3E+01
239	CWSCVPR052C	C/V 052C PLUG	2.4E-06	2.8E-05	1.3E+01
240	CWSXVPR101C	X/V 101C PLUG	2.4E-06	2.8E-05	1.3E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 25 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
241	CWSXVPR103C	X/V 103C PLUG	2.4E-06	2.8E-05	1.3E+01
242	CWSXVPR014C	X/V 014C PLUG	2.4E-06	2.8E-05	1.3E+01
243	CWSRHPFCWHXC	HEAT EXCHANGER CCWHXC PLUG / FOUL (CCW OR RHR)	1.4E-06	1.6E-05	1.3E+01
244	CWSPNELCWC	CWS TRAIN C PIPE LEAK	1.1E-06	1.3E-05	1.3E+01
245	CWSRIELCWHXC	HEAT EXCHANGER CCWHXC TUBE EXTERNAL LEAK L	7.2E-07	8.5E-06	1.3E+01
246	CWSPMELCWPC	M/P CCWPC EXTERNAL LEAK L	1.9E-07	2.3E-06	1.3E+01
247	CWSXVEL045C	X/V 045C EXTEANAL LEAK L	7.2E-08	8.5E-07	1.3E+01
248	CWSXVEL101C	X/V 101C EXTEANAL LEAK L	7.2E-08	8.5E-07	1.3E+01
249	CWSXVELCCW0001B	X/V CCW0001B EXTEANAL LEAK L	7.2E-08	8.5E-07	1.3E+01
250	HPIXVEL132C	X/V 132C EXTERNAL LEAK L	7.2E-08	8.5E-07	1.3E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 26 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
251	HPIXVEL161C	X/V 161C EXTERNAL LEAK L	7.2E-08	8.5E-07	1.3E+01
252	CWSXVEL103C	X/V 103C EXTEANAL LEAK L	7.2E-08	8.5E-07	1.3E+01
253	HPIXVEL133C	X/V 133C EXTERNAL LEAK L	7.2E-08	8.5E-07	1.3E+01
254	HPIXVEL160C	X/V 160C EXTERNAL LEAK L	7.2E-08	8.5E-07	1.3E+01
255	CWSXVEL014C	X/V 014C EXTEANAL LEAK L	7.2E-08	8.5E-07	1.3E+01
256	CWSXVEL055C	X/V 055C EXTEANAL LEAK L	7.2E-08	8.5E-07	1.3E+01
257	HPIXVELCCW0002C	X/V CCW0002C EXTERNAL LEAK L	7.2E-08	8.5E-07	1.3E+01
258	CWSCVEL052C	C/V 052C EXTERNAL LEAK L	4.8E-08	5.7E-07	1.3E+01
259	CWSMVEL043C	M/V 043C EXTEANAL LEAK L	2.4E-08	2.8E-07	1.3E+01
260	CWSMVEL056C	M/V 056C EXTEANAL LEAK L	2.4E-08	2.8E-07	1.3E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 27 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
261	RSSRIELRHEXC	CS/RHR HEAT EXCHANGER C LARGE LEAK	7.2E-07	8.5E-06	1.3E+01
262	RSSXVELRHR04C	MINIMUM FLOW LINE X/V VLV-13C(RHR04C) LARGE EXTERNAL LEAK	7.2E-08	8.5E-07	1.3E+01
263	RSSCVEL9008C	CS/RHR PUMP SUCTION LINE C/V VLV-004C(9008C) LARGE EXTERNAL LEAK	4.8E-08	5.7E-07	1.3E+01
264	EFWMVELAWDA	M/V AWDA EXTERNAL LEAK L	2.4E-08	2.8E-07	1.3E+01
265	EFWMVELAWDB	M/V AWDB EXTERNAL LEAK L	2.4E-08	2.8E-07	1.3E+01
266	EFWMVELAWCA	M/V AWCA EXTERNAL LEAK L	2.4E-08	2.8E-07	1.3E+01
267	EFWMVELAWCB	M/V AWCB EXTERNAL LEAK L	2.4E-08	2.8E-07	1.3E+01
268	SGNTMLGSC	ESFAS and SLS C MAINTENANCE	3.0E-04	3.3E-03	1.2E+01
269	RWSSUPRST01C	CONTAINMENT SUMP ST01C PLUG	2.1E-04	2.3E-03	1.2E+01
270	RWSCF4SUPRST01-123	RWSP SUMP STRAINER PLUG CCF	3.7E-06	3.8E-05	1.1E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 28 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
271	EFWCF2PMADFWP2-ALL	MOTOR-DRIVEN EMERGENCY FEED WATER PUMP FAIL TO START CCF	2.2E-04	2.1E-03	1.1E+01
272	HVACF2FAADDGF-ALL	FAN DGFAA AND DGFAB FAIL TO START (STANDBY) CCF	1.4E-04	1.4E-03	1.1E+01
273	HVACF2FALRDGF-ALL	FAN DGFAA AND DGFAB FAIL TO RUN (STANDBY) (>1H) CCF	1.3E-04	1.3E-03	1.1E+01
274	HVACF2FASRDGF-ALL	FAN DGFAA AND DGFAB FAIL TO RUN (<1H) CCF	9.4E-05	9.1E-04	1.1E+01
275	VCWCF4CHYR-ALL	CHILLER A, B, C AND D FAIL TO RUN CCF	2.7E-05	2.6E-04	1.1E+01
276	VCWCF4CHYR-23	CHILLER B AND C FAIL TO RUN CCF	1.8E-05	1.7E-04	1.1E+01
277	EFWCF2PMSRFWP2-ALL	EFW FWP2 FAIL TO RUN (<1h) CCF	1.7E-05	1.7E-04	1.1E+01
278	VCWCF4CHYR-234	CHILLER B, C AND D FAIL TO RUN CCF	9.0E-06	8.7E-05	1.1E+01
279	VCWCF4CHYR-123	CHILLER A, B AND C FAIL TO RUN CCF	9.0E-06	8.7E-05	1.1E+01
280	EFWCF2PMLRFWP2-ALL	EFW FWP2 FAIL TO RUN (>1h) CCF	5.9E-06	5.7E-05	1.1E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 29 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
281	VCWCF4PMYR-ALL	M/P A, B, C AND D FAIL TO RUN (Running)	1.5E-06	1.5E-05	1.1E+01
282	VCWCF4PMYR-23	M/P B AND C FAIL TO RUN (Running)	1.0E-06	9.7E-06	1.1E+01
283	VCWCF4PMYR-123	M/P A,B,C FAIL TO RUN (Running) CCF	5.0E-07	4.8E-06	1.1E+01
284	VCWCF4PMYR-234	M/P B,C,D FAIL TO RUN (Running) CCF	5.0E-07	4.8E-06	1.1E+01
285	EFWCF4CVODXW1-34	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	2.2E-06	1.1E+01
286	RSSRIELRHEXD	CS/RHR HEAT EXCHANGER D LARGE LEAK	7.2E-07	6.7E-06	1.0E+01
287	RSSXVELRHR04D	MINIMUM FLOW LINE X/V VLV-13D(RHR04D) LARGE EXTERNAL LEAK	7.2E-08	6.7E-07	1.0E+01
288	RSSCVEL9008D	CS/RHR PUMP SUCTION LINE C/V VLV-004D(9008D) LARGE EXTERNAL LEAK	4.8E-08	4.5E-07	1.0E+01
289	EFWXVODPW3XV	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE MANUAL VALVE XLV-004(PW3XV) FAIL TO OPEN	7.0E-04	6.4E-03	1.0E+01
290	EFWCVODPW3	C/V PW3 FAIL TO OPEN	1.2E-05	1.1E-04	1.0E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 30 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
291	EFWCVPRPW3	C/V PW3 Plug	2.4E-06	2.2E-05	1.0E+01
292	EFWXVPRPW3XV	X/V PW3XV PLUG	2.4E-06	2.2E-05	1.0E+01
293	EFWXVELPW3XV	X/V PW3XV EXTERNAL LEAK L	7.2E-08	6.6E-07	1.0E+01
294	MSRCVCD536A	MAIN STEAM ISORATION CHECK VALVE VLV-516A(536A) FAIL TO CLOSE	1.0E-04	9.2E-04	1.0E+01
295	MSRCVIL536A	C/V 536A INTERNAL LEAK LARGE	7.2E-07	6.6E-06	1.0E+01
296	EPSCF4CBTD6H-134	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	5.2E-06	4.7E-05	1.0E+01
297	RSSRIELRHEXB	CS/RHR HEAT EXCHANGER B LARGE LEAK	7.2E-07	6.6E-06	1.0E+01
298	RSSRIELRHEXA	CS/RHR HEAT EXCHANGER A LARGE LEAK	7.2E-07	6.6E-06	1.0E+01
299	RSSXVELRHR04B	MINIMUM FLOW LINE X/V VLV-13B(RHR04B) LARGE EXTERNAL LEAK	7.2E-08	6.6E-07	1.0E+01
300	RSSXVEL9009B	X/V 9009B EXTERNAL LEAK LARGE	7.2E-08	6.6E-07	1.0E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 31 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
301	RSSXVELRHR04A	MINIMUM FLOW LINE X/V VLV-13A(RHR04A) LARGE EXTERNAL LEAK	7.2E-08	6.6E-07	1.0E+01
302	RSSXVEL9009A	X/V 9009A EXTERNAL LEAK LARGE	7.2E-08	6.6E-07	1.0E+01
303	RSSXVELSFP02A	X/V SFP02A EXTERNAL LEAK L	7.2E-08	6.6E-07	1.0E+01
304	RSSXVELSFP01A	X/V SFP01A EXTERNAL LEAK L	7.2E-08	6.6E-07	1.0E+01
305	RSSCVEL9008B	CS/RHR PUMP SUCTION LINE C/V VLV-004B(9008B) LARGE EXTERNAL LEAK	4.8E-08	4.4E-07	1.0E+01
306	RSSCVEL9008A	CS/RHR PUMP SUCTION LINE C/V VLV-004A(9008A) LARGE EXTERNAL LEAK	4.8E-08	4.4E-07	1.0E+01
307	RSSMVEL9011B	M/V 9011B EXTERNAL LEAK L	2.4E-08	2.2E-07	1.0E+01
308	RSSMVEL9015B	M/V 9015B EXTERNAL LEAK L	2.4E-08	2.2E-07	1.0E+01
309	RSSMVEL9015A	M/V 9015A EXTERNAL LEAK L	2.4E-08	2.2E-07	1.0E+01
310	RSSMVEL9011A	M/V 9011A EXTERNAL LEAK L	2.4E-08	2.2E-07	1.0E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 32 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
311	RSSAVELRHR02B	A/V RHR02B EXTERNAL LEAK L	2.2E-08	2.0E-07	1.0E+01
312	RSSAVELRHR01B	A/V RHR01B EXTERNAL LEAK L	2.2E-08	2.0E-07	1.0E+01
313	CWSCF2PCYRCWPAC-ALL	CWS PUMP A,C FAIL TO RUN CCF	5.0E-06	4.5E-05	1.0E+01
314	CWSCF2RHPRHXAC-ALL	CWS HX-A,C PLUG CCF	6.8E-08	6.1E-07	1.0E+01
315	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	4.8E-02	1.0E+01
316	HPICF4PMADSIP-123	M/P FAIL TO START (Standby) CCF	9.5E-06	8.5E-05	1.0E+01
317	HPICF4PMSRSIP-123	M/P FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	2.9E-05	1.0E+01
318	HPICF4PMLRSIP-123	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	1.0E-05	1.0E+01
319	HPICF4CVOD8808-123	C/V 8808 FAIL TO OPEN CCF	2.7E-07	2.4E-06	1.0E+01
320	HPICF4CVOD8806-123	C/V 8806 FAIL TO OPEN CCF	2.7E-07	2.4E-06	1.0E+01

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 33 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
321	HPICF4CVOD8804-123	C/V 8804 FAIL TO OPEN CCF	2.7E-07	2.4E-06	1.0E+01
322	HPICF4CVOD8809-123	C/V 8809 FAIL TO OPEN CCF	2.7E-07	2.4E-06	1.0E+01
323	SWSCF2PMBDSWPBD-ALL	SWS PUMP B,D FAIL TO START CCF	1.4E-04	1.2E-03	9.6E+00
324	SWSCF2PMYRSWPBD-ALL	SWS PUMP B,D FAIL TO RUN CCF	8.9E-06	7.7E-05	9.6E+00
325	SWSCF2CVOD602BD-ALL	SWS C/V 602 FAIL TO OPEN CCF	5.6E-07	4.9E-06	9.6E+00
326	SWSCF2CVOD502BD-ALL	SWS C/V 502 FAIL TO OPEN CCF	5.6E-07	4.9E-06	9.6E+00
327	EFMBTSWCCF	EFW MDP START SIGNAL SOFTWARE CCF	1.0E-05	8.5E-05	9.5E+00
328	RSSCF4PMADCSP-123	RSS PUMP FAIL TO START CCF	6.3E-06	5.3E-05	9.5E+00
329	RSSCF4PMSRCSP-123	RSS PUMP FAIL TO RUN (<1H) CCF	1.7E-06	1.4E-05	9.5E+00
330	RSSCF4PMLRCSP-123	RSS PUMP FAIL TO RUN (>1H) CCF	5.8E-07	4.9E-06	9.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 34 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
331	RSSPMADCSPC	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP FAIL TO START (STANDBY)	1.4E-03	1.2E-02	9.3E+00
332	RSSPMSRCSPC	CS/RHR PUMP-C FAIL TO RUN (STANDBY) (<1H)	3.8E-04	3.2E-03	9.3E+00
333	RSSPMLRCSPC	CS/RHR PUMP C FAIL TO RUN (STANDBY) (>1H)	1.3E-04	1.1E-03	9.3E+00
334	RSSORPR1246C	ORIFICE 1246C PLUG	2.4E-05	2.0E-04	9.3E+00
335	RSSORPR1244C	ORIFICE 1244C PLUG	2.4E-05	2.0E-04	9.3E+00
336	RSSXVPRCCW003C	X/V CCW003C PLUG	2.4E-06	2.0E-05	9.3E+00
337	RSSXVPR187C	X/V 187C PLUG	2.4E-06	2.0E-05	9.3E+00
338	RSSXVPR183C	X/V 183C PLUG	2.4E-06	2.0E-05	9.3E+00
339	RSSMVOD114C	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145C(114C) FAIL TO OPEN	9.0E-04	7.5E-03	9.3E+00
340	SGNST-CCWC	CCW-C START SIGNAL	4.3E-04	3.5E-03	9.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 35 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
341	RSSMVFC114C	M/V 114C FAIL TO CONTROL	7.2E-05	6.0E-04	9.3E+00
342	RSSORPR1242C	ORIFICE 1242C PLUG	2.4E-05	2.0E-04	9.3E+00
343	RSSMVPR114C	M/V 114C PLUG	2.4E-06	2.0E-05	9.3E+00
344	RSSXVPR107C	X/V 107C PLUG	2.4E-06	2.0E-05	9.3E+00
345	RSSXVPR113C	X/V 113C PLUG	2.4E-06	2.0E-05	9.3E+00
346	RSSMVCM114C	M/V 114C MIS-CLOSE	9.6E-07	8.0E-06	9.3E+00
347	EPSBYFFC	BATTERY-C FAIL TO OPERATE	3.8E-06	3.1E-05	9.0E+00
348	RSSPNEL04C	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-07	2.0E-06	8.8E+00
349	RSSPNEL12C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	2.6E-08	2.0E-07	8.8E+00
350	RSSPNEL03C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.7E-09	5.2E-08	8.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 36 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
351	RSSMVFC9011C	M/V 9011C FAIL TO CONTROL	7.2E-05	5.6E-04	8.7E+00
352	RSSPNEL04A	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-07	1.9E-06	8.5E+00
353	RSSPNEL04D	CS/RHR PIPING LARGE EXTERNAL LEAK	2.5E-07	1.9E-06	8.5E+00
354	RSSPNEL04B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.5E-07	1.9E-06	8.5E+00
355	RSSPNEL12B	CS/RHR PIPING LARGE EXTERNAL LEAK	2.6E-08	1.9E-07	8.5E+00
356	RSSPNEL11D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	1.4E-07	8.5E+00
357	RSSPNEL11A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.9E-08	1.4E-07	8.5E+00
358	RSSPNEL03A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.7E-09	5.0E-08	8.5E+00
359	RSSPNEL03D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.1E-09	4.6E-08	8.5E+00
360	RSSPNEL03B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	6.1E-09	4.6E-08	8.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 37 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
361	RSSPNEL10D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	3.7E-09	2.8E-08	8.5E+00
362	RSSPNEL10A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	3.7E-09	2.8E-08	8.5E+00
363	RSSPNEL07A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	1.3E-08	8.5E+00
364	RSSPNEL07B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L	1.8E-09	1.3E-08	8.5E+00
365	RSSTMRPRHEXC	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE	5.0E-03	3.8E-02	8.5E+00
366	RSSTMPICSPC	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL PUMP OUTAGE	4.0E-03	3.0E-02	8.5E+00
367	RSSORPR908C	ORIFICE 908C PLUG	2.4E-05	1.8E-04	8.3E+00
368	RSSORPR007C	ORIFICE 007C PLUG	2.4E-05	1.8E-04	8.3E+00
369	RSSORPR006C	ORIFICE 006C PLUG	2.4E-05	1.8E-04	8.3E+00
370	RSSCVOD9008C	C/V 9008C FAIL TO OPEN	1.0E-05	7.5E-05	8.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 38 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
371	RSSRHPRRHEXC	HEAT EXCHANGER CS/RHR C PLUG / FOUL	8.9E-06	6.5E-05	8.3E+00
372	RSSXVPRRHR04C	X/V RHR04C PLUG	2.4E-06	1.8E-05	8.3E+00
373	RSSCVPR9008C	C/V 9008C PLUG	2.4E-06	1.8E-05	8.3E+00
374	EPSBSFF6ESBD	6.9KV SAFETY D BUS FAILURE	5.8E-06	4.1E-05	8.1E+00
375	HPILSFF8807C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8807C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
376	HPILSFF8805C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
377	HPILSFF8820C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
378	HPIPMADSIPC	C-SAFETY INJECTION PUMP FAIL TO START (STANDBY)	1.3E-03	9.3E-03	8.1E+00
379	HPIPMSRSIPC	M/P SIPC FAIL TO RUN (STANDBY) (<1H)	3.7E-04	2.7E-03	8.1E+00
380	HPIPMLRSIPC	M/P SIPC FAIL TO RUN (STANDBY) (>1H)	1.3E-04	9.2E-04	8.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 39 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
381	HPIFMPR862C	FM 862C PLUG	2.4E-05	1.7E-04	8.1E+00
382	HPIORPR002C	ORIFICE 002C PLUG	2.4E-05	1.7E-04	8.1E+00
383	HPIFMPR858C	FM 858C PLUG	2.4E-05	1.7E-04	8.1E+00
384	HPIORPR003C	ORIFICE 003C PLUG	2.4E-05	1.7E-04	8.1E+00
385	HPIORPR1260C	ORIFICE 1260C PLUG	2.4E-05	1.7E-04	8.1E+00
386	HPIORPR1266C	ORIFICE 1266C PLUG	2.4E-05	1.7E-04	8.1E+00
387	HPICVOD8804C	C/V 8804C FAIL TO OPEN	9.7E-06	7.0E-05	8.1E+00
388	HPICVOD8806C	C/V 8806C FAIL TO OPEN	9.7E-06	7.0E-05	8.1E+00
389	HPICVOD8808C	C/V 8808C FAIL TO OPEN	9.7E-06	7.0E-05	8.1E+00
390	HPICVOD8809C	C/V 8809C FAIL TO OPEN	9.7E-06	7.0E-05	8.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 40 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
391	HPIMVPR8805C	M/V 8805C PLUG	2.4E-06	1.7E-05	8.1E+00
392	HPIMVPR8807C	M/V 8807C PLUG	2.4E-06	1.7E-05	8.1E+00
393	HPIXVPR160C	HPI PUMP C OIL COOLING FAILURE DUE TO X/V 160C PLUG	2.4E-06	1.7E-05	8.1E+00
394	HPIXVPR133C	X/V 133C PLUG	2.4E-06	1.7E-05	8.1E+00
395	HPIXVPR132C	X/V 132C PLUG	2.4E-06	1.7E-05	8.1E+00
396	HPICVPR8804C	C/V 8804C PLUG	2.4E-06	1.7E-05	8.1E+00
397	HPIMVPR8820C	M/V 8820C PLUG	2.4E-06	1.7E-05	8.1E+00
398	HPIXVPR161C	X/V 161C PLUG	2.4E-06	1.7E-05	8.1E+00
399	HPICVPR8809C	C/V 8809C PLUG	2.4E-06	1.7E-05	8.1E+00
400	HPICVPR8808C	C/V 8808C PLUG	2.4E-06	1.7E-05	8.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 41 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
401	HPICVPR8806C	C/V 8806C PLUG	2.4E-06	1.7E-05	8.1E+00
402	HPIXVPR8825C	X/V 8825C PLUG	2.4E-06	1.7E-05	8.1E+00
403	HPIXVPRCCW0002C	CCW LINE X/V 0002C PLUG	2.4E-06	1.7E-05	8.1E+00
404	HPIMVCM8820C	M/V 8820C MIS-CLOSE	9.6E-07	6.9E-06	8.1E+00
405	HPIMVOM8810C	M/V 8810C MIS-OPENING	9.6E-07	6.9E-06	8.1E+00
406	HPIMVCM8805C	M/V 8805C MIS-CLOSE	9.6E-07	6.9E-06	8.1E+00
407	HPIMVCM8807C	M/V 8807C MIS-CLOSE	9.6E-07	6.9E-06	8.1E+00
408	HPIPNELINJLC	PIPE IN CV EXTERNAL LEAK L	1.0E-07	7.2E-07	8.1E+00
409	HPIXVEL8825C	X/V 8825C EXTERNAL LEAK L	7.2E-08	5.2E-07	8.1E+00
410	HPIXVEL8813C	X/V 8813C EXTERNAL LEAK L	7.2E-08	5.2E-07	8.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 42 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
411	HPIMVIL8810C	M/V 8810C INTERNAL LEAK L	7.2E-08	5.2E-07	8.1E+00
412	HPICVEL8809C	C/V 8809C EXTERNAL LEAK L	4.8E-08	3.5E-07	8.1E+00
413	HPICVEL8808C	C/V 8808C EXTERNAL LEAK L	4.8E-08	3.5E-07	8.1E+00
414	HPICVEL8806C	C/V 8806C EXTERNAL LEAK L	4.8E-08	3.5E-07	8.1E+00
415	HPIPNELTESTCC	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L CLOSE SIDE	4.4E-08	3.1E-07	8.1E+00
416	HPIPNELTESTOC	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L OPEN SIDE	4.2E-08	3.0E-07	8.1E+00
417	HPIXVIL8813C	X/V 8813C INTERNAL LEAK L	2.9E-08	2.1E-07	8.1E+00
418	HPIMVEL8807C	M/V 8807C EXTERNAL LEAK L	2.4E-08	1.7E-07	8.1E+00
419	HPIMVEL8810C	M/V 8810C EXTERNAL LEAK L	2.4E-08	1.7E-07	8.1E+00
420	RSSCF4PMADCSP-13	RSS PUMP FAIL TO START CCF	1.3E-05	8.7E-05	8.0E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 43 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
421	RSSCF4PMSRCSP-13	RSS PUMP FAIL TO RUN (<1H) CCF	3.3E-06	2.3E-05	8.0E+00
422	RSSCF4PMLRCSP-13	RSS PUMP FAIL TO RUN (>1H) CCF	1.2E-06	8.0E-06	8.0E+00
423	RSSCF4PMADCSP-23	RSS PUMP FAIL TO START CCF	1.3E-05	8.6E-05	7.9E+00
424	RSSCF4PMSRCSP-23	RSS PUMP FAIL TO RUN (<1H) CCF	3.3E-06	2.3E-05	7.9E+00
425	RSSCF4PMLRCSP-23	RSS PUMP FAIL TO RUN (>1H) CCF	1.2E-06	7.9E-06	7.9E+00
426	HPIPMELSIPD	SAFETY INJECTION PUMP D LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
427	HPIPMELSIPC	SAFETY INJECTION PUMP C LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
428	HPIPMELSIPA	SAFETY INJECTION PUMP A LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
429	HPIPMELSIPB	SAFETY INJECTION PUMP B LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
430	SWSTMPESWPD	ESW PUMP-D OUTAGE	1.2E-02	8.3E-02	7.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 44 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
431	CWSTMRCCWHXD	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE	7.0E-03	4.8E-02	7.8E+00
432	CWSTMPCCWPD	D-CCW PUMP OUTAGE	6.0E-03	4.1E-02	7.8E+00
433	RSSPMELCSPC	CS/RHR PUMP C LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
434	RSSPMELCSPB	CS/RHR PUMP B LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
435	RSSPMELCSPD	CS/RHR PUMP D LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
436	RSSPMELCSPA	CS/RHR PUMP A LARGE EXTERNAL LEAK	1.9E-07	1.3E-06	7.8E+00
437	SWSPMBDSWPD	D-ESSENTIAL SERVICE WATER PUMP FAIL TO START (RUNNING)	1.9E-03	1.3E-02	7.7E+00
438	CWSPCBDCWPD	D-COMPONENT COOLING WATER PUMP FAIL TO START (RUNNING)	1.0E-03	6.9E-03	7.7E+00
439	SWSSTPRST07	STRAINER ST07 PLUG	1.7E-04	1.1E-03	7.7E+00
440	SWSSTPRST02D	STRAINER ST02D PLUG	1.7E-04	1.1E-03	7.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 45 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
441	SWSPMYRSWPD	SWP-D FAIL TO RUN (RUNNING)	1.1E-04	7.5E-04	7.7E+00
442	CWSPCYRCWPD	CCWP-D FAIL TO RUN (RUNNING)	6.2E-05	4.2E-04	7.7E+00
443	SWSORPROR24D	ORIFICE OR24D PLUG	2.4E-05	1.6E-04	7.7E+00
444	CWSORPR1230D	ORIFICE 1230D PLUG	2.4E-05	1.6E-04	7.7E+00
445	SWSORPROR04D	ORIFICE OR04D PLUG	2.4E-05	1.6E-04	7.7E+00
446	SWSORPRESS0003D	ORIFICE ESS0003D PLUG	2.4E-05	1.6E-04	7.7E+00
447	SWSFMPR2055D	FM 2055D PLUG	2.4E-05	1.6E-04	7.7E+00
448	CWSORPR1224D	ORIFICE 1224D PLUG	2.4E-05	1.6E-04	7.7E+00
449	SWSCVOD602D	C/V 602D FAIL TO OPEN	1.1E-05	7.7E-05	7.7E+00
450	SWSCVOD502D	C/V 052D FAIL TO OPEN	1.1E-05	7.7E-05	7.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 46 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
451	CWSCVOD052D	C/V 052D FAIL TO OPEN	1.1E-05	7.7E-05	7.7E+00
452	SWSPEELSWPD1	SWS PIPE D1 LEAK	3.9E-06	2.6E-05	7.7E+00
453	SWSXVPR601D	X/V 601D PLUG	2.4E-06	1.6E-05	7.7E+00
454	SWSXVPR503D	X/V 503D PLUG	2.4E-06	1.6E-05	7.7E+00
455	SWSXVPR507D	X/V 507D PLUG	2.4E-06	1.6E-05	7.7E+00
456	SWSXVPR570D	X/V 570D PLUG	2.4E-06	1.6E-05	7.7E+00
457	CWSXVPR101D	X/V 101D PLUG	2.4E-06	1.6E-05	7.7E+00
458	CWSXVPR103D	X/V 103D PLUG	2.4E-06	1.6E-05	7.7E+00
459	SWSCVPR502D	C/V 502D PLUG	2.4E-06	1.6E-05	7.7E+00
460	CWSXVPR045D	X/V 045D PLUG	2.4E-06	1.6E-05	7.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 47 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
461	CWSXVPR055D	X/V 055D PLUG	2.4E-06	1.6E-05	7.7E+00
462	CWSCVPR052D	C/V 052D PLUG	2.4E-06	1.6E-05	7.7E+00
463	SWSCVPR602D	C/V 602D PLUG	2.4E-06	1.6E-05	7.7E+00
464	SWSXVPR562D	X/V 562D PLUG	2.4E-06	1.6E-05	7.7E+00
465	SWSXVPR561D	X/V 561D PLUG	2.4E-06	1.6E-05	7.7E+00
466	SWSXVPR509D	X/V 509D PLUG	2.4E-06	1.6E-05	7.7E+00
467	CWSXVPR014D	X/V 014D PLUG	2.4E-06	1.6E-05	7.7E+00
468	SWSXVPR569D	X/V 569D PLUG	2.4E-06	1.6E-05	7.7E+00
469	CWSRHPFCWHXD	HEAT EXCHANGER CCWHXD PLUG / FOUL (CCW OR RHR)	1.4E-06	9.2E-06	7.7E+00
470	CWSPNELCWD	CWS TRAIN D PIPE LEAK	9.1E-07	6.1E-06	7.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 48 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
471	CWSRIELCWHXD	HEAT EXCHANGER CCWHXD TUBE EXTERNAL LEAK L	7.2E-07	4.8E-06	7.7E+00
472	SWSRIELSWHXD	HEAT EXCHANGER CCWHXD TUBE EXTERNAL LEAK L	7.2E-07	4.8E-06	7.7E+00
473	SWSPEELSWSD2	SWS PIPE D2 LEAK	3.8E-07	2.5E-06	7.7E+00
474	SWSPEELSWSD3	SWS PIPE D3 LEAK	2.1E-07	1.4E-06	7.7E+00
475	CWSPMELCWPD	M/P CCWPD EXTERNAL LEAK L	1.9E-07	1.3E-06	7.7E+00
476	SWSPMELSWPD	M/P SWPD EXTERNAL LEAK L	1.9E-07	1.3E-06	7.7E+00
477	SWSXVEL561D	X/V 561D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
478	SWSXVEL601D	X/V 601D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
479	SWSXVEL503D	X/V 503D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
480	SWSXVEL507D	X/V 507D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 49 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
481	SWSXVEL562D	X/V 562D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
482	SWSXVEL509D	X/V 509D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
483	HPIXVEL160D	X/V 160D EXTERNAL LEAK L	7.2E-08	4.8E-07	7.7E+00
484	HPIXVEL161D	X/V 161D EXTERNAL LEAK L	7.2E-08	4.8E-07	7.7E+00
485	HPIXVEL132D	X/V 132D EXTERNAL LEAK L	7.2E-08	4.8E-07	7.7E+00
486	CWSXVEL045D	X/V 045D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
487	CWSXVEL055D	X/V 055D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
488	HPIXVELCCW0002D	X/V CCW0002D EXTERNAL LEAK L	7.2E-08	4.8E-07	7.7E+00
489	CWSXVEL103D	X/V 103D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
490	CWSXVEL101D	X/V 101D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 50 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
491	SWSXVELESS0001D	X/V ESS0001D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
492	HPIXVEL133D	X/V 133D EXTERNAL LEAK L	7.2E-08	4.8E-07	7.7E+00
493	SWSXVELESS0002D	X/V ESS0002D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
494	CWSXVEL014D	X/V 014D EXTEANAL LEAK L	7.2E-08	4.8E-07	7.7E+00
495	SWSCVEL602D	C/V 602D EXTERNAL LEAK L	4.8E-08	3.2E-07	7.7E+00
496	SWSCVEL502D	C/V 502D EXTERNAL LEAK L	4.8E-08	3.2E-07	7.7E+00
497	CWSCVEL052D	C/V 052D EXTERNAL LEAK L	4.8E-08	3.2E-07	7.7E+00
498	CWSMVEL056D	M/V 056D EXTEANAL LEAK L	2.4E-08	1.6E-07	7.7E+00
499	CWSMVEL043D	M/V 043D EXTEANAL LEAK L	2.4E-08	1.6E-07	7.7E+00
500	RWSPMELRWPA	M/P RWPA EXTERNAL LEAK L	1.9E-07	1.3E-06	7.6E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 51 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
501	RWSPMELRWPB	M/P RWPB EXTERNAL LEAK L	1.9E-07	1.3E-06	7.6E+00
502	RWSXVEL026	X/V 026 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
503	RWSXVEL005B	X/V 005B EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
504	RWSXVEL005A	X/V 005A EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
505	RWSXVEL016	X/V 016 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
506	RWSXVELRWS07	X/V RWS07 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
507	RWSXVEL004	X/V 004 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
508	RWSXVEL008	X/V 008 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
509	RWSXVEL007B	X/V 007B EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
510	RWSXVELRWS06	X/V RWS06 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 52 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
511	RWSXVEL007A	X/V 007A EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
512	RWSXVELRWS11	X/V RWS11 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
513	RWSXVELRWS09	X/V RWS09 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
514	RWSXVELRWS12	X/V RWS12 EXTERNAL LEAK L	7.2E-08	4.8E-07	7.6E+00
515	RWSCVELRWS10	C/V RWS10 EXTERNAL LEAK L	4.8E-08	3.2E-07	7.6E+00
516	RWSCVELRWS08	C/V RWS08 EXTERNAL LEAK L	4.8E-08	3.2E-07	7.6E+00
517	RWSCVEL015	C/V 015 EXTERNAL LEAK L	4.8E-08	3.2E-07	7.6E+00
518	RWSCVEL006B	C/V 006B EXTERNAL LEAK L	4.8E-08	3.2E-07	7.6E+00
519	RWSCVEL006A	C/V 006A EXTERNAL LEAK L	4.8E-08	3.2E-07	7.6E+00
520	RWSCVELRWS13	C/V RWS13 EXTERNAL LEAK L	4.8E-08	3.2E-07	7.6E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 53 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
521	RWSCF4SUPRST01-13	SUMP STRAINER PLUG CCF	3.0E-06	2.0E-05	7.6E+00
522	RWSCF4SUPRST01-23	SUMP STRAINER PLUG CCF	3.0E-06	2.0E-05	7.6E+00
523	HPITMPISIPC	C-SAFETY INJECTION PUMP OUTAGE	4.0E-03	2.6E-02	7.6E+00
524	EFWCF2TPADFWP1-ALL	EMERGENCY FEED WATER PUMP A,D FAIL TO START CCF	4.5E-04	2.9E-03	7.4E+00
525	EFWCF2PTSRFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO RUN (<1H) CCF	1.1E-04	7.2E-04	7.4E+00
526	EFWCF2PTLRFWP1-ALL	A,D-EMERGENCY FEED WATER PUMP(FWP1A,B) FAIL TO RUN (>1H) CCF	7.2E-05	4.6E-04	7.4E+00
527	SGNTMLGSD	ESFAS and SLS D MAINTENANCE	3.0E-04	1.9E-03	7.4E+00
528	RSSXVELSFP01D	X/V SFP01D EXTERNAL LEAK L	7.2E-08	4.6E-07	7.4E+00
529	RSSXVEL9009D	X/V 9009D EXTERNAL LEAK LARGE	7.2E-08	4.6E-07	7.4E+00
530	RSSXVELSFP02D	X/V SFP02D EXTERNAL LEAK L	7.2E-08	4.6E-07	7.4E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 54 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
531	RSSMVEL9015D	M/V 9015D EXTERNAL LEAK L	2.4E-08	1.5E-07	7.4E+00
532	RSSMVEL9011D	M/V 9011D EXTERNAL LEAK L	2.4E-08	1.5E-07	7.4E+00
533	RSSCF4MVOD114-13	RSS M/V 114 FAIL TO OPEN CCF	5.7E-06	3.6E-05	7.3E+00
534	RSSCF4MVOD114-23	RSS M/V 114 FAIL TO OPEN CCF	5.7E-06	3.6E-05	7.3E+00
535	EFWCF4CVODXW1-13	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	1.4E-06	7.1E+00
536	CWSCF4MVCD043-ALL	CWS M/V 043 FAILTO CLOSE CCF	1.3E-05	7.5E-05	7.0E+00
537	CWSCF4MVCD056-ALL	CWS M/V 056 FAILTO CLOSE	1.3E-05	7.5E-05	7.0E+00
538	HPICF4PMADSIP-13	M/P FAIL TO START (Standby) CCF	2.2E-05	1.3E-04	6.9E+00
539	HPICF4PMSRSIP-13	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	2.1E-05	6.9E+00
540	HPICF4PMLRSIP-23	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	7.3E-06	6.9E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 55 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
541	HPICF4CVOD8804-13	C/V 8804 FAIL TO OPEN CCF	1.6E-07	9.5E-07	6.9E+00
542	HPICF4CVOD8808-13	C/V 8808 FAIL TO OPEN CCF	1.6E-07	9.5E-07	6.9E+00
543	HPICF4CVOD8806-13	C/V 8806 FAIL TO OPEN CCF	1.6E-07	9.5E-07	6.9E+00
544	HPICF4CVOD8809-13	C/V 8809 FAIL TO OPEN CCF	1.6E-07	9.5E-07	6.9E+00
545	EPSCF4CBTD6H-234	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.2E-06	3.0E-05	6.9E+00
546	EPSCF4CBTD6H-34	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	2.9E-05	6.9E+00
547	CWSCF4MVCD056-23	CWS M/V 056 FAILTO CLOSE	8.3E-06	4.9E-05	6.8E+00
548	CWSCF4MVCD043-34	CWS M/V 043 FAILTO CLOSE CCF	8.3E-06	4.9E-05	6.8E+00
549	EPSCF4CBTD6H-124	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	5.2E-06	3.0E-05	6.8E+00
550	HPICF4PMADSIP-23	M/P FAIL TO START (Standby) CCF	2.2E-05	1.2E-04	6.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 56 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
551	HPICF4PMSRSIP-23	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	2.1E-05	6.8E+00
552	HPICF4PMLRSIP-13	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	7.1E-06	6.8E+00
553	HPICF4CVOD8806-23	C/V 8806 FAIL TO OPEN CCF	1.6E-07	9.3E-07	6.8E+00
554	HPICF4CVOD8804-23	C/V 8804 FAIL TO OPEN CCF	1.6E-07	9.3E-07	6.8E+00
555	HPICF4CVOD8808-23	C/V 8808 FAIL TO OPEN CCF	1.6E-07	9.3E-07	6.8E+00
556	HPICF4CVOD8809-23	C/V 8809 FAIL TO OPEN CCF	1.6E-07	9.3E-07	6.8E+00
557	CWSCF2PCBDCWPBD-ALL	CWS PUMP B,D FAIL TO START CCF	7.5E-05	4.3E-04	6.7E+00
558	CWSCF2PCYRCWPBD-ALL	CWS PUMP B,D FAIL TO RUN CCF	5.0E-06	2.8E-05	6.7E+00
559	CWSCF2CVOD052BD-ALL	CWS C/V 052B,D FAIL TO OPEN CCF	5.6E-07	3.2E-06	6.7E+00
560	CWSCF2RHPRHXBD-ALL	CWS HX-B,D PLUG CCF	6.8E-08	3.9E-07	6.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 57 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
561	HPIPNELINJSA	SAFETY INJECTION SYSTEM A TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.2E-08	5.1E-07	6.5E+00
562	HPIPNELINJSC	SAFETY INJECTION SYSTEM C TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.2E-08	5.1E-07	6.5E+00
563	HPIPNELINJSD	SAFETY INJECTION SYSTEM D TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.0E-08	5.0E-07	6.5E+00
564	HPIPNELINJSB	SAFETY INJECTION SYSTEM B TRAIN PIPE OUTSIDE CV LARGE EXTERNAL LEAK	9.0E-08	5.0E-07	6.5E+00
565	HPICVEL8804D	SAFETY INJECTION PUMP DISCHARGE C/V VLV004D(8804D) LARGE LEAK	4.8E-08	2.7E-07	6.5E+00
566	HPICVEL8804B	SAFETY INJECTION PUMP DISCHARGE C/V VLV004B(8804B) LARGE LEAK	4.8E-08	2.7E-07	6.5E+00
567	HPICVEL8804A	SAFETY INJECTION PUMP DISCHARGE C/V VLV004A(8804A) LARGE LEAK	4.8E-08	2.7E-07	6.5E+00
568	HPICVEL8804C	SAFETY INJECTION PUMP DISCHARGE C/V VLV004C(8804C) LARGE LEAK	4.8E-08	2.7E-07	6.5E+00
569	HPIPNELSUCTLC	PIPE OUT OF CV EXTERNAL LEAK L	3.3E-08	1.8E-07	6.5E+00
570	HPIPNELSUCTLA	PIPE OUT OF CV EXTERNAL LEAK L	3.3E-08	1.8E-07	6.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 58 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
571	HPIPNELSUCTLD	PIPE OUT OF CV EXTERNAL LEAK L	3.1E-08	1.7E-07	6.5E+00
572	HPIPNELSUCTLB	PIPE OUT OF CV EXTERNAL LEAK L	3.1E-08	1.7E-07	6.5E+00
573	HPIMVEL8805B	M/V 8805B EXTERNAL LEAK L	2.4E-08	1.3E-07	6.5E+00
574	HPIMVEL8805D	M/V 8805D EXTERNAL LEAK L	2.4E-08	1.3E-07	6.5E+00
575	HPIMVEL8805A	M/V 8805A EXTERNAL LEAK L	2.4E-08	1.3E-07	6.5E+00
576	HPIMVEL8805C	M/V 8805C EXTERNAL LEAK L	2.4E-08	1.3E-07	6.5E+00
577	RSSCF4MVOD114-123	RSS M/V 114 FAIL TO OPEN CCF	1.5E-06	7.6E-06	6.3E+00
578	RSSMVOD9011C	CONTAINMENT SPRAY HEADER CONTAINMENT ISOLATION VALVES MOV-004C(9011C) FAIL TO OPEN	9.0E-04	4.5E-03	6.0E+00
579	RSSCVOD9012C	C/V 9012C FAIL TO OPEN	1.0E-05	5.2E-05	6.0E+00
580	RSSXVPR9009C	X/V 9009C PLUG	2.4E-06	1.2E-05	6.0E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 59 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
581	RSSMVPR9011C	M/V 9011C PLUG	2.4E-06	1.2E-05	6.0E+00
582	RSSCVPR9012C	C/V 9012C PLUG	2.4E-06	1.2E-05	6.0E+00
583	RSSMVCM9011C	M/V 9011C MIS-CLOSE	9.6E-07	4.8E-06	6.0E+00
584	CWSCF4MVCD056-123	CWS M/V 056 FAILTO CLOSE	4.2E-06	2.1E-05	6.0E+00
585	CWSCF4MVCD043-234	CWS M/V 043 FAILTO CLOSE CCF	4.2E-06	2.1E-05	6.0E+00
586	CWSCF4MVCD043-134	CWS M/V 043 FAILTO CLOSE CCF	4.2E-06	2.1E-05	6.0E+00
587	CWSCF4MVCD056-234	CWS M/V 056 FAILTO CLOSE	4.2E-06	2.1E-05	6.0E+00
588	RSSCF4MVOD9011-123	RSS M/V 9011 FAIL TO OPEN CCF	1.5E-06	6.6E-06	5.6E+00
589	RSSCF4CVOD9012-123	RSS C/V 9012 FAIL TO OPEN CCF	2.2E-07	1.0E-06	5.6E+00
590	RWSSUPRST01D	CONTAINMENT SUMP ST01D PLUG	2.1E-04	9.3E-04	5.4E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 60 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
591	RSSMVPR9007C	M/V 9007C PLUG	2.4E-06	1.1E-05	5.4E+00
592	RSSMVCM9007C	M/V 9007C MIS-CLOSE	9.6E-07	4.2E-06	5.4E+00
593	HPICF4PMADSIP-124	M/P FAIL TO START (Standby) CCF	9.5E-06	3.8E-05	5.0E+00
594	HPICF4PMSRSIP-124	M/P FAIL TO RUN (Standby) (<1h) CCF	3.3E-06	1.3E-05	5.0E+00
595	HPICF4PMLRSIP-124	M/P FAIL TO RUN (Standby) (>1h) CCF	1.1E-06	4.5E-06	5.0E+00
596	HPICF4CVOD8809-124	C/V 8809 FAIL TO OPEN CCF	2.7E-07	1.1E-06	5.0E+00
597	HPICF4CVOD8806-124	C/V 8806 FAIL TO OPEN CCF	2.7E-07	1.1E-06	5.0E+00
598	HPICF4CVOD8808-124	C/V 8808 FAIL TO OPEN CCF	2.7E-07	1.1E-06	5.0E+00
599	HPICF4CVOD8804-124	C/V 8804 FAIL TO OPEN CCF	2.7E-07	1.1E-06	5.0E+00
600	EFWCF2MVODTS1-ALL	EFW M/V TS1 FAIL TO OPEN CCF	4.2E-05	1.6E-04	4.9E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 61 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
601	EPSTRFFPTD	6.9kV-480V D CLASS 1E STATION SERVICE TRANSFORMER FAIL TO RUN	8.2E-06	3.2E-05	4.9E+00
602	EPSBSFF4ESBD	480V CLASS 1E BUS D FAIL	5.8E-06	2.2E-05	4.9E+00
603	EPSCBWR4ID	4ID BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	1.2E-05	4.9E+00
604	EPSCF4CBWRVIT4-ALL	CIRCUIT BREAKER BETWEEN 125V DC BUS AND INVERTER (VIT4A,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	6.1E-07	4.9E+00
605	RSSCF4MVOD9011-13	RSS M/V 9011 FAIL TO OPEN CCF	5.7E-06	2.2E-05	4.8E+00
606	RSSCF4CVOD9012-13	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	7.7E-07	4.8E+00
607	RSSCF4MVOD9011-23	RSS M/V 9011 FAIL TO OPEN CCF	5.7E-06	2.1E-05	4.8E+00
608	RWSCF4SUPRST01-124	SUMP STRAINER PLUG CCF	3.7E-06	1.4E-05	4.8E+00
609	RSSCF4CVOD9012-23	RSS C/V 9012 FAIL TO OPEN CCF	2.0E-07	7.6E-07	4.8E+00
610	EPSCF4IVFFINV-124	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	1.8E-06	4.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 62 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
611	EPSCF4IVFFINV-134	EPS INVA,B,C,D FAIL TO OPERATE CCF	5.0E-07	1.8E-06	4.5E+00
612	EPSCF4IVFFINV-34	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	3.5E-06	4.5E+00
613	HPILSFF8820D	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001D(8820D) LIMIT SWITCH FAIL	4.8E-03	1.7E-02	4.5E+00
614	HPILSFF8807D	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011D(8807D) LIMIT SWITCH FAIL	4.8E-03	1.7E-02	4.5E+00
615	HPILSFF8805D	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009D(8805D) LIMIT SWITCH FAIL	4.8E-03	1.7E-02	4.5E+00
616	HPIPMADSIPD	D-SAFETY INJECTION PUMP FAIL TO START (STANDBY)	1.3E-03	4.6E-03	4.5E+00
617	HPIPMSRSIPD	M/P SIPD FAIL TO RUN (STANDBY) (<1H)	3.7E-04	1.3E-03	4.5E+00
618	HPIPMLRSIPD	M/P SIPD FAIL TO RUN (STANDBY) (>1H)	1.3E-04	4.5E-04	4.5E+00
619	HPIFMPR862D	FM 862D PLUG	2.4E-05	8.5E-05	4.5E+00
620	HPIORPR003D	ORIFICE 003D PLUG	2.4E-05	8.5E-05	4.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 63 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
621	HPIORPR002D	ORIFICE 002D PLUG	2.4E-05	8.5E-05	4.5E+00
622	HPIORPR1266D	ORIFICE 1266D PLUG	2.4E-05	8.5E-05	4.5E+00
623	HPIFMPR858D	FM 858D PLUG	2.4E-05	8.5E-05	4.5E+00
624	HPIORPR1260D	ORIFICE 1260D PLUG	2.4E-05	8.5E-05	4.5E+00
625	HPICVOD8806D	C/V 8806D FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
626	HPICVOD8808D	C/V 8808D FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
627	HPICVOD8809D	C/V 8809D FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
628	HPICVOD8804D	C/V 8804D FAIL TO OPEN	9.7E-06	3.4E-05	4.5E+00
629	HPIXVPR161D	X/V 161D PLUG	2.4E-06	8.5E-06	4.5E+00
630	HPIXVPR160D	HPI PUMP D OIL COOLING FAILURE DUE TO X/V 160D PLUG	2.4E-06	8.5E-06	4.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 64 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
631	HPIXVPR132D	X/V 132D PLUG	2.4E-06	8.5E-06	4.5E+00
632	HPIXVPR133D	X/V 133D PLUG	2.4E-06	8.5E-06	4.5E+00
633	HPIXVPRCCW0002D	CCW LINE X/V 0002D PLUG	2.4E-06	8.5E-06	4.5E+00
634	HPICVPR8808D	C/V 8808D PLUG	2.4E-06	8.5E-06	4.5E+00
635	HPICVPR8809D	C/V 8809D PLUG	2.4E-06	8.5E-06	4.5E+00
636	HPICVPR8806D	C/V 8806D PLUG	2.4E-06	8.5E-06	4.5E+00
637	HPIMVPR8820D	M/V 8820D PLUG	2.4E-06	8.5E-06	4.5E+00
638	HPICVPR8804D	C/V 8804D PLUG	2.4E-06	8.5E-06	4.5E+00
639	HPIXVPR8825D	X/V 8825D PLUG	2.4E-06	8.5E-06	4.5E+00
640	HPIMVPR8805D	M/V 8805D PLUG	2.4E-06	8.5E-06	4.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 65 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
641	HPIMVPR8807D	M/V 8807D PLUG	2.4E-06	8.5E-06	4.5E+00
642	HPIMVCM8807D	M/V 8807D MIS-CLOSE	9.6E-07	3.4E-06	4.5E+00
643	HPIMVOM8810D	M/V 8810D MIS-OPENING	9.6E-07	3.4E-06	4.5E+00
644	HPIMVCM8805D	M/V 8805D MIS-CLOSE	9.6E-07	3.4E-06	4.5E+00
645	HPIMVCM8820D	M/V 8820D MIS-CLOSE	9.6E-07	3.4E-06	4.5E+00
646	HPIPNELINJLD	PIPE IN CV EXTERNAL LEAK L	1.0E-07	3.5E-07	4.5E+00
647	HPIXVEL8813D	X/V 8813D EXTERNAL LEAK L	7.2E-08	2.5E-07	4.5E+00
648	HPIXVEL8825D	X/V 8825D EXTERNAL LEAK L	7.2E-08	2.5E-07	4.5E+00
649	HPIMVIL8810D	M/V 8810D INTERNAL LEAK L	7.2E-08	2.5E-07	4.5E+00
650	HPICVEL8806D	C/V 8806D EXTERNAL LEAK L	4.8E-08	1.7E-07	4.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 66 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
651	HPICVEL8808D	C/V 8808D EXTERNAL LEAK L	4.8E-08	1.7E-07	4.5E+00
652	HPICVEL8809D	C/V 8809D EXTERNAL LEAK L	4.8E-08	1.7E-07	4.5E+00
653	HPIPNELTESTCD	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L CLOSE SIDE	4.4E-08	1.5E-07	4.5E+00
654	HPIPNELTESTOD	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK L OPEN SIDE	4.2E-08	1.5E-07	4.5E+00
655	HPIXVIL8813D	X/V 8813D INTERNAL LEAK L	2.9E-08	1.0E-07	4.5E+00
656	HPIMVEL8807D	M/V 8807D EXTERNAL LEAK L	2.4E-08	8.5E-08	4.5E+00
657	HPIMVEL8810D	M/V 8810D EXTERNAL LEAK L	2.4E-08	8.5E-08	4.5E+00
658	EPSBSFFDCA	125V DC BUS-A FAILURE	5.8E-06	1.9E-05	4.3E+00
659	PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN	8.7E-04	2.9E-03	4.3E+00
660	PZRMVPR58MB	M/V 58MB PLUG	2.4E-06	7.9E-06	4.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 67 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
661	PZRMVPR58RB	M/V 58RB PLUG	2.4E-06	7.9E-06	4.3E+00
662	PZRMVCM58MB	M/V 58MB MIS-CLOSE	9.6E-07	3.2E-06	4.3E+00
663	PZRMVCM58RB	M/V 58RB MIS-CLOSE	9.6E-07	3.2E-06	4.3E+00
664	HVAFAADDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)	2.9E-03	9.4E-03	4.2E+00
665	HVAFALRDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)	2.6E-03	8.6E-03	4.2E+00
666	VCWCHYRC	C-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)	2.1E-03	6.7E-03	4.2E+00
667	HVAFASRDGFAB	C-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)	1.9E-03	6.2E-03	4.2E+00
668	EFWPMADFWP2B	M/P FWP2B FAIL TO START (STANDBY)	1.3E-03	4.2E-03	4.2E+00
669	SGNST-SIMDB	MDP-B START SIGNAL	4.3E-04	1.4E-03	4.2E+00
670	EFWPMSRFWP2B	M/P FWP2B FAIL TO RUN (STANDBY) (<1H)	3.8E-04	1.3E-03	4.2E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 68 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
671	EFWPMLRFWP2B	M/P FWP2B FAIL TO RUN (STANDBY) (>1H)	1.3E-04	4.3E-04	4.2E+00
672	VCWPMYRC	M/P FAIL TO RUN (Running)	1.1E-04	3.7E-04	4.2E+00
673	VCWCF4CHYR-34	CHILLER C,D FAIL TO RUN (RUNNING) CCF	1.8E-05	5.9E-05	4.2E+00
674	VCWCF4CHYR-13	CHILLER A, C FAIL TO RUN (RUNNING) CCF	1.8E-05	5.9E-05	4.2E+00
675	EFWXVILMW6BA	X/V MW6BA INTERNAL LEAK L	1.1E-05	3.5E-05	4.2E+00
676	EFWCVODMW1B	C/V MW1B FAIL TO OPEN	9.5E-06	3.1E-05	4.2E+00
677	VCWCF4CHYR-134	CHILLER A, C,D FAIL TO RUN (RUNNING) CCF	9.0E-06	2.9E-05	4.2E+00
678	EFWXVPRMW3B	X/V MW3B PLUG	2.4E-06	7.9E-06	4.2E+00
679	EFWXVPRMW4B	X/V MW4B PLUG	2.4E-06	7.9E-06	4.2E+00
680	EFWCVPRMW1B	C/V MW1B PLUG	2.4E-06	7.9E-06	4.2E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 69 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
681	VCWCF4PMYR-34	M/P C,D FAIL TO RUN (Running) CCF	1.0E-06	3.3E-06	4.2E+00
682	VCWCF4PMYR-13	M/P A,C FAIL TO RUN (Running) CCF	1.0E-06	3.3E-06	4.2E+00
683	VCWCF4PMYR-134	M/P A,C,D FAIL TO RUN (Running) CCF	5.0E-07	1.6E-06	4.2E+00
684	EFWPMELFWP2B	M/P FWP2B EXTERNAL LEAK L	1.9E-07	6.3E-07	4.2E+00
685	EFWXVELMW6BA	X/V MW6BA EXTEANAL LEAK L	7.2E-08	2.4E-07	4.2E+00
686	EFWXVELMW6BB	X/V MW6AB EXTEANAL LEAK L	7.2E-08	2.4E-07	4.2E+00
687	EFWCVELMW7BA	C/V MW7BA EXTERNAL LEAK L	4.8E-08	1.6E-07	4.2E+00
688	EFWCVELMW7BB	C/V MW7BB EXTERNAL LEAK L	4.8E-08	1.6E-07	4.2E+00
689	EPSCF4CBTD6H-14	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	1.6E-05	4.2E+00
690	EPSCF4IVFFINV-14	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	3.2E-06	4.2E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 70 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
691	SGNST-EPSD	VOLTAGE LOW SIGNAL FAIL	4.3E-04	1.3E-03	4.1E+00
692	EPSCBTD6HD	6HD BREAKER FAIL TO OPEN	3.5E-04	1.1E-03	4.1E+00
693	EPSBSFFVITD	120V BUS-D FAILURE	5.8E-06	1.7E-05	4.0E+00
694	EPSBSFF4MCCD1	480V MCC D1 BUS FAILURE	5.8E-06	1.7E-05	4.0E+00
695	EPSCBWR4JD	4JD BREAKER FAIL OPERATE (MALFUNCTION)	3.0E-06	8.9E-06	4.0E+00
696	EPSIVFFINVD	INVERTER-D FAIL TO OPERATE	1.1E-04	3.4E-04	3.9E+00
697	HPITMPISIPD	D-SAFETY INJECTION PUMP OUTAGE	4.0E-03	1.2E-02	3.9E+00
698	EPSCF4CBTD6H-24	EPS C/B 6HA,B,C,D FAIL TO CLOSED CCF	5.0E-06	1.4E-05	3.8E+00
699	EPSCBWRVIT4D	INVERTER INPUT BREAKER FAIL OPERATE	3.0E-06	8.5E-06	3.8E+00
700	EPSCF4IVFFINV-24	EPS INVA,B,C,D FAIL TO OPERATE CCF	1.0E-06	2.8E-06	3.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 71 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
701	EFWTMPAB	C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE	4.0E-03	1.1E-02	3.8E+00
702	EFWPTADFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START	6.5E-03	1.8E-02	3.7E+00
703	EFWPTSRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (<1H)	2.4E-03	6.5E-03	3.7E+00
704	EFWPTLRFWP1A	A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO RUN (>1H)	1.5E-03	4.2E-03	3.7E+00
705	EFWPTELFWP1A	T/P FWP1A EXTERNAL LEAK L	2.2E-07	5.9E-07	3.7E+00
706	EFWTMTAA	A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE	5.0E-03	1.3E-02	3.6E+00
707	RSSXVEL9009C	X/V 9009C EXTERNAL LEAK LARGE	7.2E-08	1.9E-07	3.6E+00
708	RSSMVEL9011C	M/V 9011C EXTERNAL LEAK L	2.4E-08	6.2E-08	3.6E+00
709	RSSMVEL9015C	M/V 9015C EXTERNAL LEAK L	2.4E-08	6.2E-08	3.6E+00
710	HPICF4PMADSIP-14	M/P FAIL TO START (Standby) CCF	2.2E-05	5.5E-05	3.6E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 72 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
711	HPICF4PMSRSIP-14	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	9.2E-06	3.6E+00
712	HPICF4PMLRSIP-24	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	3.2E-06	3.6E+00
713	HPICF4CVOD8808-14	C/V 8808 FAIL TO OPEN CCF	1.6E-07	4.1E-07	3.6E+00
714	HPICF4CVOD8809-14	C/V 8809 FAIL TO OPEN CCF	1.6E-07	4.1E-07	3.6E+00
715	HPICF4CVOD8806-14	C/V 8806 FAIL TO OPEN CCF	1.6E-07	4.1E-07	3.6E+00
716	HPICF4CVOD8804-14	C/V 8804 FAIL TO OPEN CCF	1.6E-07	4.1E-07	3.6E+00
717	EFWMVODTS1A	M/V TS1A FAIL TO OPEN	9.6E-04	2.4E-03	3.5E+00
718	HPICF4PMADSIP-24	M/P FAIL TO START (Standby) CCF	2.2E-05	5.4E-05	3.5E+00
719	HPICF4PMSRSIP-24	M/P FAIL TO RUN (Standby) (<1h) CCF	3.6E-06	8.9E-06	3.5E+00
720	HPICF4PMLRSIP-14	M/P FAIL TO RUN (Standby) (>1h) CCF	1.2E-06	3.1E-06	3.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 73 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
721	HPICF4CVOD8808-24	C/V 8808 FAIL TO OPEN CCF	1.6E-07	4.0E-07	3.5E+00
722	HPICF4CVOD8809-24	C/V 8809 FAIL TO OPEN CCF	1.6E-07	4.0E-07	3.5E+00
723	HPICF4CVOD8806-24	C/V 8806 FAIL TO OPEN CCF	1.6E-07	4.0E-07	3.5E+00
724	HPICF4CVOD8804-24	C/V 8804 FAIL TO OPEN CCF	1.6E-07	4.0E-07	3.5E+00
725	SGNST-EFWTDA	TURBIN SIGNAL-A FAIL	4.3E-04	1.0E-03	3.4E+00
726	RWSCF4SUPRST01-24	SUMP STRAINER PLUG CCF	3.0E-06	7.1E-06	3.4E+00
727	RWSCF4SUPRST01-14	SUMP STRAINER PLUG CCF	3.0E-06	7.1E-06	3.4E+00
728	SWSTMPESWPB	ESW PUMP-B OUTAGE	1.2E-02	2.9E-02	3.3E+00
729	SWSPMBDSWPB	B-ESSENTIAL SERVICE WATER PUMP FAIL TO START (RUNNING)	1.9E-03	4.4E-03	3.3E+00
730	SWSSTPRST02B	STRAINER ST02B PLUG	1.7E-04	4.0E-04	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 74 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
731	SWSSTPRST03	STRAINER ST03 PLUG	1.7E-04	4.0E-04	3.3E+00
732	SWSPMYRSWPB	SWP-B FAIL TO RUN (RUNNING)	1.1E-04	2.6E-04	3.3E+00
733	SWSORPROR04B	ORIFICE OR04B PLUG	2.4E-05	5.6E-05	3.3E+00
734	SWSORPRESS0003B	ORIFICE ESS0003B PLUG	2.4E-05	5.6E-05	3.3E+00
735	SWSFMPR2055B	FM 2055B PLUG	2.4E-05	5.6E-05	3.3E+00
736	SWSORPROR24B	ORIFICE OR24B PLUG	2.4E-05	5.6E-05	3.3E+00
737	SWSCVOD602B	C/V 602B FAIL TO OPEN	1.1E-05	2.7E-05	3.3E+00
738	SWSCVOD502B	C/V 052B FAIL TO OPEN	1.1E-05	2.7E-05	3.3E+00
739	SWSPEELSWPB1	SWS PIPE B1 LEAK	3.9E-06	9.1E-06	3.3E+00
740	SWSXVPR569B	X/V 569B PLUG	2.4E-06	5.6E-06	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 75 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
741	SWSCVPR602B	C/V 602B PLUG	2.4E-06	5.6E-06	3.3E+00
742	SWSXVPR509B	X/V 509B PLUG	2.4E-06	5.6E-06	3.3E+00
743	SWSXVPR561B	X/V 561B PLUG	2.4E-06	5.6E-06	3.3E+00
744	SWSCVPR502B	C/V 502B PLUG	2.4E-06	5.6E-06	3.3E+00
745	SWSXVPR562B	X/V 562B PLUG	2.4E-06	5.6E-06	3.3E+00
746	SWSXVPR601B	X/V 601B PLUG	2.4E-06	5.6E-06	3.3E+00
747	SWSXVPR507B	X/V 507B PLUG	2.4E-06	5.6E-06	3.3E+00
748	SWSXVPR503B	X/V 503B PLUG	2.4E-06	5.6E-06	3.3E+00
749	SWSXVPR570B	X/V 570B PLUG	2.4E-06	5.6E-06	3.3E+00
750	SWSRIELSWHXB	HEAT EXCHANGER CCWHXB TUBE EXTERNAL LEAK L	7.2E-07	1.7E-06	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 76 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
751	SWSPEELSWSB2	SWS PIPE B2 LEAK	3.8E-07	8.8E-07	3.3E+00
752	SWSPEELSWSB3	SWS PIPE B3 LEAK	2.1E-07	5.0E-07	3.3E+00
753	SWSPMELSWPB	M/P SWPB EXTERNAL LEAK L	1.9E-07	4.5E-07	3.3E+00
754	SWSXVEL507B	X/V 507B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
755	SWSXVEL509B	X/V 509B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
756	SWSXVEL561B	X/V 561B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
757	SWSXVELESS0002B	X/V ESS0002B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
758	SWSXVELESS0001B	X/V ESS0001B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
759	SWSXVEL503B	X/V 503B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
760	SWSXVEL562B	X/V 562B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 77 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
761	SWSXVEL601B	X/V 601B EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
762	SWSCVEL502B	C/V 502B EXTERNAL LEAK L	4.8E-08	1.1E-07	3.3E+00
763	SWSCVEL602B	C/V 602B EXTERNAL LEAK L	4.8E-08	1.1E-07	3.3E+00
764	VCWCHBDB	CHILLER FAIL TO START (RUNNING)	1.0E-02	2.4E-02	3.3E+00
765	HVAFAADDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO START (STANDBY)	2.9E-03	6.8E-03	3.3E+00
766	HVAFALRDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)	2.6E-03	6.2E-03	3.3E+00
767	VCWCHYRB	B-EMERGENCY FEED WATER PUMP AREA HVAC System CHILLER FAIL TO RUN (RUNNING)	2.1E-03	4.8E-03	3.3E+00
768	VCWPMBDB	B-SAFETY CHILLER PUMP FAIL TO START (Running)	2.0E-03	4.7E-03	3.3E+00
769	HVAFASRDGFAA	B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (<1H)	1.9E-03	4.5E-03	3.3E+00
770	EFWPMADFWP2A	B-EMERGENCY FEED WATER PUMP FAIL TO START (STANDBY)	1.3E-03	3.0E-03	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 78 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
771	SGNST-SIMDA	MDP-A START SIGNAL	4.3E-04	1.0E-03	3.3E+00
772	EFWPMSRFWP2A	M/P FWP2A FAIL TO RUN (STANDBY) (<1H)	3.8E-04	9.0E-04	3.3E+00
773	EFWPMLRFWP2A	M/P FWP2A FAIL TO RUN (STANDBY) (>1H)	1.3E-04	3.1E-04	3.3E+00
774	VCWPMYRB	M/P FAIL TO RUN (Running)	1.1E-04	2.7E-04	3.3E+00
775	VCWCF4CHYR-24		1.8E-05	4.3E-05	3.3E+00
776	VCWCF4CHYR-12		1.8E-05	4.3E-05	3.3E+00
777	EFWXVILMW6AA	X/V MW6AA INTERNAL LEAK L	1.1E-05	2.5E-05	3.3E+00
778	EFWCVODMW1A	C/V MW1A FAIL TO OPEN	9.5E-06	2.2E-05	3.3E+00
779	VCWCF4CHYR-124		9.0E-06	2.1E-05	3.3E+00
780	EFWCVPRMW1A	C/V MW1A PLUG	2.4E-06	5.7E-06	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 79 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
781	EFWXVPRMW3A	X/V MW3A PLUG	2.4E-06	5.7E-06	3.3E+00
782	EFWXVPRMW4A	X/V MW4A PLUG	2.4E-06	5.7E-06	3.3E+00
783	VCWCF4PMYR-12		1.0E-06	2.4E-06	3.3E+00
784	VCWCF4PMYR-24		1.0E-06	2.4E-06	3.3E+00
785	VCWCF4PMYR-124		5.0E-07	1.2E-06	3.3E+00
786	EFWPMELFWP2A	M/P FWP2A EXTERNAL LEAK L	1.9E-07	4.5E-07	3.3E+00
787	EFWXVELMW6AB	X/V MW6AB EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
788	EFWXVELMW6AA	X/V MW6AA EXTEANAL LEAK L	7.2E-08	1.7E-07	3.3E+00
789	EFWCVELMW7AB	C/V MW7AB EXTERNAL LEAK L	4.8E-08	1.1E-07	3.3E+00
790	EFWCVELMW7AA	C/V MW7AA EXTERNAL LEAK L	4.8E-08	1.1E-07	3.3E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 80 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
791	SGNTMLGSB	ESFAS and SLS B MAINTENANCE	3.0E-04	7.0E-04	3.3E+00
792	EFWTMPAA	B-EMERGENCY FEED WATER PUMP(FWP2A) OUTAGE	4.0E-03	9.1E-03	3.3E+00
793	EPSTRFFPTB	4PTB TRANSFORMER FAIL TO RUN	8.2E-06	1.7E-05	3.1E+00
794	EPSBSFF4ESBB	480V BUS B FAILURE	5.8E-06	1.2E-05	3.1E+00
795	EPSBSFF6ESBB	6.9KV SAFETY B BUS FAILURE	5.8E-06	1.1E-05	3.0E+00
796	EPSTRFFMTF	MAIN TRANSFORMER MALFUNCTION	8.2E-06	1.6E-05	2.9E+00
797	EPSCF4CBWR6H-ALL	EPS C/B 6HA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	3.0E-07	2.9E+00
798	EPSCBWR4IB	4IB BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	5.7E-06	2.9E+00
799	EFWMVFCTS1A	M/V TS1A FAIL TO CONTROL	7.2E-05	1.4E-04	2.9E+00
800	EFWMVPRTS1A	M/V TS1A PLUG	2.4E-06	4.5E-06	2.9E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 81 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
801	EFWMVCMTS1A	M/V TS1A MIS-CLOSE	9.6E-07	1.8E-06	2.9E+00
802	EFWMVELTS1A	M/V TS1A EXTERNAL LEAK L	2.4E-08	4.5E-08	2.9E+00
803	EFWPNELSTA	STEAM LINE A PIPE LEAK	6.0E-10	1.1E-09	2.9E+00
804	EFWOO04LBBB	EFW PIT WATER LEVEL GAGE B CALIBRATION MISS (HE)	2.2E-04	4.1E-04	2.8E+00
805	RSSPMADCSPD	CS/RHR PUMP FAIL TO START (STANDBY)	1.4E-03	2.6E-03	2.8E+00
806	RSSPMSRCSPD	CS/RHR PUMP-D FAIL TO RUN (STANDBY) (<1H)	3.8E-04	7.0E-04	2.8E+00
807	RSSPMLRCSPD	CS/RHR PUMP D FAIL TO RUN (STANDBY) (>1H)	1.3E-04	2.4E-04	2.8E+00
808	RSSORPR1246D	ORIFICE 1246D PLUG	2.4E-05	4.4E-05	2.8E+00
809	RSSORPR1244D	ORIFICE 1244D PLUG	2.4E-05	4.4E-05	2.8E+00
810	RSSXVPR183D	X/V 183D PLUG	2.4E-06	4.4E-06	2.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 82 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
811	RSSXVPR187D	X/V 187D PLUG	2.4E-06	4.4E-06	2.8E+00
812	RSSXVPRCCW003D	X/V CCW003D PLUG	2.4E-06	4.4E-06	2.8E+00
813	RSSMVOD114D	M/V 114D FAIL TO OPEN	9.0E-04	1.6E-03	2.8E+00
814	SGNST-CCWD	CCW-D START SIGNAL	4.3E-04	7.8E-04	2.8E+00
815	RSSMVFC114D	M/V 114D FAIL TO CONTROL	7.2E-05	1.3E-04	2.8E+00
816	RSSORPR1242D	ORIFICE 1242D PLUG	2.4E-05	4.4E-05	2.8E+00
817	RSSXVPR107D	X/V 107D PLUG	2.4E-06	4.4E-06	2.8E+00
818	RSSXVPR113D	X/V 113D PLUG	2.4E-06	4.4E-06	2.8E+00
819	RSSMVPR114D	M/V 114D PLUG	2.4E-06	4.4E-06	2.8E+00
820	RSSMVCM114D	M/V 114D MIS-CLOSE	9.6E-07	1.8E-06	2.8E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 83 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
821	EFWCF4CVODXW1-14	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	3.9E-07	2.7E+00
822	EFWPTADFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO START	6.5E-03	1.1E-02	2.7E+00
823	EFWPTSRFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO RUN (<1H)	2.4E-03	4.2E-03	2.7E+00
824	EFWPTLRFWP1B	D-EMERGENCY FEED WATER PUMP(FWP1B) FAIL TO RUN (>1H)	1.5E-03	2.7E-03	2.7E+00
825	EFWMVODTS1B	M/V TS1B FAIL TO OPEN	9.6E-04	1.7E-03	2.7E+00
826	SGNST-EFWTDB	TURBIN SIGNAL-B FAIL	4.3E-04	7.4E-04	2.7E+00
827	EFWMVFCTS1B	M/V TS1B FAIL TO CONTROL	7.2E-05	1.3E-04	2.7E+00
828	EFWXVILTW6BA	X/V TW6BA INTERNAL LEAK L	1.1E-05	1.8E-05	2.7E+00
829	EFWCVODTW1B	C/V TW1B FAIL TO OPEN	9.5E-06	1.7E-05	2.7E+00
830	EFWXVPRTW4B	X/V TW4B PLUG	2.4E-06	4.2E-06	2.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 84 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
831	EFWXVPRTW3B	X/V TW3B PLUG	2.4E-06	4.2E-06	2.7E+00
832	EFWCVPRTW1B	C/V TW1B PLUG	2.4E-06	4.2E-06	2.7E+00
833	EFWMVPRTS1B	M/V TS1B PLUG	2.4E-06	4.2E-06	2.7E+00
834	EFWMVCMTS1B	M/V TS1B MIS-CLOSE	9.6E-07	1.7E-06	2.7E+00
835	EFWPTELFWP1B	T/P FWP1B EXTERNAL LEAK L	2.2E-07	3.8E-07	2.7E+00
836	EFWXVELTW6BA	X/V TW6BA EXTEANAL LEAK L	7.2E-08	1.3E-07	2.7E+00
837	EFWXVELTW6BB	X/V TW6BB EXTEANAL LEAK L	7.2E-08	1.3E-07	2.7E+00
838	EFWCVELTW7BA	C/V TW7BA EXTERNAL LEAK L	4.8E-08	8.4E-08	2.7E+00
839	EFWCVELTW7BB	C/V TW7BB EXTERNAL LEAK L	4.8E-08	8.4E-08	2.7E+00
840	EFWMVELTS1B	M/V TS1B EXTERNAL LEAK L	2.4E-08	4.2E-08	2.7E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 85 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
841	EFWPNELSTB	STEAM LINE B PIPE LEAK	6.0E-10	1.0E-09	2.7E+00
842	EPSTRFFPTA	4PTA TRANSFORMER FAIL TO RUN	8.2E-06	1.4E-05	2.7E+00
843	EPSBSFF4ESBA	480V BUS A FAILURE	5.8E-06	9.6E-06	2.7E+00
844	EPSBSFF6ESBA	6.9KV SAFETY A BUS FAILURE	5.8E-06	9.5E-06	2.7E+00
845	EPSTRFFUAT3	UNIT AUXILIARY TRANSFORMER UAT3 FAIL	8.2E-06	1.3E-05	2.6E+00
846	EPSCF4CBWR6H-12	EPS C/B 6HA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	5.4E-08	2.6E+00
847	EFWXVELEFW01A	X/V EFW01A EXTERNAL LEAK L	7.2E-08	1.1E-07	2.6E+00
848	EFWCF4CVODXW1-123	EFW C/V XW1 FAIL TO OPEN CCF	6.2E-08	9.9E-08	2.6E+00
849	EFWPNELTESTA	TEST LINE A PIPE LEAK	6.0E-10	9.6E-10	2.6E+00
850	EFWOO01EFW04	PUMP OUTLET TIE LINE FAIL TO OPEN HUMAN ERROR	2.6E-03	4.1E-03	2.6E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 86 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
851	MSRCF4AVCD533-ALL	MAIN STEAM ISOLATION VALVE AOV-515A,B,C,D(533A,B,C,D) FAIL TO CLOSED	1.8E-04	2.7E-04	2.5E+00
852	MSRCF4AVCD533-34	MAIN STEAM ISOLATION VALVE AOV-515C,D(533C,D) FAIL TO CLOSED	5.2E-05	8.1E-05	2.5E+00
853	MSRCF4AVCD533-24	MAIN STEAM ISOLATION VALVE AOV-515B,D(533B,D) FAIL TO CLOSED	5.2E-05	8.1E-05	2.5E+00
854	MSRCF4AVCD533-13	MAIN STEAM ISOLATION VALVE AOV-515A,C(533A,C) FAIL TO CLOSED	5.2E-05	8.1E-05	2.5E+00
855	MSRCF4AVCD533-14	MAIN STEAM ISOLATION VALVE AOV-515A,D(533A,D) FAIL TO CLOSED	5.2E-05	8.1E-05	2.5E+00
856	MSRCF4AVCD533-23	MAIN STEAM ISOLATION VALVE AOV-515B,C(533B,C) FAIL TO CLOSED	5.2E-05	8.1E-05	2.5E+00
857	MSRCF4AVCD533-12	MAIN STEAM ISOLATION VALVE AOV-515A,B(533A,B) FAIL TO CLOSED	5.2E-05	8.1E-05	2.5E+00
858	MSRCF4AVCD533-134	MAIN STEAM ISOLATION VALVE AOV-515A,C,D(533A,C,D) FAIL TO CLOSED	2.6E-05	4.0E-05	2.5E+00
859	MSRCF4AVCD533-234	MAIN STEAM ISOLATION VALVE AOV-515B,C,D(533B,C,D) FAIL TO CLOSED	2.6E-05	4.0E-05	2.5E+00
860	MSRCF4AVCD533-123	MAIN STEAM ISOLATION VALVE AOV-515A,B,C(533A,B,C) FAIL TO CLOSED	2.6E-05	4.0E-05	2.5E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 87 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
861	MSRCF4AVCD533-124	MAIN STEAM ISOLATION VALVE AOV-515A,B,D(533A,B,D) FAIL TO CLOSED	2.6E-05	4.0E-05	2.5E+00
862	MSRBTSWCCF	MSR STEAM LINE ISORATION SIGNAL SOFTWARE CCF	1.0E-05	1.5E-05	2.5E+00
863	RSSMVFC9011D	M/V 9011D FAIL TO CONTROL	7.2E-05	1.0E-04	2.4E+00
864	EFWMVODEFW04C	M/V EFW04C FAIL TO OPEN	9.1E-04	1.3E-03	2.4E+00
865	RSSMVOD9011D	M/V 9011D FAIL TO OPEN	9.0E-04	1.3E-03	2.4E+00
866	RSSCVOD9012D	C/V 9012D FAIL TO OPEN	1.0E-05	1.5E-05	2.4E+00
867	RSSCVPR9012D	C/V 9012D PLUG	2.4E-06	3.4E-06	2.4E+00
868	RSSXVPR9009D	X/V 9009D PLUG	2.4E-06	3.4E-06	2.4E+00
869	RSSMVPR9011D	M/V 9011D PLUG	2.4E-06	3.4E-06	2.4E+00
870	RSSMVCM9011D	M/V 9011D MIS-CLOSE	9.6E-07	1.4E-06	2.4E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 88 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
871	EFWCF4CVODXW1-23	EFW C/V XW1 FAIL TO OPEN CCF	2.3E-07	3.1E-07	2.4E+00
872	EFWMVODEFW04D	M/V EFW04D FAIL TO OPEN	9.1E-04	1.2E-03	2.4E+00
873	EFWTMTAB	D-EMERGENCY FEED WATER PUMP(FWP1B) OUTAGE	5.0E-03	6.7E-03	2.3E+00
874	EPSCBWR4IA	4IA BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	4.0E-06	2.3E+00
875	EPSCBWR6HA	6HA BREAKER MALFUNCTION	3.0E-06	3.8E-06	2.3E+00
876	EFWXVILTW6AA	X/V TW6AA INTERNAL LEAK L	1.1E-05	1.3E-05	2.2E+00
877	EFWXVELTW6AB	X/V TW6AB EXTEANAL LEAK L	7.2E-08	8.8E-08	2.2E+00
878	EFWXVELTW6AA	X/V TW6AA EXTEANAL LEAK L	7.2E-08	8.8E-08	2.2E+00
879	EFWCVELTW7AB	C/V TW7AB EXTERNAL LEAK L	4.8E-08	5.8E-08	2.2E+00
880	EFWCVELTW7AA	C/V TW7AA EXTERNAL LEAK L	4.8E-08	5.8E-08	2.2E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 89 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
881	EFWCVODTW1A	C/V TW1A FAIL TO OPEN	9.5E-06	1.1E-05	2.2E+00
882	EFWCVPRTW1A	C/V TW1A PLUG	2.4E-06	2.9E-06	2.2E+00
883	EFWXVPRTW4A	X/V TW4A PLUG	2.4E-06	2.9E-06	2.2E+00
884	EPSBCFFCHRGA	A-TRAIN BATTERY CHARGER FAIL	1.4E-05	1.6E-05	2.2E+00
885	EFWXVPRPW2A	X/V PW2A PLUG	2.4E-06	2.7E-06	2.1E+00
886	EPSBSFF4MCCSA1	480V SWING A1 BUS FAILURE	5.8E-06	6.5E-06	2.1E+00
887	EPSCBWR4SA1	480 SA1 BREAKER FAIL OPERATE (MALFUNCTION)	3.1E-06	3.5E-06	2.1E+00
888	EPSCBWRVIT1A	VIT1A BREAKER FAIL OPERATE	3.0E-06	3.4E-06	2.1E+00
889	EFWXVPRTW3A	X/V TW3A PLUG	2.4E-06	2.7E-06	2.1E+00
890	EPSCF4DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (>1H) CCF	9.9E-04	1.1E-03	2.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 90 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
891	EPSCF4DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO START CCF	2.1E-04	2.3E-04	2.1E+00
892	EPSCF4DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C,D) FAIL TO RUN (<1H) CCF	1.6E-04	1.7E-04	2.1E+00
893	EPSCF4SEFFDG-ALL	GAS TURBINE GENERATOR SEQUENCER FAIL TO OPERATE CCF	3.8E-05	4.2E-05	2.1E+00
894	EPSCF4CBTDDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO CLOSE CCF	2.0E-05	2.3E-05	2.1E+00
895	EPSCF4CBWRDG-ALL	GAS TURBINE DISCHARGE CIRCUIT BREAKER (GTGBA,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	1.8E-07	2.1E+00
896	RSSORPR007D	ORIFICE 007D PLUG	2.4E-05	2.7E-05	2.1E+00
897	RSSORPR006D	ORIFICE 006D PLUG	2.4E-05	2.7E-05	2.1E+00
898	RSSORPR908D	ORIFICE 908D PLUG	2.4E-05	2.7E-05	2.1E+00
899	RSSCVOD9008D	C/V 9008D FAIL TO OPEN	1.0E-05	1.1E-05	2.1E+00
900	RSSRHPRRHEXD	HEAT EXCHANGER CS/RHR D PLUG / FOUL	8.9E-06	9.9E-06	2.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-69 Basic Events (Hardware Failure, Human Error) RAW for Flood (Sheet 91 of 91)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
901	RSSCVPR9008D	C/V 9008D PLUG	2.4E-06	2.7E-06	2.1E+00
902	RSSXVPRRHR04D	X/V RHR04D PLUG	2.4E-06	2.7E-06	2.1E+00
903	MFWOO02R	OPERATOR FAILS TO RECOVER MAIN FEED WATER SYSTEM (HE)	3.8E-03	4.2E-03	2.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-70 Common Cause Failure FV Importance for Flood

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	HPICF4PMADSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO START CCF	1.1E-04	2.8E-02	2.5E+02
2	PZRCF2MVOD58R-ALL	SAFETY DEPRESSURIZATION VALVE MOV-117A,B(58RA,B) FAIL TO OPEN CCF	1.3E-04	2.7E-02	2.1E+02
3	RSSCF4MVOD114-ALL	CS/RHR HEAT EXCHANGER DISCHARGE LINE M/V MOV-145A,B,C,D(114A,B,C,D) FAIL TO OPEN CCF	8.4E-05	9.1E-03	1.1E+02
4	RSSCF4MVOD9011-ALL	CONTAINMENT SPRAY HEADER CONTAINMENT ISOLATION VALVES MOV-004A,B,C,D(9011A,B,C,D) FAIL TO OPEN CCF	8.4E-05	6.3E-03	7.6E+01
5	CHICF2PMBD-ALL	CHARGING PUMP A,B FAIL TO START CCF	2.0E-04	4.7E-03	2.4E+01
6	RWSCF4SUPRST01-ALL	RWSP SUMP STRAINER PLUG CCF	9.7E-06	3.3E-03	3.4E+02
7	HPICF4PMADSIP-34	SAFETY INJECTION PUMP C,D FAIL TO START (Standby) CCF	2.2E-05	3.1E-03	1.4E+02
8	EFWCF2TPADFWP1-ALL	EMERGENCY FEED WATER PUMP A,D FAIL TO START CCF	4.5E-04	2.9E-03	7.4E+00
9	EFWCF2PMADFWP2-ALL	MOTOR-DRIVEN EMERGENCY FEED WATER PUMP FAIL TO START CCF	2.2E-04	2.1E-03	1.1E+01
10	HPICF4PMSRSIP-ALL	SAFETY INJECTION PUMP A,B,C,D FAIL TO RUN (Standby) (<1h) CCF	8.5E-06	2.1E-03	2.5E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-71 Common Cause Failure RAW for Flood

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4CBWR4I-ALL	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	1.6E-07	5.4E-04	3.4E+03
2	SWSCF4PMYR-FF	ESW PUMP A,B,C,D FAIL TO RUN CCF	1.2E-08	2.7E-05	2.2E+03
3	EPSCF4CBWR4I-124	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	2.9E-08	4.9E-05	1.7E+03
4	EPSCF4CBWR4I-134	CIRCUIT BREAKER BETWEEN 6.9KV BUS AND 6.9KV/480V SAFETY POWER TRANSFORMER(4IA,B,C,D) FAIL TO REMAIN CLOSED CCF	2.9E-08	3.2E-05	1.1E+03
5	EPSCF4BYFF-ALL	EPS BATTERY A,B,C,D FAIL TO OPERATE CCF	5.0E-08	4.1E-05	8.2E+02
6	EPSCF4BYFF-234	EPS BATTERY A,C,D FAIL TO OPERATE CCF	1.2E-08	9.0E-06	7.3E+02
7	EPSCF4BYFF-124	EPS BATTERY A,B,D FAIL TO OPERATE CCF	1.2E-08	9.0E-06	7.3E+02
8	EFWCF2CVODEFW03-ALL	EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN	2.4E-06	1.5E-03	6.4E+02
9	EFWCF4CVODXW1-ALL	EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF	1.7E-06	1.0E-03	6.3E+02
10	EFWCF4CVODAW1-ALL	FEED WATER LINE C/V VLV-018A,B,C,D(AW1A,B,C,D) FAIL TO OPEN CCF	1.7E-06	1.0E-03	6.3E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-72 Human Error FV Importance for Flood

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	8.2E-01	4.1E+01
2	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	4.6E-01	1.8E+02
3	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.3E-01	3.6E+01
4	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	6.7E-02	2.7E+01
5	EFWOO04LAAA	EFW PIT WATER LEVEL GAGE A CALIBRATION MISS (HE)	2.2E-04	6.5E-03	3.0E+01
6	RSSOO02LNUP-DP2	OPERATOR FAILS TO LINE UP FOR ALTERNATIVE CORE COOLING (HE)	5.8E-02	4.3E-03	1.1E+00
7	MFWOO02R	OPERATOR FAILS TO RECOVER MAIN FEED WATER SYSTEM (HE)	3.8E-03	4.2E-03	2.1E+00
8	HPIOO02FWBD-DP2	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	5.4E-02	4.2E-03	1.1E+00
9	EFWOO01EFW04	PUMP OUTLET TIE LINE FAIL TO OPEN HUMAN ERROR	2.6E-03	4.1E-03	2.6E+00
10	MSPOO02STRV-DP2	MAIN STEAM RELIEF VALVE (MSRV) OPEN OPERATION FAIL (HE)	5.2E-02	3.8E-03	1.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-73 Human Error RAW for Flood

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)	2.6E-03	4.6E-01	1.8E+02
2	EFWOO01PW2AB	OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE)	2.0E-02	8.2E-01	4.1E+01
3	HPIOO02FWBD	OPERATOR FAILS BLEED AND FEED OPERATION (HE)	3.8E-03	1.3E-01	3.6E+01
4	EFWOO04LAAA	EFW PIT WATER LEVEL GAGE A CALIBRATION MISS (HE)	2.2E-04	6.5E-03	3.0E+01
5	CHIOO01CHIB	OPERATOR FAILS TO ACTUATE B-CHARGING PUMP (HE)	2.6E-03	6.7E-02	2.7E+01
6	EFWOO04LBBB	EFW PIT WATER LEVEL GAGE B CALIBRATION MISS (HE)	2.2E-04	4.1E-04	2.8E+00
7	EFWOO01EFW04	PUMP OUTLET TIE LINE FAIL TO OPEN HUMAN ERROR	2.6E-03	4.1E-03	2.6E+00
8	MFWOO02R	OPERATOR FAILS TO RECOVER MAIN FEED WATER SYSTEM (HE)	3.8E-03	4.2E-03	2.1E+00
9	SGNOO04ICVR12	CALIBRATION MISS (SGNICVRP10012A-D) (HE)	6.7E-05	2.5E-05	1.4E+00
10	EFWOO01EFW04-SB	PUMP OUTLET TIE LINE FAIL TO OPEN HUMAN ERROR (SB)	3.8E-03	9.1E-04	1.2E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-74 Hardware Single Failure FV Importance for Flood

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RCP----SEAL	RCP SEAL LOCA	1.0E+00	1.1E-01	1.0E+00
2	SWSTMPESWPD	ESW PUMP-D OUTAGE	1.2E-02	8.3E-02	7.8E+00
3	CWSTMRCCWHXD	D-COMPONENT COOLING HEAT EXCHENGER OUTAGE	7.0E-03	4.8E-02	7.8E+00
4	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	4.8E-02	1.0E+01
5	CHIPMBDCHPB-R	B-CHARGING PUMP FAIL TO START	1.8E-03	4.2E-02	2.4E+01
6	CWSTMPCCWPD	D-CCW PUMP OUTAGE	6.0E-03	4.1E-02	7.8E+00
7	RSSTMRPRHEXC	C-CONTAINMENT SPRAY/RESIDUAL HEAT REMOVAL HEAT EXCHANGER OUTAGE	5.0E-03	3.8E-02	8.5E+00
8	HPILSFF8807C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-011C(8807C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
9	HPILSFF8805C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-009C(8805C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00
10	HPILSFF8820C	CONTAINMENT ISOLATION MOTOR OPERATED VALVE MOV-001C(8820C) LIMIT SWITCH FAIL	4.8E-03	3.4E-02	8.1E+00

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-75 Hardware Single Failure RAW for Flood

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EFWXVELPW2B	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006B(PW2B) LARGE LEAK	7.2E-08	4.0E-05	5.6E+02
2	EFWXVELPW2A	SECONDARY DEMINERALIZER WATER TANK DISCHARGE LINE X/V VLV-006A(PW2A) LARGE LEAK	7.2E-08	4.0E-05	5.6E+02
3	EPSBSFFDCD	DC-D SWITCH BOARD FAILURE	5.8E-06	2.1E-03	3.7E+02
4	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL LEAK	7.2E-08	2.1E-05	2.9E+02
5	RWSTNELRWSP	REFUELING WATER STORAGE PIT LARGE EXTERNAL LEAK	4.8E-08	1.4E-05	2.9E+02
6	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	7.0E-06	2.9E+02
7	HPIMVEL8820D	CONTAINMENT ISOLATION M/V MOV-001D(8820D) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02
8	HPIMVEL8820A	CONTAINMENT ISOLATION M/V MOV-001A(8820A) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02
9	HPIMVEL8820C	CONTAINMENT ISOLATION M/V MOV-001C(8820C) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02
10	HPIMVEL8820B	CONTAINMENT ISOLATION M/V MOV-001B(8820B) LARGE LEAK	2.4E-08	7.0E-06	2.9E+02

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-76 Subdivided State of POS 4 (Mid-Loop Operation) for LPSD PRA

	Open S/G manhole lid ↓	Install S/G nozzle lid ↓		Remarks
RCS water level	Mid-loop (nozzle center)			
POS	(POS4-1)	(POS4-2)	(POS4-3)	
RCS conditions	RCS close	RCS open	RCS close SG Isolated	
Mitigating systems				
SG and secondary systems	×	N/A	N/A	
Gravitational injection	N/A	×	N/A	
Initiating events				
Over-drain	×	N/A	N/A	
Fail to maintain water level	N/A	×	×	

Table 19.1-77 Subdivided State of POS 8 (Mid-Loop Operation) for LPSD PRA

	Remove S/G nozzle lid ↓	Close S/G manhole Lid ↓		Remarks
RCS water level	Mid-loop (nozzle center)			
POS	(POS 8-1)	(POS 8-2)	(POS 8-3)	
RCS conditions	RCS close SG Isolated	RCS open	RCS close	
Mitigating systems				
SG and secondary systems	N/A	N/A	×	
Gravitational injection	N/A	×	N/A	
Initiating events				
Over-drain	×	N/A	N/A	
Fail to maintain water level	N/A	×	×	

Table 19.1-78 Disposition of Plant Operating States for LPSD PRA (Sheet 1 of 2)

POS	Description	POS modeled?	Reason for model exclusion
1	Low power operation	No	This POS is a low power shutdown state and SI signal is still available. Further, all components will not be planned to be maintenance in this POS. Therefore, the risk of this POS will be included in full power PRA
2	Hot standby condition	No	This POS is a hot standby state before RHR cooling and SI signal is still available. Further, all components will not be planned to be maintenance in this POS. Therefore, the risk of this POS will be included in full power PRA.
3	RHR cooling (RCS full)	Yes	N/A
4	RHR cooling (mid-loop operation)	Yes	N/A
5	Refueling cavity is filled with water (refueling)	No	This POS is the state that refueling cavity is filled with water. Since there is large inventory water in the cavity, there would be sufficient time by core exposure and operator action will be more reliable. CDF during this POS is considered negligible.
6	No fuels in the core	No	This POS is the state of no fuels in the reactor core. Fuels are transported from the RV to the SFP during this POS. In the case of loss of SFP cooling, sufficient time to recover SFP cooling is available because of large coolant inventory in the pool. Therefore, this POS is excluded from the analysis.
7	Refueling cavity is filled with water (refueling)	No	This POS is the state that refueling cavity is filled with water. Since there is large inventory in the cavity, there would be sufficient time by core exposure and operator action will be more reliable. CDF during this POS is considered negligible.
8	RHR cooling (mid-loop operation)	Yes	N/A
9	RHR cooling (RCS full)	Yes	N/A

Table 19.1-78 Disposition of Plant Operating States for LPSD PRA (Sheet 2 of 2)

POS	Description	POS Modeled?	Reason for Model Exclusion
10	RCS leakage test (RHR isolated)	No	POS 10: This POS is the RCS leakage test state. Since the RCS pressure is high and the RHRS is isolated from the RCS, loss of RHRS is excluded from Initiating events, also LOCA event by operation error is excluded. Since the risk in this POS will be smaller compared to other POS, CDF during this POS is considered negligible.
11	RHR cooling (RCS full)	Yes	N/A
12	Hot standby condition	No	This POS is a hot standby state before heatup, and SI signal is already available. Further, all components will not be planned to be maintenance in this POS. Therefore, the risk of this POS will be included in full power PRA
13	Low power operation	No	This POS is a low power shutdown state, and SI signal is already available. Further, all components will not be planned to be maintenance in this POS. Therefore, the risk of this POS will be included in full power PRA.

Table 19.1-79 Duration Time of Each POS for LPSD PRA

Time		POS	Description	Duration time(hr)
1d	0:00			
		1	Low power operation	2.0
1d	2:00			
		2	Hot standby	7.7
1d	9:40			
		3	Hot and cold shutdown (RCS is filled with coolant)	2.3
1d	12:00			
		4-1	Cold shutdown (Mid-loop operation)	39.2
3d	3:10			
		4-2	Cold shutdown (Mid-loop operation)	12.0
3d	15:10			
		4-3	Cold shutdown (Mid-loop operation)	6.0
3d	21:10			
		5	Refueling cavity is filled with water	82.7
7d	7:50			
		6	No fuels in the core	108.0
11d	19:50			
		7	Refueling cavity is filled with water	75.8
14d	23:40			
		8-1	Cold shutdown (Mid-loop operation)	55.5
17d	7:10			
		8-2	Cold shutdown (Mid-loop operation)	12.0
17d	19:10			
		8-3	Cold shutdown (Mid-loop operation)	11.0
18d	6:10			
		9	Cold shutdown (RCS is filled with coolant)	10.0
18d	16:10			
		10	RCS leakage test (RHRS isolated from RCS)	20.5
19d	12:40			
		11	Cold and hot shutdown (RCS is filled with coolant)	43.5
21d	8:10			
		12	Hot standby	51.0
23d	11:10			
		13	Low power operation	4.0
23d	15:10			
			Total time	543
			Total days	22.6

Table 19.1-80 Planned Maintenance Schedule for LPSD PRA

System \ POS	(1) Low power operation	(2) Hot standby	(3) Hot and cold shutdown (RCS is filled with coolant)	(4)-1 Cold shutdown (Mid-loop operation) (RCS closed)	(4)-2 Cold shutdown (Mid-loop operation) (RCS opened)	(4)-3 Cold shutdown (Mid-loop operation) (SG isolated)	(5) Refueling cavity is filled with water	(6) No fuels in the core	(7) Refueling cavity is filled with water	(8)-1 Cold shutdown (Mid-loop operation) (SG isolated)	(8)-2 Cold shutdown (Mid-loop operation) (RCS opened)	(8)-3 Cold shutdown (Mid-loop operation) (RCS closed)	(9) Cold shutdown (RCS is filled with coolant)	(10) RCS leakage test (RHRS isolated from RCS)	(11) Cold and hot shutdown (RCS is filled with coolant)	(12) Hot standby	(13) Low power operation
A safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
Offsite power main transformer	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
Offsite power reserve transformer	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A emergency generator	N/A	N/A	△	×	×	×	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B emergency generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C emergency generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D emergency generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	×	×	×	×	N/A	△	N/A	N/A
A essential service water pump	N/A	N/A	○	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B essential service water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C essential service water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D essential service water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
A essential service water header	N/A	N/A	○	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B essential service water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C essential service water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D essential service water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
A component cooling water pump	N/A	N/A	×	×	×	×	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B component cooling water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C component cooling water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D component cooling water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	×	△	△	△	N/A	○	N/A	N/A
A component cooling water header	N/A	N/A	×	×	×	×	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B component cooling water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C component cooling water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D component cooling water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	×	△	△	△	N/A	○	N/A	N/A
A CS/RHR pump	N/A	N/A	×	×	×	×	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B CS/RHR pump	N/A	N/A	○	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C CS/RHR pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
D CS/RHR pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	×	△	△	△	N/A	○	N/A	N/A
A Safety injection pump	N/A	N/A	×	×	×	×	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Safety injection pump	N/A	N/A	×	×	×	×	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Safety injection pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	×	×	×	△	N/A	△	N/A	N/A
D Safety injection pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	×	×	×	△	N/A	△	N/A	N/A
A Charging pump	N/A	N/A	×	×	×	×	N/A	N/A	N/A	△	○	○	○	N/A	○	N/A	N/A
B Charging pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Motor-driven emergency feed water pump	N/A	N/A	×	×	×	×	N/A	N/A	N/A	×	×	△	△	N/A	△	N/A	N/A
C Motor-driven emergency feed water pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	×	×	N/A	×	N/A	N/A
A main steam relief valve	N/A	N/A	×	×	×	×	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B main steam relief valve	N/A	N/A	×	×	×	×	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C main steam relief valve	N/A	N/A	△	△	×	×	N/A	N/A	N/A	×	×	△	△	N/A	△	N/A	N/A
D main steam relief valve	N/A	N/A	△	△	×	×	N/A	N/A	N/A	×	×	△	△	N/A	△	N/A	N/A
RWSP	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
RWSAT	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A

○:Run
△:Standby
×:Outage
N/A:Not applicable

Table 19.1-81 Success Criteria of POS 8-1 for LPSD PRA (Example) (Sheet 1 of 4)

Success Criteria of High head injection

Initiating event identifier	Except loss of CCW/essential service water	Loss of CCW/essential service water
Success criteria	SI pumps 1 of 2	unavailable
	Pump A: standby Pump B: standby Pump C: outage Pump D: outage	Pump A: standby (unavailable) Pump B: standby (unavailable) Pump C: outage Pump D: outage
Mission time	24 hours	None
Operator actions	Manual starting of S signal	None

Success Criteria of RHRS

Initiating event identifier	Except loss of offsite power	Loss of offsite power (ac power recovery)
Success criteria	CS/RHR pump C	CS/RHR pumps 1 of 3
	Pump A: run (unavailable) Pump B: run (unavailable) Pump C: standby Pump D: outage	Pump A: run (need to restart) Pump B: run (need to restart) Pump C: standby Pump D: outage
Mission time	24 hours	24 hours
Operator actions	Manual starting of S and P signal	Manual starting of S and P signal

Success Criteria of CVCS

Initiating event identifier	All (RCS makeup)	ALL (Injection to the RCS)
Success criteria	Charging pump 1 of 2	Charging pumps 1 of 2
	Pump A: standby Pump B: standby	Pump A: standby Pump B: standby Need to RWSAT makeup
Mission time	24 hours	24 hours
Operator actions	Manual starting of Charging pump.	Manual starting of Charging pump. RWSAT makeup

Table 19.1-81 Success Criteria of POS 8-1 for LPSD PRA (Example) (Sheet 2 of 4)

Success Criteria of CCWS

Initiating event identifier	Except loss of offsite power and loss of CCW/essential service water	
Success criteria	(A, B sub-train) CCW pumps 1 of 2	(C, D sub-train) CCW pump C
	Pump A: run Pump B: run	Pump C: run Pump D: outage
Mission time	24 hours	24 hours
Operator actions	None	None
Initiating event identifier	Loss of offsite power	
Success criteria	(A, B sub-train) CCW pumps 1 of 2	(C, D sub-train) CCW pump C
	Pump A: run (need to restart) Pump B: run (need to restart)	Pump C: run (need to restart) Pump D: outage
Mission time	24 hours	24 hours
Operator actions	Manual starting of P signal	Manual starting of P signal
Initiating event identifier	Loss of CCW/essential service water	
Success criteria	Unavailable	
	Pump A: run (unavailable) Pump B: run (unavailable) Pump C: run (unavailable) Pump D: outage	
Mission time	None	
Operator actions	None	

Table 19.1-81 Success Criteria of POS 8-1 for LPSD PRA (Example) (Sheet 3 of 4)

Success Criteria of ESWS

Initiating event identifier	Except loss of offsite power and loss of CCW/essential service water	
Success criteria	(A, B, C sub-train) ESW 1 pump/train	(D sub-train) Unavailable
	Pump A: run Pump B: run Pump C: run	Pump D: outage
Mission time	24 hours	-
Operator actions	Change of strainer line by manual operation (if necessary)	-
Initiating event identifier	Loss of offsite power	
Success criteria	(A, B, C sub-train) ESW 1 pump/train	(D sub-train) Unavailable
	Pump A: run (need to restart) Pump B: run (need to restart) Pump C: run (need to restart)	Pump D: outage
Mission time	24 hours	-
Operator actions	Change of strainer line by manual operation (if necessary)	-
Initiating event identifier	Loss of CCW/essential service water	
Success criteria	Unavailable	
	Pump A: run (unavailable) Pump B: run (unavailable) Pump C: run (unavailable) Pump D: outage	
Mission time	-	
Operator actions	-	

Table 19.1-81 Success Criteria of POS 8-1 for LPSD PRA (Example) (Sheet 4 of 4)

Success Criteria of Emergency Power Supply System

Initiating event identifier	Except loss of offsite power	
Success criteria	(A sub-train) Offsite power or Emergency power source	(B sub-train) Offsite power or Emergency power source
	Offsite power: available GT A: standby	Offsite power: available GT B: standby
Mission time	24 hours	24 hours
Operator actions	None	None
Success criteria	(C sub-train) Offsite power or Emergency power source	(D sub-train) Offsite power
	Offsite power: available GT C: standby	Offsite power: available GT D: outage
Mission time	24 hours	24 hours
Operator actions	None	None
Initiating event identifier	Loss of offsite power	
Success criteria	(A sub-train) Emergency power source	(B sub-train) Emergency power source
	Offsite power: unavailable GT A: standby	Offsite power: unavailable GT B: standby
Mission time	24 hours	24 hours
Operator actions	Non	Non
Success criteria	(C sub-train) Emergency power source	(D sub-train) Unavailable
	Offsite power: unavailable GT C: standby	Offsite power: unavailable GT D: outage
Mission time	24 hours	24 hours
Operator actions	None	None

Table19.1-82 Summary of Front-line System Failure Probabilities for LPSD PRA

Fault tree name	Fault tree description	Fault tree probability
High head injection system (SI)		
HPI2	Failure of high head injection system (LOCA, OVDR, LORH)	5.4E-03
HPI2-LON	Failure of high head injection system (LOOP with "GT" failure and "PR" success)	5.4E-03
HPI2-LOSP	Failure of high head injection system (LOOP with "GT" success and "RH" failure)	9.6E-03
Charging injection system (CV)		
CHI	Failure of charging injection system (LOCA, OVDR, LORH)	2.7E-02
CHI21	Failure of charging injection system (LOCA, OVDR)	3.0E-03
CHI2-LO	Failure of charging injection system (LOOP with "GT" success and "RH" failure)	3.3E-02
CHI2-LOSP	Failure of charging injection system (LOOP with "GT" failure and "PR" success)	2.7E-02
Containment spray system/residual heat removal system (RH)		
RSS2	Failure of residual heat removal system (LOCA, OVDR)	1.6E-02
RSS6	Failure of residual heat removal system (LOOP with "GT" success and "PR" success)	8.1E-03
RSS6-LON	Failure of residual heat removal system (LOOP with "GT" failure and "SP" success)	6.3E-03
CCW/essential service water Restart (PR)		
PRS	Failure of CCW/essential service water restart (LOOP)	1.0E-04
Injection by CVCS using alternate component cooling (SC)		
ACW	Failure of injection by CVCS using alternate component cooling (LOCS)	3.2E-02
ACW-LO	Failure of injection by CVCS using alternate component cooling (LOOP with "GT" success and "PR" failure)	3.3E-02
ACW-LON	Failure of injection by CVCS using alternate component cooling (LOOP with "GT" failure and "PR" failure)	3.2E-02
Isolation of CS/RHR hot leg suction valves (LOA)		
LOA	Isolation of CS/RHR hot leg suction valves (LOCA)	2.6E-03
Isolation of low-pressure letdown line (LOB)		
LOB	Isolation of low-pressure letdown line (OVDR)	5.0E-03
Main G/T power		
LOSP-DG	Main G/T power (LOOP)	1.8E-03
Spare G/T power		
SDG	Spare G/T power (LOOP)	2.5E-02

Table19.1-83 Summary of Support System Failure Probabilities for LPSD PRA (Sheet 1 of 2)

Fault tree name	Fault tree description	Fault tree probability
6.9kV ac emargency power bus		
EPS-69KA	A Train (Except LOOP)	2.1E-05
EPS-69KA(LOSP)	A Train (LOOP)	3.1E-02
EPS-69KB	B Train (Except LOOP)	1.7E-04
EPS-69KB(LOSP)	B Train (LOOP)	3.1E-02
EPS-69KC	C Train (Except LOOP)	1.7E-04
EPS-69KC(LOSP)	C Train (LOOP)	3.1E-02
EPS-69KD	D Train (Except LOOP)	3.5E-04
EPS-69KD(LOSP)	D Train (LOOP)	6.4E-02
480V ac emargency power bus		
EPS-480A	A Train (Except LOOP)	3.8E-05
EPS-480A(LOSP)	A Train (LOOP)	3.1E-02
EPS-480B	B Train (Except LOOP)	1.9E-04
EPS-480B(LOSP)	B Train (LOOP)	3.1E-02
EPS-480C	C Train (Except LOOP)	1.9E-04
EPS-480C(LOSP)	C Train (LOOP)	3.1E-02
EPS-480D	D Train (Except LOOP)	3.7E-04
EPS-480D(LOSP)	D Train (LOOP)	6.4E-02
480V ac swing power bus		
EPS-48A1	A1 Train (Except LOOP)	4.8E-05
EPS-48A1(LOSP)	A1 Train (LOOP)	3.1E-02
EPS-48D1	D1 Train (Except LOOP)	3.8E-04
EPS-48D1(LOSP)	D1 Train (LOOP)	6.4E-02
Motor control center power bus		
EPS-MCA1	A1 Train (Except LOOP)	4.8E-05
EPS-MCA1(LOSP)	A1 Train (LOOP)	3.1E-02
EPS-MCA2	A2 Train (Except LOOP)	4.8E-05
EPS-MCA2(LOSP)	A2 Train (LOOP)	3.1E-02
EPS-MCB1	B1 Train (Except LOOP)	2.0E-04
EPS-MCB1(LOSP)	B1 Train (LOOP)	3.1E-02
EPS-MCB2	B2 Train (Except LOOP)	2.0E-04
EPS-MCB2(LOSP)	B2 Train (LOOP)	3.1E-02
EPS-MCC1	C1 Train (Except LOOP)	2.0E-04
EPS-MCC1(LOSP)	C1 Train (LOOP)	3.1E-02
EPS-MCC2	C2 Train (Except LOOP)	2.0E-04
EPS-MCC2(LOSP)	C2 Train (LOOP)	3.1E-02
EPS-MCD1	D1 Train (Except LOOP)	3.8E-04
EPS-MCD1(LOSP)	D1 Train (LOOP)	6.4E-02
EPS-MCD2	D2 Train (Except LOOP)	3.8E-04
EPS-MCD2(LOSP)	D2 Train (LOOP)	6.4E-02
125V dc emergency power bus (Fail after plant trip)		
EPS-DCA	A Train (Except LOOP)	5.8E-06
EPS-DCA(LOSP)	A Train (LOOP)	9.7E-06
EPS-DCB	B Train (Except LOOP)	5.8E-06
EPS-DCB(LOSP)	B Train (LOOP)	9.7E-06
EPS-DCC	C Train (Except LOOP)	5.8E-06
EPS-DCC(LOSP)	C Train (LOOP)	9.7E-06
EPS-DCD	D Train (Except LOOP)	5.8E-06
EPS-DCD(LOSP)	D Train (LOOP)	9.7E-06

Table19.1-83 Summary of Support System Failure Probabilities for LPSD PRA (Sheet 2 of 2)

Fault tree name	Fault tree description	Fault tree probability
120V ac vital bus		
EPS-VITALA	A Train (Except LOOP)	6.5E-06
EPS-VITALA(LOSP)	A Train (LOOP)	1.4E-04
EPS-VITALB	B Train (Except LOOP)	6.5E-06
EPS-VITALB(LOSP)	B Train (LOOP)	1.4E-04
EPS-VITALC	C Train (Except LOOP)	6.5E-06
EPS-VITALC(LOSP)	C Train (LOOP)	1.4E-04
EPS-VITALD	D Train (Except LOOP)	6.5E-06
EPS-VITALD(LOSP)	D Train (LOOP)	1.4E-04
Component cooling water system		
CWS-CCA2	A Train (Except LOOP)	3.4E-05
CWS-CCA2-LO	A Train (LOOP with "GT" success and "PR" success)	3.3E-03
CWS-CCA2-LON	A Train (LOOP with "GT" failure and "PR" success)	3.2E-05
CWS-CCB2	B Train (Except LOOP)	3.4E-05
CWS-CCB2-LO	B Train (LOOP with "GT" success and "PR" success)	3.3E-03
CWS-CCB2-LON	B Train (LOOP with "GT" failure and "PR" success)	3.2E-05
CWS-CCC2	C Train (Except LOOP)	7.2E-04
CWS-CCC2-LO	C Train (LOOP with "GT" success and "PR" success)	3.2E-02
CWS-CCC2-LON	C Train (LOOP with "GT" failure and "PR" success)	5.5E-04
CWS-CCA12	Charging pump cooling A train (Except LOOP)	3.9E-05
CWS-CCA12-LO	Charging pump cooling A train (LOOP with "GT" success and "PR" success)	3.3E-03
CWS-CCA12-LON	Charging pump cooling A train (LOOP with "GT" failure and "PR" success)	3.7E-05
CWS-CCC12	Charging pump cooling C train (Except LOOP)	7.4E-04
CWS-CCC12-LO	Charging pump cooling C train (LOOP with "GT" success and "PR" success)	3.2E-02
CWS-CCC12-LON	Charging pump cooling C train (LOOP with "GT" failure and "PR" success)	5.6E-04
Essential service water system		
SWS-SWCA3	A Train (Except LOOP)	4.4E-04
SWS-SWCA3-LO	A Train (LOOP with "GT" success and "PR" success)	3.1E-02
SWS-SWCA3-LON	A Train (LOOP with "GT" failure and "PR" success)	4.2E-04
SWS-SWCB3	B Train (Except LOOP)	5.9E-04
SWS-SWCB3-LO	B Train (LOOP with "GT" success and "PR" success)	3.1E-02
SWS-SWCB3-LON	B Train (LOOP with "GT" failure and "PR" success)	4.2E-04
SWS-SWCC3	C Train (Except LOOP)	5.9E-04
SWS-SWCC3-LO	C Train (LOOP with "GT" success and "PR" success)	3.1E-02
SWS-SWCC3-LON	C Train (LOOP with "GT" failure and "PR" success)	4.2E-04

Table19.1-84 Frequency of Initiating Events for LPSD PRA

IE	Event description	POS3	POS4-1	POS4-2	POS4-3	POS8-1	POS8-2	POS8-3	POS9	POS11	Reference
LORH	Loss of RHRS caused by other failures	2.6E-07	4.3E-06	1.3E-06	6.5E-07	6.0E-06	1.2E-06	1.1E-06	1.0E-06	4.5E-06	Fault tree analysis
LOCS	Loss of CCW/essential service water	1.1E-08	1.8E-07	5.6E-08	2.8E-08	2.6E-07	2.3E-08	2.1E-08	1.9E-08	1.9E-07	Fault tree analysis
LOOP	Loss of offsite power	5.3E-06	8.9E-05	2.7E-05	1.4E-05	1.3E-04	2.7E-05	2.5E-05	2.3E-05	9.9E-05	NUREG/CR-6890
LOCA	Loss of coolant accident	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	Human reliability analysis
OVDR	Loss of RHRS due to over-drain	N/A	5.3E-06	N/A	N/A	5.3E-06	N/A	N/A	N/A	N/A	Fault tree analysis and human reliability analysis
FLML	Loss of RHRS caused by failing to maintain water level	N/A	N/A	9.2E-07	9.2E-07	N/A	2.9E-07	2.9E-07	N/A	N/A	Fault tree analysis

N/A not applicable

Table19.1-85 Core Damage Frequency for LPSD PRA

IE	Event description	POS3[2]	POS4-1[2]	POS4-2[2]	POS4-3[2]	POS8-1[1]	POS8-2[2]	POS8-3[2]	POS9[2]	POS11[2]	Total
LORH	Loss of RHRS caused by other failures	1.9E-11	3.3E-10	2.5E-10	2.5E-10	2.3E-09	2.3E-10	8.4E-11	7.6E-11	3.4E-10	3.9E-09
LOCS	Loss of CCW/essential service water	3.4E-10	5.8E-09	3.6E-10	8.9E-10	8.3E-09	1.5E-10	6.7E-10	6.0E-10	5.9E-09	2.3E-08
LOOP	Loss of offsite power	4.0E-10	6.9E-09	2.0E-09	1.5E-09	1.4E-08	2.0E-09	1.9E-09	1.8E-09	7.6E-09	3.8E-08
LOCA	Loss of coolant accident	1.3E-08	1.3E-08	1.1E-08	2.3E-08	2.3E-08	1.1E-08	1.3E-08	1.3E-08	1.3E-08	1.3E-07
OVDR	Loss of RHRS due to over-drain	N/A	7.3E-10	N/A	N/A	1.3E-09	N/A	N/A	N/A	N/A	2.0E-09
FLML	Loss of RHRS caused by failing to maintain wate level	N/A	N/A	5.4E-10	5.2E-09	N/A	1.7E-10	2.2E-10	N/A	N/A	6.1E-09
TOTAL		1.3E-08	2.6E-08	1.5E-08	3.1E-08	4.8E-08	1.4E-08	1.5E-08	1.5E-08	2.6E-08	2.0E-07

N/A: not applicable
1: POS which carried out detailed quantitative evaluation
2: POS which carried out simple evaluation

Table19.1-86 Dominant Sequences of POS 8-1 for LPSD PRA

Number	Sequence ID	Sequence Name	Sequence Frequency (/ry)	Percent Contrib.	Percent Contrib. Total
1	SDLOCA-0011	SDLOCA8-1-MC-SG-SIA1-CVA1-GI	1.5E-08	30.4%	30.4%
2	SDLOOP-0006	SDLOOP8-1-RHC-SG-SIC-CVC-GI	8.4E-09	17.2%	47.7%
3	SDLOCS-0003	SDLOCS8-1-GI-SC1	8.3E-09	16.9%	64.6%
4	SDLOCA-0006	SDLOCA8-1-RHA-SG-SIA1-CVA1-GI	5.9E-09	12.1%	76.6%
5	SDLOOP-0028	SDLOOP8-1-GT-SP-AC	5.1E-09	10.4%	87.0%
6	SDLOCA-0015	SDLOCA8-1-LOA-SIA1-CVA1-GI	2.3E-09	4.8%	91.8%
7	SDLORH-0005	SDLORH8-1-SG-SIA-CVA3-GI	2.3E-09	4.7%	96.5%
8	SDOVDR-0011	SDOVDR8-1-MC-SG-SIA2-CVA2-GI	7.7E-10	1.6%	98.1%
9	SDLOOP-0009	SDLOOP8-1-PR-GI-SC2	4.1E-10	0.8%	98.9%
10	SDOVDR-0006	SDOVDR8-1-RHA-SG-SIA2-CVA2-GI	3.1E-10	0.6%	99.5%
11	SDOVDR-0015	SDOVDR8-1-LOB-SIA2-CVA2-GI	1.9E-10	0.4%	99.9%
12	SDLOOP-0027	SDLOOP8-1-GT-SP-PR-GI-SC2	2.0E-11	0.0%	100%
13	SDLOOP-0015	SDLOOP8-1-GT-RHC-SG-SIC-CVC-GI	1.3E-11	0.0%	100%
14	SDLOOP-0024	SDLOOP8-1-GT-SP-RHC-SG-SIC-CVC-GI	9.5E-12	0.0%	100%
15	SDLOOP-0018	SDLOOP8-1-GT-PR-GI-SC2	1.1E-12	0.0%	100%
TOTAL =			4.8E-08	100%	

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 1 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
1	1.4E-08	28.9	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV21	2.6E-03	OPERATOR FAILS TO START STANDBY CHARGING PUMP (HE)
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
2	8.1E-09	16.7	SDLOCS	2.6E-07	INITIATING EVENT (LOCS)
			ACWOO02SC	3.1E-02	OPERATOR FAILS TO ESTABLISH THE ALTERNATIVE CCWS BY FIRE SUPPRESSION SYSTEM (HE)
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
3	7.2E-09	14.8	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			CHIOO02CV212-DP3	1.6E-01	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			RSSOO02RHR2	6.2E-03	OPERATOR FAILS TO START STANDBY RHR PUMP (HE)
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
4	5.5E-09	11.3	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV2-DP3	1.6E-01	OPERATOR FAILS TO CONNECT THE RWAT MAKEUP LINE UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO TASKS (HE)
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			RSSOO02RHR2	6.2E-03	OPERATOR FAILS TO START STANDBY RHR PUMP (HE)
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 2 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
5	2.3E-09	4.7	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV212-DP3	1.6E-01	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			LOAOO02LC	2.6E-03	OPERATOR FAILS TO ISOLATE THE LEAKAGE RHR TRAIN (HE)
6	2.1E-09	4.4	SDLORH	6.0E-06	INITIATING EVENT (LORH)
			CHIOO02CV212-DP2	7.3E-02	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S	4.9E-03	OPERATOR FAILS TO START STANDBY SI PUMP (HE)
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
7	1.6E-09	3.3	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			EPSCF3DLLRDG-ALL	1.1E-03	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C) FAIL TO RUN (>1H) CCF
			EPSOO02RDG	2.1E-02	OPERATOR FAILS TO CONNECT THE ALTERNATIVE POWER TO EMERGENCY POWER BUS (HE)
8	1.4E-09	2.9	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr
			EPSCF4CBTD6H-ALL	2.0E-05	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
9	7.4E-10	1.5	SDOVDR	5.3E-06	INITIATING EVENT (OVDR)
			CHIOO02CV21	2.6E-03	OPERATOR FAILS TO START STANDBY CHARGING PUMP (HE)
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 3 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
10	6.9E-10	1.4	SDLOOP AC2-F EPSBTSWCCF	1.3E-04 5.3E-01 1.0E-05	INITIATING EVENT (LOOP) FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr EPS SOFTWARE CCF
11	3.4E-10	0.7	SDLOOP AC2-F EPSCF3DLADDG-ALL EPSOO02RDG	1.3E-04 5.3E-01 2.4E-04 2.1E-02	INITIATING EVENT (LOOP) OFFSITE POWER RECOVERY FAIL G/T-A,B,C FAIL TO START CCF (HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR
12	2.9E-10	0.6	SDOVDR CHIOO02CV2-DP3 GI HPIOO02S-DP2 RSSOO02RHR2 SG	5.3E-06 1.6E-01 1.0E+00 5.5E-02 6.2E-03 1.0E+00	INITIATING EVENT (OVDR) FIELD SITE OPERATION (HUMAN ERROR) FAIL TO GRAVITY INJECT FROM SFP HUMAN ERROR HUMAN ERROR FAIL TO REMOVE DECAY HEAT BY SGS
13	2.6E-10	0.5	SDLOOP AC2-F EPSCF3DLSRDG-ALL EPSOO02RDG	1.3E-04 5.3E-01 1.8E-04 2.1E-02	INITIATING EVENT (LOOP) OFFSITE POWER RECOVERY FAIL G/T-A,B,C FAIL TO RUN (<1H) CCF (HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR
14	2.4E-10	0.5	SDLOOP ACWOO02SC ESWCF3PMBDSWPABC- GI	1.3E-04 3.1E-02 6.0E-05 1.0E+00	INITIATING EVENT (LOOP) ALTERNATIVE SEAL WATER FAIL TO OPERATE ESW PUMP A,B,C FAIL TO RE-START CCF FAIL TO GRAVITY INJECT FROM SFP
15	1.8E-10	0.4	SDOVDR CHIOO02CV212-DP3 GI HPIOO02S-DP2 LOAOO02OD	5.3E-06 1.6E-01 1.0E+00 5.5E-02 3.8E-03	INITIATING EVENT (OVDR) FIELD SITE OPERATION (HUMAN ERROR) FAIL TO GRAVITY INJECT FROM SFP HUMAN ERROR HUMAN ERROR (OVDR)

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 4 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
16	1.3E-10	0.3	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			ACWOO02SC	3.1E-02	ALTERNATIVE SEAL WATER FAIL TO OPERATE
			CWSCF3PCBDCWPABC-	3.3E-05	CWS PUMP A,B,C FAIL TO RE-START CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
17	1.1E-10	0.2	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF2DLLRDGP-ALL	1.5E-03	SPARE G/T P1,P2 FAIL TO RUN (>1H) CCF
			EPSCF3DLLRDG-ALL	1.1E-03	G/T-A,B,C FAIL TO RUN (>1H) CCF
18	1.1E-10	0.2	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF3SEFFDG-ALL	7.5E-05	EPS SG SEQUENCER FAIL TO OPERATE CCF
			EPSOO02RDG	2.1E-02	(HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR
19	1.0E-10	0.2	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHICF2PMBDCHP-ALL	2.0E-04	CHP-A,B FAIL TO START CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
20	6.9E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV2-DP2	7.0E-02	FIELD SITE OPERATION (HUMAN ERROR)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			RSSPMBDCPC	2.0E-03	CS/RHR PUMP FAIL TO START (ALTERNATIVE)
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
21	4.0E-11	0.1	SDLOCS	2.6E-07	INITIATING EVENT (LOCS)
			ACWPMBDCHP-ALL	1.5E-04	ACW CHP-A,B FAIL TO START (RUNNING) CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 5 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
22	3.9E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV21	2.6E-03	REMOTE OPERATION (HUMAN ERROR)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPICF2PMADSIP-ALL	1.5E-04	M/P SIPA,B FAIL TO START (STANDBY) CCF
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
23	3.5E-11	0.1	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S-DP2	5.5E-02	HUMAN ERROR
			RSSOO02RHR2	6.2E-03	HUMAN ERROR
			RWSOO04XV027	8.0E-04	HUMAN ERROR (RECOVERY FAILURE)
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
24	3.4E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV2-DP2	7.0E-02	FIELD SITE OPERATION (HUMAN ERROR)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			RSSMVCD9007C	1.0E-03	M/V 9007C FAIL TO CLOSE
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
25	3.4E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV2-DP2	7.0E-02	FIELD SITE OPERATION (HUMAN ERROR)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			RSSMVOD9015C	1.0E-03	M/V 9015C FAIL TO OPEN
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
26	3.4E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIOO02CV2-DP2	7.0E-02	FIELD SITE OPERATION (HUMAN ERROR)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			RSSMVOD9001C	1.0E-03	M/V 9001C FAIL TO OPEN
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 6 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
27	3.4E-11	0.1	SDLOCA CHIOO02CV2-DP2 GI HPIOO02S RSSMVOD114C SG	1.0E-04 7.0E-02 1.0E+00 4.9E-03 1.0E-03 1.0E+00	INITIATING EVENT (LOCA) FIELD SITE OPERATION (HUMAN ERROR) FAIL TO GRAVITY INJECT FROM SFP HUMAN ERROR M/V 114C FAIL TO OPEN FAIL TO REMOVE DECAY HEAT BY SGS
28	3.4E-11	0.1	SDLOCA CHIOO02CV2-DP2 GI HPIOO02S RSSMVOD9000C SG	1.0E-04 7.0E-02 1.0E+00 4.9E-03 1.0E-03 1.0E+00	INITIATING EVENT (LOCA) FIELD SITE OPERATION (HUMAN ERROR) FAIL TO GRAVITY INJECT FROM SFP HUMAN ERROR M/V 9000C FAIL TO OPEN FAIL TO REMOVE DECAY HEAT BY SGS
29	3.4E-11	0.1	SDLOCA CHIOO02CV2-DP2 GI HPIOO02S RSSMVOD9014C SG	1.0E-04 7.0E-02 1.0E+00 4.9E-03 1.0E-03 1.0E+00	INITIATING EVENT (LOCA) FIELD SITE OPERATION (HUMAN ERROR) FAIL TO GRAVITY INJECT FROM SFP HUMAN ERROR M/V 9014C FAIL TO OPEN FAIL TO REMOVE DECAY HEAT BY SGS
30	3.1E-11	0.1	SDLOOP GI HPIOO02S-DP2 RSSOO02RHR2 RWSXVOD026 SG	1.3E-04 1.0E+00 5.5E-02 6.2E-03 7.0E-04 1.0E+00	INITIATING EVENT (LOOP) FAIL TO GRAVITY INJECT FROM SFP HUMAN ERROR HUMAN ERROR X/V 026 FAIL TO OPEN FAIL TO REMOVE DECAY HEAT BY SGS
31	3.1E-11	0.1	SDLOOP GI HPIOO02S-DP2 RSSOO02RHR2 RWSXVOD028 SG	1.3E-04 1.0E+00 5.5E-02 6.2E-03 7.0E-04 1.0E+00	INITIATING EVENT (LOOP) FAIL TO GRAVITY INJECT FROM SFP HUMAN ERROR HUMAN ERROR X/V 028 FAIL TO OPEN FAIL TO REMOVE DECAY HEAT BY SGS

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 7 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
32	3.0E-11	0.1	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			CHIOO02CV212-DP2	7.3E-02	FIELD SITE OPERATION (HUMAN ERROR)
			EPSCF3DLLRDG-12	5.1E-04	G/T-A,B,C FAIL TO RUN (>1H) CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			RSSOO02RHR2	6.2E-03	HUMAN ERROR
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
33	2.9E-11	0.1	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF3CBTDDG-ALL	2.0E-05	G/T BREAKER A,B,C FAIL TO OPEN CCF
			EPSOO02RDG	2.1E-02	(HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR
34	2.7E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S-DP2	5.5E-02	HUMAN ERROR
			RSSOO02RHR2	6.2E-03	HUMAN ERROR
			RWSOO04XV027	8.0E-04	HUMAN ERROR (RECOVERY FAILURE)
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
35	2.4E-11	0.1	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF2DLLRDGP-ALL	1.5E-03	SPARE G/T P1,P2 FAIL TO RUN (>1H) CCF
			EPSCF3DLADDG-ALL	2.4E-04	G/T-A,B,C FAIL TO START CCF
36	2.4E-11	0.1	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF3DLLRDG-ALL	1.1E-03	G/T-A,B,C FAIL TO RUN (>1H) CCF
			EPSDLLRDGP1-L2	1.8E-02	SPARE G/T P1 FAIL TO RUN (>1H)
			EPSDLLRDGP2-L2	1.8E-02	SPARE G/T P2 FAIL TO RUN (>1H)

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 8 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
37	2.4E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S-DP2	5.5E-02	HUMAN ERROR
			RSSOO02RHR2	6.2E-03	HUMAN ERROR
			RWSXVOD026	7.0E-04	X/V 026 FAIL TO OPEN
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
38	2.4E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S-DP2	5.5E-02	HUMAN ERROR
			RSSOO02RHR2	6.2E-03	HUMAN ERROR
			RWSXVOD028	7.0E-04	X/V 028 FAIL TO OPEN
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
39	2.4E-11	0.1	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF2DLADDGP-ALL	3.1E-04	SPARE G/T P1, P2 FAIL TO START CCF
			EPSCF3DLLRDG-ALL	1.1E-03	G/T-A,B,C FAIL TO RUN (>1H) CCF
40	2.3E-11	0.1	SDLORH	6.0E-06	INITIATING EVENT (LORH)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			RWSOO04XV027	8.0E-04	HUMAN ERROR (RECOVERY FAILURE)
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
41	2.3E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIMVCD121BC-ALL	4.7E-05	M/V 121B,C FAIL TO CLOSE CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 9 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
42	2.3E-11	0.1	SDLOCA	1.0E-04	INITIATING EVENT (LOCA)
			CHIMVOD121DE-ALL	4.7E-05	M/V 121D,E FAIL TO OPEN CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
43	2.2E-11	0.1	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			EPSCF3DLLRDG-13	5.1E-04	G/T-A,B,C FAIL TO RUN (>1H) CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S-DP2	5.5E-02	HUMAN ERROR
			RSSOO02RHR2	6.2E-03	HUMAN ERROR
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
44	2.2E-11	0.1	SDLORH	6.0E-06	INITIATING EVENT (LORH)
			CHIOO02CV212	2.4E-02	REMOTE OPERATION & FIELD SITE OPERATION (HUMAN ERROR)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPICF2PMADSIP-ALL	1.5E-04	M/P SIPA,B FAIL TO START (STANDBY) CCF
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
45	2.1E-11	0.04	SDLORH	6.0E-06	INITIATING EVENT (LORH)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			RWSXVOD026	7.0E-04	X/V 026 FAIL TO OPEN
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS
46	2.1E-11	0.04	SDLORH	6.0E-06	INITIATING EVENT (LORH)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			HPIOO02S	4.9E-03	HUMAN ERROR
			RWSXVOD028	7.0E-04	X/V 028 FAIL TO OPEN
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-87 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 10 of 10)

No.	Cut Sets Freq. (/ry)	Percent	Cutsets	Frequency/ Probability	Basic Event Name
47	1.9E-11	0.04	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-S	4.7E-01	OFFSITE POWER RECOVERY SUCCESS
			ACWOO02SC	3.1E-02	ALTERNATIVE SEAL WATER FAIL TO OPERATE
			EPSBTSWCCF	1.0E-05	EPS P SOFTWARE CCF
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
48	1.8E-11	0.04	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF2DLSRDGP-ALL	2.3E-04	SPARE G/T P1, P2 FAIL TO RUN (<1H) CCF
			EPSCF3DLLRDG-ALL	1.1E-03	G/T-A,B,C FAIL TO RUN (>1H) CCF
49	1.8E-11	0.04	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			AC2-F	5.3E-01	OFFSITE POWER RECOVERY FAIL
			EPSCF2DLLRDGP-ALL	1.5E-03	SPARE G/T P1, P2 FAIL TO RUN (>1H) CCF
			EPSCF3DLSRDG-ALL	1.8E-04	G/T-A,B,C FAIL TO RUN (<1H) CCF
50	1.7E-11	0.03	SDLOOP	1.3E-04	INITIATING EVENT (LOOP)
			CHIOO02CV212-DP2	7.3E-02	FIELD SITE OPERATION (HUMAN ERROR)
			EPSDLLRDGA-CG3	1.7E-02	G/T-A FAIL TO RUN (>1H)
			EPSDLLRDGB-CG3	1.7E-02	G/T-B FAIL TO RUN (>1H)
			GI	1.0E+00	FAIL TO GRAVITY INJECT FROM SFP
			RSSOO02RHR2	6.2E-03	HUMAN ERROR
			SG	1.0E+00	FAIL TO REMOVE DECAY HEAT BY SGS

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-88 Planned Maintenance Schedule for Sensitivity Case 3

System \ POS	(1) Low power operation	(2) Hot standby	(3) Hot and cold shutdown (RCS is filled with coolant)	(4)-1 Cold shutdown (Mid-loop operation) (RCS closed)	(4)-2 Cold shutdown (Mid-loop operation) (RCS opened)	(4)-3 Cold shutdown (Mid-loop operation) (SG isolated)	(5) Refueling cavity is filled with water	(6) No fuels in the core	(7) Refueling cavity is filled with water	(8)-1 Cold shutdown (Mid-loop operation) (SG isolated)	(8)-2 Cold shutdown (Mid-loop operation) (RCS opened)	(8)-3 Cold shutdown (Mid-loop operation) (RCS closed)	(9) Cold shutdown (RCS is filled with coolant)	(10) RCS leakage test (RHRS isolated from RCS)	(11) Cold and hot shutdown (RCS is filled with coolant)	(12) Hot standby	(13) Low power operation
A safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D safety 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D safety 480V bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D safety 480V motor control center	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
Offsite power main transformer	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
Offsite power reserve transformer	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A emergency generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B emergency generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C emergency generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D emergency generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A essential service water pump	N/A	N/A	○	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B essential service water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C essential service water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D essential service water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
A essential service water header	N/A	N/A	○	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B essential service water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C essential service water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D essential service water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
A component cooling water pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B component cooling water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C component cooling water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D component cooling water pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
A component cooling water header	N/A	N/A	△	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B component cooling water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C component cooling water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	○	△	△	△	N/A	○	N/A	N/A
D component cooling water header	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
A CS/RHR pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
B CS/RHR pump	N/A	N/A	○	△	△	△	N/A	N/A	N/A	○	○	○	○	N/A	○	N/A	N/A
C CS/RHR pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
D CS/RHR pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	○	N/A	N/A
A Safety injection pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Safety injection pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Safety injection pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Safety injection pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A Charging pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	○	○	○	N/A	○	N/A	N/A
B Charging pump	N/A	N/A	○	○	○	○	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Motor-driven emergency feed water pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Motor-driven emergency feed water pump	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A main steam relief valve	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B main steam relief valve	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C main steam relief valve	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D main steam relief valve	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
RWSP	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
RWSAT	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A

○ : Run
△ : Standby
× : Outage
N/A : Not applicable
shaded region : difference from base case

Table 19.1-89 Basic Events (Hardware Failure, Human Error) FV Importance of POS 8-1 for LPSD PRA (Sheet 1 of 2)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	HPIOO02S-DP2	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	5.5E-02	6.3E-01	1.2E+01
2	CHIOO02CV21	OPERATOR FAILS TO START STANDBY CHARGING PUMP (HE)	2.6E-03	3.1E-01	1.2E+02
3	RSSOO02RHR2	OPERATOR FAILS TO START STANDBY RHR PUMP (HE)	6.2E-03	2.8E-01	4.6E+01
4	CHIOO02CV212-DP3	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWSAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO TASKS (HE)	1.6E-01	2.0E-01	2.0E+00
5	ACWOO02SC	OPERATOR FAILS TO ESTABLISH THE ALTERNATIVE CCWS BY FIRE SUPPRESSION SYSTEM (HE)	3.1E-02	1.8E-01	6.5E+00
6	CHIOO02CV2-DP3	OPERATOR FAILS TO CONNECT THE RWSAT MAKEUP LINE UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO TASKS (HE)	1.6E-01	1.2E-01	1.6E+00
7	AC2-F	FAILURE OF OFFSITE POWER RECOVERY WITHIN 1hr	5.3E-01	1.0E-01	1.1E+00
8	HPIOO02S	OPERATOR FAILS TO START STANDBY SI PUMP (HE)	4.9E-03	5.8E-02	1.3E+01
9	EPSOO02RDG	OPERATOR FAILS TO CONNECT THE ALTERNATIVE POWER TO EMERGENCY POWER BUS (HE)	2.1E-02	5.5E-02	3.6E+00
10	CHIOO02CV212-DP2	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWSAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	7.3E-02	4.8E-02	1.6E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-89 Basic Events (Hardware Failure, Human Error) FV Importance of POS 8-1 for LPSD PRA (Sheet 2 of 2)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
11	LOAOO02LC	HUMAN ERROR (LOCA)	2.6E-03	4.8E-02	2.0E+01
12	EPSCF3DLLRDG-ALL	G/T-A,B,C FAIL TO RUN (>1H) CCF	1.1E-03	4.1E-02	3.7E+01
13	EPSCF4CBTD6H-ALL	6HA,B,C,D BREAKER FAIL TO OPEN CCF	2.0E-05	2.9E-02	1.4E+03
14	EPSBTSWCCF	EPS P SOFTWARE CCF	1.0E-05	1.5E-02	1.5E+03
15	EPSCF3DLADDG-ALL	G/T-A,B,C FAIL TO START CCF	2.4E-04	8.6E-03	3.7E+01
16	EPSDLLRDGA-CG3	G/T-A FAIL TO RUN (>1H)	1.7E-02	7.8E-03	1.5E+00
17	CHIOO02CV2-DP2	FIELD SITE OPERATION (HUMAN ERROR)	7.0E-02	7.6E-03	1.1E+00
18	EPSCF3DLSRDG-ALL	G/T-A,B,C FAIL TO RUN (<1H) CCF	1.8E-04	6.4E-03	3.7E+01
19	EPSDLLRDGB-CG3	G/T-B FAIL TO RUN (>1H)	1.7E-02	5.5E-03	1.3E+00
20	ESWCF3PMBDSWPABC-ALL	ESW PUMP A,B,C FAIL TO RE-START	6.0E-05	5.3E-03	8.9E+01

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 1 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
1	SWSCF3PMYRSWPABC-ALL	ESW PUMP A,B,C FAIL TO RUN CCF	1.2E-07	5.0E+03	6.0E-04
2	CWSCF3PCYRCWPABC-ALL	CCW PUMP A,B,C FAIL TO RUN CCF	6.7E-08	5.0E+03	3.4E-04
3	CWSCF3RHPRHXABC1-ALL	CCW HEAT EXCHANGER A,B,C PLUG (CCW) CCF	3.6E-08	5.0E+03	1.8E-04
4	EPSBTSWCCF	EPS SOFTWARE CCF	1.0E-05	1.5E+03	1.5E-02
5	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.4E+03	2.9E-02
6	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL LEAK	7.2E-08	1.9E+02	1.3E-05
7	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	1.9E+02	4.4E-06
8	RTPBTSWCCF	SUPPORT SOFTWARE CCF	1.0E-07	1.3E+02	1.3E-05
9	CWSPNELCCWB	CCW TRAIN B PIPE LARGE EXTERNAL LEAK	1.1E-06	1.2E+02	1.3E-04
10	CWSRIELCCWHXB1	CCW HEAT EXCHANGER B LARGE EXTERNAL LEAK	7.2E-07	1.2E+02	8.8E-05

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 2 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
11	CWSPMELCCWPB	M/P CCWPB EXTERNAL LEAK L	1.9E-07	1.2E+02	2.3E-05
12	HPIXVEL133B	X/V 133B EXTERNAL LEAK L	7.2E-08	1.2E+02	8.8E-06
13	CWSXVEL103B	X/V 103B EXTEANAL LEAK L	7.2E-08	1.2E+02	8.8E-06
14	HPIXVEL160B	X/V 160B EXTERNAL LEAK L	7.2E-08	1.2E+02	8.8E-06
15	HPIXVELCCW0002B	X/V CCW0002B EXTERNAL LEAK L	7.2E-08	1.2E+02	8.8E-06
16	HPIXVEL132B	X/V 132B EXTERNAL LEAK L	7.2E-08	1.2E+02	8.8E-06
17	HPIXVEL161B	X/V 161B EXTERNAL LEAK L	7.2E-08	1.2E+02	8.8E-06
18	CWSXVEL055B	X/V 055B EXTEANAL LEAK L	7.2E-08	1.2E+02	8.8E-06
19	CWSXVEL045B	X/V 045B EXTEANAL LEAK L	7.2E-08	1.2E+02	8.8E-06
20	CWSXVEL014B	X/V 014B EXTEANAL LEAK L	7.2E-08	1.2E+02	8.8E-06
21	CWSXVEL101B	X/V 101B EXTEANAL LEAK L	7.2E-08	1.2E+02	8.8E-06
22	CWSCVEL052B	C/V 052B EXTERNAL LEAK L	4.8E-08	1.2E+02	5.8E-06
23	CWSMVEL043B	M/V 043B EXTEANAL LEAK L	2.4E-08	1.2E+02	2.9E-06
24	CWSMVEL056B	M/V 056B EXTEANAL LEAK L	2.4E-08	1.2E+02	2.9E-06
25	CWSPNELCCWA	PIPING NON-SERVICE WATER SYSTEM CCWA EXTERNAL LEAK L	8.8E-07	1.2E+02	1.1E-04
26	CWSRIELCCWHXA1	HEAT EXCHANGER CCWHXA1 TUBE EXTERNAL LEAK L	7.2E-07	1.2E+02	8.7E-05
27	CWSPMELCCWPA	M/P CCWPA EXTERNAL LEAK L	1.9E-07	1.2E+02	2.3E-05
28	CWSXVELCCW0001A	X/V CCW0001A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
29	CWSXVEL045A	X/V 045A EXTEANAL LEAK L	7.2E-08	1.2E+02	8.7E-06
30	CWSXVEL014A	X/V 014A EXTEANAL LEAK L	7.2E-08	1.2E+02	8.7E-06
31	HPIXVEL132A	X/V 132A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
32	HPIXVEL133A	X/V 133A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
33	CWSXVEL103A	X/V 103A EXTEANAL LEAK L	7.2E-08	1.2E+02	8.7E-06
34	HPIXVELCCW0002A	X/V CCW0002A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
35	HPIXVEL160A	X/V 160A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
36	HPIXVEL161A	X/V 161A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
37	CWSXVEL055A	X/V 055A EXTEANAL LEAK L	7.2E-08	1.2E+02	8.7E-06
38	CWSXVEL101A	X/V 101A EXTEANAL LEAK L	7.2E-08	1.2E+02	8.7E-06
39	CWSCVEL052A	C/V 052A EXTERNAL LEAK L	4.8E-08	1.2E+02	5.8E-06
40	CWSMVEL056A	M/V 056A EXTEANAL LEAK L	2.4E-08	1.2E+02	2.9E-06

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 3 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
41	CWSMVEL043A	M/V 043A EXTEANAL LEAK L	2.4E-08	1.2E+02	2.9E-06
42	CWSPNELCCWA1	PIPING NON-SERVICE WATER SYSTEM CCWA1 EXTERNAL LEAK L	8.2E-07	1.2E+02	1.0E-04
43	CHIXVEL224A	X/V 224A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
44	CHIXVEL300A	X/V 300A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
45	CHIXVEL226A	X/V 226A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
46	CHIXVEL225A	X/V 225A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
47	CWSXVELCCW0005A	X/V CCW0005A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
48	CWSXVELCCW0006A	X/V CCW0006A EXTERNAL LEAK L	7.2E-08	1.2E+02	8.7E-06
49	CHIOO02CV21	REMOTE OPERATION (HUMAN ERROR)	2.6E-03	1.2E+02	3.1E-01
50	RSSRXELRHEXB	CS/RHR HEAT EXCHANGER SHELL B EXTERNAL LEAK L	9.6E-08	1.2E+02	1.1E-05
51	RSSRXELRHEXA	CS/RHR HEAT EXCHANGER SHELL A EXTERNAL LEAK L	9.6E-08	1.2E+02	1.1E-05
52	RSSXVEL107A	X/V 107A EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.4E-06
53	RSSXVEL107B	X/V 107B EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.4E-06
54	RSSXVEL113A	X/V 113A EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.4E-06
55	RSSXVEL113B	X/V 113B EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.4E-06
56	RSSMVEL114A	M/V 114A EXTERNAL LEAK L	2.4E-08	1.2E+02	2.8E-06
57	RSSMVEL114B	M/V 114B EXTERNAL LEAK L	2.4E-08	1.2E+02	2.8E-06
58	RSSXVEL187A	X/V 187A EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.3E-06
59	RSSXVEL183A	X/V 183A EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.3E-06
60	RSSXVEL183B	X/V 183B EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.3E-06
61	RSSXVEL187B	X/V 187B EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.3E-06
62	RSSXVELCCW0003B	X/V CCW0003B EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.3E-06
63	RSSXVELCCW0003A	X/V CCW0003A EXTERNAL LEAK LARGE	7.2E-08	1.2E+02	8.3E-06
64	CWSCF3RHPRHXABC1-12	CWS HX-A,B,C PLUG (CCW) CCF	1.8E-08	1.1E+02	1.9E-06
65	EPSCF4CBTD6H-124	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.2E-06	1.1E+02	5.4E-04
66	EPSCF4CBTD6H-134	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.2E-06	9.9E+01	5.1E-04
67	ESWCF3PMBDSWPABC-ALL	ESW PUMP A,B,C FAIL TO RE-START	6.0E-05	8.9E+01	5.3E-03
68	CWSCF3PCBDCWPABC-ALL	CWS PUMP A,B,C FAIL TO RE-START CCF	3.3E-05	8.9E+01	2.9E-03
69	ESWCF3CVOD502ABC-ALL	ESW C/V 502A,B,C FAIL TO RE-OPEN	3.0E-07	8.9E+01	2.7E-05
70	CWSCF3CVOD052ABC-ALL	CWS C/V 052 A,B,C FAIL TO RE-OPEN CCF	3.0E-07	8.9E+01	2.7E-05

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 4 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
71	ESWCF3CVOD602ABC-ALL	ESW C/V 602A,B,C FAIL TO RE-OPEN	3.0E-07	8.9E+01	2.7E-05
72	CWSCF3RHPRHXABC1-13	CWS HX-A,B,C PLUG (CCW) CCF	1.8E-08	7.8E+01	1.4E-06
73	CWSCF3RHPRHXABC1-23	CWS HX-A,B,C PLUG (CCW) CCF	1.8E-08	7.8E+01	1.4E-06
74	EPSCF4IVFFINV-134	INVERTER-A,B,C,D FAIL TO OPERATE	5.0E-07	5.5E+01	2.7E-05
75	EPSCF4CBWRVIT4-134	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	5.5E+01	1.6E-06
76	EPSCF4BYFF-134	BATTERY A,B,C,D FAIL TO OPERATE CCF	1.2E-08	5.1E+01	6.2E-07
77	EPSCF4CBTD6H-234	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.2E-06	4.9E+01	2.5E-04
78	EPSCF4IVFFINV-ALL	INVERTER-A,B,C,D FAIL TO OPERATE	1.5E-06	4.9E+01	7.1E-05
79	EPSCF4CBWRVIT4-ALL	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	4.9E+01	7.5E-06
80	EPSCF4IVFFINV-124	INVERTER-A,B,C,D FAIL TO OPERATE	5.0E-07	4.9E+01	2.4E-05
81	EPSCF4CBWRVIT4-124	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.9E+01	1.4E-06
82	EPSCF4BYFF-ALL	BATTERY A,B,C,D FAIL TO OPERATE CCF	5.0E-08	4.7E+01	2.3E-06
83	RSSOO02RHR2	HUMAN ERROR	6.2E-03	4.6E+01	2.8E-01
84	EPSCF4BYFF-124	BATTERY A,B,C,D FAIL TO OPERATE CCF	1.2E-08	4.5E+01	5.5E-07
85	EPSCF3DLLRDG-ALL	DG-A,B,C FAIL TO RUN (>1H) CCF	1.1E-03	3.7E+01	4.1E-02
86	EPSCF3DLADDG-ALL	DG-A,B,C FAIL TO START CCF	2.4E-04	3.7E+01	8.6E-03
87	EPSCF3DLSRDG-ALL	DG-A,B,C FAIL TO RUN (<1H) CCF	1.8E-04	3.7E+01	6.4E-03
88	EPSCF3SEFFDG-ALL	EPS SG SEQUENCER FAIL TO OPERATE CCF	7.5E-05	3.7E+01	2.7E-03
89	EPSCF3CBTDDG-ALL	BREAKER DGBA,DGBB,DGBC FAIL TO CLOSE CCF	2.0E-05	3.7E+01	7.3E-04
90	EPSCF3CBWRDGB-ALL	DGBA,DGBB,DGBC BREAKER FAIL OPERATE CCF	1.7E-07	3.7E+01	6.1E-06
91	EPSCF4CBWR4I-ALL	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	2.3E+01	3.5E-06
92	EPSCF4CBWR4I-234	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	2.1E+01	5.9E-07
93	CHICF2CVOD163-ALL	CHI C/V163A,B FAIL TO OPEN CCF	2.0E-06	2.0E+01	3.9E-05
94	CHICF2CVOD165-ALL	CHI C/V165A,B FAIL TO OPEN CCF	2.0E-06	2.0E+01	3.9E-05
95	LOAOO02LC	HUMAN ERROR (LOCA)	2.6E-03	2.0E+01	4.8E-02
96	EPSCF4CBWR4J-ALL	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	1.6E-07	1.9E+01	2.9E-06
97	EPSCF4CBWR4J-14	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	1.7E+01	5.5E-07
98	EPSCF4CBWR4I-34	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	1.7E+01	5.5E-07
99	EPSCF4CBWR4J-124	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	1.7E+01	4.8E-07
100	EPSCF4CBWR4J-134	EPS C/B 4JA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	1.7E+01	4.8E-07
101	EPSCF4CBWR4I-134	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	1.7E+01	4.8E-07

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 5 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
102	EPSCF4CBWR4I-24	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	1.7E+01	5.2E-07
103	EPSCF4CBWR4I-124	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	1.6E+01	4.4E-07
104	CHICF2PMBDCHP-ALL	CHP-A,B FAIL TO START CCF	2.0E-04	1.5E+01	2.8E-03
105	CHIMVCD121BC-ALL	M/V 121B,C FAIL TO CLOSE	4.7E-05	1.5E+01	6.4E-04
106	CHIMVOD121DE-ALL	M/V 121D,E FAIL TO OPEN	4.7E-05	1.5E+01	6.4E-04
107	CHIORPROR02	ORIFICE OR02 PLUG	2.4E-05	1.5E+01	3.3E-04
108	CHIORPRFE138	ORIFICE FE138 PLUG	2.4E-05	1.5E+01	3.3E-04
109	CHIAVCM138	A/V 138 MIS-CLOSE	4.8E-06	1.5E+01	6.5E-05
110	CHIAVCM215	A/V 215 MIS-CLOSE	4.8E-06	1.5E+01	6.5E-05
111	CHIAVCM236	A/V 236 MIS-CLOSE	4.8E-06	1.5E+01	6.5E-05
112	CHIMVPR220	M/V 220 PLUG	2.4E-06	1.5E+01	3.3E-05
113	CHICVPR239	C/V 239 PLUG	2.4E-06	1.5E+01	3.3E-05
114	CHICVPR237	C/V 237 PLUG	2.4E-06	1.5E+01	3.3E-05
115	CHIAVPR138	A/V 138 PLUG	2.4E-06	1.5E+01	3.3E-05
116	CHIXVPR242	X/V 242 PLUG	2.4E-06	1.5E+01	3.3E-05
117	CHIMVPR221	M/V 221 PLUG	2.4E-06	1.5E+01	3.3E-05
118	CHIXVPR167	X/V 167 PLUG	2.4E-06	1.5E+01	3.3E-05
119	CHIAVPR236	A/V 236 PLUG	2.4E-06	1.5E+01	3.3E-05
120	CHIAVPR215	A/V 215 PLUG	2.4E-06	1.5E+01	3.3E-05
121	CHIXVPR241	X/V 241 PLUG	2.4E-06	1.5E+01	3.3E-05
122	CHICVPR222	C/V 222 PLUG	2.4E-06	1.5E+01	3.3E-05
123	CHIMVCM220	M/V 220 MIS-CLOSE	9.6E-07	1.5E+01	1.3E-05
124	CHIMVCM221	M/V 221 MIS-CLOSE	9.6E-07	1.5E+01	1.3E-05
125	CHIAVIL227	A/V 227 INTERNAL LEAK L	1.2E-07	1.5E+01	1.6E-06
126	CHICVOD169	C/V 169 FAIL TO OPEN	1.2E-05	1.5E+01	1.6E-04
127	CHICVPR169	C/V 169 PLUG	2.4E-06	1.5E+01	3.2E-05
128	CHIXVPR240C	X/V 240C PLUG	2.4E-06	1.5E+01	3.2E-05
129	CHIXVEL240C	X/V 240C EXTERNAL LEAK L	7.2E-08	1.5E+01	9.7E-07
130	CHICVEL169	C/V 169 EXTERNAL LEAK L	4.8E-08	1.5E+01	6.5E-07
131	RWSTNELRWSAT	TANK UNPRESSURIZED EXTERNAL LEAK L	4.8E-08	1.5E+01	6.5E-07
132	CHIMVEL121D	M/V 121D EXTERNAL LEAK L	2.4E-08	1.5E+01	3.2E-07

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 6 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
133	CHIMVEL121E	M/V 121E EXTERNAL LEAK L	2.4E-08	1.5E+01	3.2E-07
134	CHIRIELHXCH	HEAT EXCHANGER HXCH TUBE EXTERNAL LEAK L	7.2E-07	1.4E+01	9.5E-06
135	CHIPMELCHPA	M/P CHPA EXTERNAL LEAK L	1.9E-07	1.4E+01	2.5E-06
136	CHIPMELCHPB	M/P CHPB EXTERNAL LEAK L	1.9E-07	1.4E+01	2.5E-06
137	CHIXVEL240B	X/V 240B EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
138	CHIXVEL241	X/V 241 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
139	CHIXVELCVC02	X/V CVC02 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
140	CHIXVEL242	X/V 242 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
141	CHIXVELCVC01	X/V CVC01 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
142	CHIXVEL166B	X/V 166B EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
143	CHIXVEL167	X/V 167 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
144	CHIXVELCVC11	X/V CVC11 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
145	CHIXVEL162A	X/V 162A EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
146	CHIXVEL162B	X/V 162B EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
147	CHIXVELCVC06	X/V CVC06 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
148	CHIXVELCVC09	X/V CVC09 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
149	CHIXVELCVC07	X/V CVC07 EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
150	CHIXVEL240A	X/V 240A EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
151	CHIXVEL166A	X/V 166A EXTERNAL LEAK L	7.2E-08	1.4E+01	9.5E-07
152	CHICVEL237	C/V 237 EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
153	CHICVEL239	C/V 239 EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
154	CHICVEL222	C/V 222 EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
155	CHICVEL165A	C/V 165A EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
156	CHICVEL152	C/V 152 EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
157	CHICVEL165B	C/V 165B EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
158	CHICVEL163A	C/V 163A EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
159	CHICVEL163B	C/V 163B EXTERNAL LEAK L	4.8E-08	1.4E+01	6.3E-07
160	CHIMVEL221	M/V 221 EXTERNAL LEAK L	2.4E-08	1.4E+01	3.2E-07
161	CHIMVEL220	M/V 220 EXTERNAL LEAK L	2.4E-08	1.4E+01	3.2E-07
162	CHIMVEL121B	M/V 121B EXTERNAL LEAK L	2.4E-08	1.4E+01	3.2E-07
163	CHIMVEL121C	M/V 121C EXTERNAL LEAK L	2.4E-08	1.4E+01	3.2E-07

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 7 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
164	CHIAVEL236	A/V 236 EXTERNAL LEAK L	2.2E-08	1.4E+01	2.8E-07
165	CHIAVEL138	A/V 138 EXTERNAL LEAK L	2.2E-08	1.4E+01	2.8E-07
166	CHIAVEL215	A/V 215 EXTERNAL LEAK L	2.2E-08	1.4E+01	2.8E-07
167	CHIAVELCVC03	A/V CVC03 EXTERNAL LEAK L	2.2E-08	1.4E+01	2.8E-07
168	CHIAVEL227	A/V 227 EXTERNAL LEAK L	2.2E-08	1.4E+01	2.8E-07
169	CHIAVELCVC04	A/V CVC04 EXTERNAL LEAK L	2.2E-08	1.4E+01	2.8E-07
170	HPICF2PMADSIP-ALL	M/P SIPA,B FAIL TO START (STANDBY) CCF	1.5E-04	1.4E+01	2.0E-03
171	HPICF2PMSRSIP-ALL	M/P SIPA,B FAIL TO RUN (STANDBY) (<1H) CCF	1.7E-05	1.4E+01	2.2E-04
172	RWSCF4SUPRST01-ALL	SUMP STRAINER PLUG CCF	9.7E-06	1.4E+01	1.3E-04
173	HPICF2PMLRSIP-ALL	M/P SIPA,B FAIL TO RUN (STANDBY) (>1H) CCF	5.7E-06	1.4E+01	7.4E-05
174	RWSCF4SUPRST01-124	SUMP STRAINER PLUG CCF	3.7E-06	1.4E+01	4.7E-05
175	RWSCF4SUPRST01-134	SUMP STRAINER PLUG CCF	3.7E-06	1.4E+01	4.7E-05
176	RWSCF4SUPRST01-14	SUMP STRAINER PLUG CCF	3.0E-06	1.4E+01	3.8E-05
177	HPICF2CVOD8806-ALL	HPI C/V 8806A,B FAIL TO OPEN CCF	2.0E-06	1.4E+01	2.6E-05
178	HPICF2CVOD8804-ALL	HPI C/V 8804A,B FAIL TO OPEN CCF	2.0E-06	1.4E+01	2.6E-05
179	HPICF2CVOD8809-ALL	HPI C/V 8809A,B FAIL TO OPEN CCF	2.0E-06	1.4E+01	2.6E-05
180	HPICF2CVOD8808-ALL	HPI C/V 8808A,B FAIL TO OPEN CCF	2.0E-06	1.4E+01	2.6E-05
181	HPIOO02S	HUMAN ERROR	4.9E-03	1.3E+01	5.8E-02
182	RWSTNELRWSP	TANK UNPRESSURIZED EXTERNAL LEAK L	4.8E-08	1.2E+01	5.4E-07
183	RSSPNEL01D	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	2.9E-08	1.2E+01	3.2E-07
184	RSSPNEL01B	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	2.9E-08	1.2E+01	3.2E-07
185	RSSPNEL01C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	2.8E-08	1.2E+01	3.2E-07
186	RSSPNEL01A	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	2.8E-08	1.2E+01	3.2E-07
187	HPIPNELSUCTSD	PIPE IN CV EXTERNAL LEAK L	2.8E-08	1.2E+01	3.1E-07
188	HPIPNELSUCTSC	PIPE IN CV EXTERNAL LEAK L	2.8E-08	1.2E+01	3.1E-07
189	RSSMVEL9007B	M/V 9007B EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07
190	RSSMVEL9007A	M/V 9007A EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07
191	RSSMVEL9007D	M/V 9007D EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07
192	RSSMVEL9007C	M/V 9007C EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07
193	HPIMVEL8820B	M/V 8820B EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07
194	HPIMVEL8820A	M/V 8820A EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 8 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
195	HPIMVEL8820C	M/V 8820C EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07
196	HPIMVEL8820D	M/V 8820D EXTERNAL LEAK L	2.4E-08	1.2E+01	2.7E-07
197	HPIOO02S-DP2	HUMAN ERROR	5.5E-02	1.2E+01	6.3E-01
198	EPSCF4CBTD6H-14	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.0E-06	1.1E+01	5.2E-05
199	HPIPNELSUCTSB	PIPE IN CV EXTERNAL LEAK L	2.8E-08	1.1E+01	2.9E-07
200	HPIPNELSUCTSA	PIPE IN CV EXTERNAL LEAK L	2.8E-08	1.1E+01	2.9E-07
201	RWSXVEL026	X/V 026 EXTERNAL LEAK L	7.2E-08	9.5E+00	6.1E-07
202	RWSXVEL007A	X/V 007A EXTERNAL LEAK L	7.2E-08	9.5E+00	6.1E-07
203	RWSXVEL005A	X/V 005A EXTERNAL LEAK L	7.2E-08	9.5E+00	6.1E-07
204	RWSXVEL008	X/V 008 EXTERNAL LEAK L	7.2E-08	9.5E+00	6.1E-07
205	RWSXVEL004	X/V 004 EXTERNAL LEAK L	7.2E-08	9.5E+00	6.1E-07
206	EPSCF3DLLRDG-12	DG-A,B,C FAIL TO RUN (>1H) CCF	5.1E-04	9.0E+00	4.1E-03
207	EPSCF3DLADDG-13	DG-A,B,C FAIL TO START CCF	9.6E-05	9.0E+00	7.7E-04
208	EPSCF3DLSRDG-13	DG-A,B,C FAIL TO RUN (<1H) CCF	8.0E-05	9.0E+00	6.4E-04
209	EPSCF3SEFFDG-12	EPS SG SEQUENCER FAIL TO OPERATE CCF	3.8E-05	9.0E+00	3.0E-04
210	EPSCF3CBTDDG-12	BREAKER DGBA,DGBB,DGBC FAIL TO CLOSE CCF	1.0E-05	9.0E+00	8.1E-05
211	EPSCF3CBWRDGB-12	DGBA,DGBB,DGBC BREAKER FAIL OPERATE CCF	8.5E-08	9.0E+00	6.8E-07
212	EPSCF4IVFFINV-14	INVERTER-A,B,C,D FAIL TO OPERATE	1.0E-06	9.0E+00	8.0E-06
213	EPSCF4CBWRVIT4-14	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	9.0E+00	2.7E-07
214	EPSCF4CBTD6H-34	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.0E-06	8.5E+00	3.7E-05
215	EPSCF4CBTD6H-24	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.0E-06	7.1E+00	3.0E-05
216	RWSMVEL003	M/V 003 EXTERNAL LEAK L	2.4E-08	6.8E+00	1.4E-07
217	ACWPMBDCHP-ALL	ACW CHP-A,B FAIL TO START (RUNNING) CCF	1.5E-04	6.6E+00	8.6E-04
218	ACWMVODCH4AB-ALL	ACW MVCH4A,B FAIL TO OPEN CCF	4.7E-05	6.6E+00	2.6E-04
219	ACWMVCDCH6AB-ALL	ACW MVCH6A,B FAIL TO CLOSE CCF	4.7E-05	6.6E+00	2.6E-04
220	ACWMVODCH1AB-ALL	ACW MVCH1A,B FAIL TO OPEN CCF	4.7E-05	6.6E+00	2.6E-04
221	ACWMVODCH3AB-ALL	ACW MVCH3A,B FAIL TO OPEN CCF	4.7E-05	6.6E+00	2.6E-04
222	ACWMVODCH2AB-ALL	ACW MVCH2A,B FAIL TO OPEN CCF	4.7E-05	6.6E+00	2.6E-04
223	ACWPMYRCHP-ALL	ACW M/P CHPA,B FAIL TO RUN (RUNNING) CCF	5.0E-06	6.6E+00	2.8E-05
224	ACWCVCDCH5AB-ALL	ACW CVCH5A,B FAIL TO CLOSE CCF	4.7E-06	6.6E+00	2.6E-05
225	ACWCVELCH5B	C/V ACWCH5B EXTERNAL LEAK L	4.8E-08	6.6E+00	2.7E-07

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 9 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
226	ACWCVELCH5A	C/V ACWCH5A EXTERNAL LEAK L	4.8E-08	6.6E+00	2.7E-07
227	ACWTNELFWT	TANK UNPRESSURIZED EXTERNAL LEAK L	4.8E-08	6.6E+00	2.7E-07
228	ACWMVELCH7B	M/V ACWCH7B EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
229	ACWMVELCH3A	M/V ACWCH3A EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
230	ACWMVELCH3B	M/V ACWCH3B EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
231	ACWMVELCH1B	M/V ACWCH1B EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
232	ACWMVELCH1A	M/V ACWCH1A EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
233	ACWMVELCH2A	M/V ACWCH2A EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
234	ACWMVELCH7A	M/V ACWCH7A EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
235	ACWMVELCH2B	M/V ACWCH2B EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
236	ACWMVELCH6B	M/V ACWCH6B EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
237	ACWMVELCH6A	M/V ACWCH6A EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
238	ACWMVELCH4B	M/V ACWCH4B EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
239	ACWMVELCH8A	M/V ACWCH8A EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
240	ACWMVELCH8B	M/V ACWCH8B EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
241	ACWMVELCH4A	M/V ACWCH4A EXTERNAL LEAK L	2.4E-08	6.6E+00	1.3E-07
242	ACWOO02SC	ALTERNATIVE SEAL WATER FAIL TO OPERATE	3.1E-02	6.5E+00	1.8E-01
243	SWSSTPRST02C	STRAINER ST02C PLUG	1.7E-04	6.1E+00	8.5E-04
244	SWSORPROR24C	ORIFICE OR24C PLUG	2.4E-05	6.1E+00	1.2E-04
245	SWSFMPR2055C	FM 2055C BLOCKAGE	2.4E-05	6.1E+00	1.2E-04
246	SWSORPRESS0003C	ORIFICE ESS0003C PLUG	2.4E-05	6.1E+00	1.2E-04
247	SWSORPROR04C	ORIFICE OR04C PLUG	2.4E-05	6.1E+00	1.2E-04
248	CWSORPR1230C	ORIFICE 1230C PLUG	2.4E-05	6.1E+00	1.2E-04
249	CWSXVPR045C	X/V 045C PLUG	2.4E-06	6.1E+00	1.2E-05
250	CWSCVPR052C	C/V 052C PLUG	2.4E-06	6.1E+00	1.2E-05
251	CWSXVPR103C	X/V 103C PLUG	2.4E-06	6.1E+00	1.2E-05
252	CWSXVPR101C	X/V 101C PLUG	2.4E-06	6.1E+00	1.2E-05
253	CWSXVPR055C	X/V 055C PLUG	2.4E-06	6.1E+00	1.2E-05
254	SWSXVPR561C	X/V 561C PLUG	2.4E-06	6.1E+00	1.2E-05
255	SWSXVPR601C	X/V 601C PLUG	2.4E-06	6.1E+00	1.2E-05
256	SWSCVPR602C	C/V 602C PLUG	2.4E-06	6.1E+00	1.2E-05

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 10 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
257	SWSXVPR570C	X/V 570C PLUG	2.4E-06	6.1E+00	1.2E-05
258	SWSXVPR562C	X/V 562C PLUG	2.4E-06	6.1E+00	1.2E-05
259	SWSXVPR569C	X/V 569C PLUG	2.4E-06	6.1E+00	1.2E-05
260	CWSRIELCCWHXC2	HEAT EXCHANGER CCWHXC2 TUBE EXTERNAL LEAK L	7.2E-07	6.1E+00	3.6E-06
261	SWSPEELSWPC2	PIPING SERVICE WATER SYSTEM SWPC2 EXTERNAL	3.8E-07	6.1E+00	1.9E-06
262	SWSPEELSWPC3	PIPING SERVICE WATER SYSTEM SWPC3 EXTERNAL	2.1E-07	6.1E+00	1.1E-06
263	SWSPMELSWPC	M/P SWPC EXTERNAL LEAK L	1.9E-07	6.1E+00	9.7E-07
264	SWSXVEL601C	X/V 601C EXTEANAL LEAK L	7.2E-08	6.1E+00	3.6E-07
265	SWSXVEL561C	X/V 561C EXTEANAL LEAK L	7.2E-08	6.1E+00	3.6E-07
266	SWSXVEL562C	X/V 562C EXTEANAL LEAK L	7.2E-08	6.1E+00	3.6E-07
267	SWSCVEL602C	C/V 602C EXTERNAL LEAK L	4.8E-08	6.1E+00	2.4E-07
268	SWSPMYRSWPC-CG3	SWP-C FAIL TO RUN (RUNNING)	1.2E-04	6.1E+00	6.1E-04
269	CWSPCYRCCWPC-CG3	CCWP-C FAIL TO RUN (RUNNING)	6.7E-05	6.0E+00	3.4E-04
270	EPSTRFFPTC	4PTC TRANSFORMER FAIL TO RUN	8.2E-06	6.0E+00	4.1E-05
271	EPSBSFF4ESBC	480V BUS C FAILURE	5.8E-06	6.0E+00	2.9E-05
272	SWSPEELSWPC1	PIPING SERVICE WATER SYSTEM SWPC1 EXTERNAL	3.9E-06	6.0E+00	1.9E-05
273	SWSCVPR502C	C/V 502C PLUG	2.4E-06	6.0E+00	1.2E-05
274	SWSXVPR507C	X/V 507C PLUG	2.4E-06	6.0E+00	1.2E-05
275	SWSXVPR509C	X/V 509C PLUG	2.4E-06	6.0E+00	1.2E-05
276	SWSXVPR503C	X/V 503C PLUG	2.4E-06	6.0E+00	1.2E-05
277	SWSXVEL507C	X/V 507C EXTEANAL LEAK L	7.2E-08	6.0E+00	3.6E-07
278	SWSXVEL503C	X/V 503C EXTEANAL LEAK L	7.2E-08	6.0E+00	3.6E-07
279	SWSXVEL509C	X/V 509C EXTEANAL LEAK L	7.2E-08	6.0E+00	3.6E-07
280	SWSXVELESS0001C	X/V ESS0001C EXTEANAL LEAK L	7.2E-08	6.0E+00	3.6E-07
281	SWSXVELESS0002C	X/V ESS0002C EXTEANAL LEAK L	7.2E-08	6.0E+00	3.6E-07
282	SWSCVEL502C	C/V 502C EXTERNAL LEAK L	4.8E-08	6.0E+00	2.4E-07
283	EPSCBWR4IC	4IC BREAKER FAIL TO OPERATE (MALFUNCTION)	3.0E-06	5.9E+00	1.5E-05
284	CWSRHPRCCWHXC1-CG3	HEAT EXCHANGER PLUG / FOUL (CCW OR RHR)	1.4E-06	5.8E+00	6.6E-06
285	CWSPNELCCWC	PIPING NON-SERVICE WATER SYSTEM CCWC EXTERNAL LEAK L	1.1E-06	5.7E+00	5.4E-06
286	RSSMVOM114C	M/V 114C MIS-OPENING	9.6E-07	5.7E+00	4.6E-06

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 11 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
287	CWSRIELCCWHXC1	HEAT EXCHANGER CCWHXC1 TUBE EXTERNAL LEAK L	7.2E-07	5.7E+00	3.4E-06
288	CWSPMELCCWPC	M/P CCWPC EXTERNAL LEAK L	1.9E-07	5.7E+00	9.1E-07
289	CWSXVELCCW0001B	X/V CCW0001B EXTEANAL LEAK L	7.2E-08	5.7E+00	3.4E-07
290	HPIXVEL133C	X/V 133C EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
291	CWSXVEL045C	X/V 045C EXTEANAL LEAK L	7.2E-08	5.7E+00	3.4E-07
292	CWSXVEL014C	X/V 014C EXTEANAL LEAK L	7.2E-08	5.7E+00	3.4E-07
293	HPIXVELCCW0002C	X/V CCW0002C EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
294	CWSXVEL101C	X/V 101C EXTEANAL LEAK L	7.2E-08	5.7E+00	3.4E-07
295	HPIXVEL160C	X/V 160C EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
296	HPIXVEL161C	X/V 161C EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
297	CWSXVEL055C	X/V 055C EXTEANAL LEAK L	7.2E-08	5.7E+00	3.4E-07
298	CWSXVEL103C	X/V 103C EXTEANAL LEAK L	7.2E-08	5.7E+00	3.4E-07
299	HPIXVEL132C	X/V 132C EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
300	CWSCVEL052C	C/V 052C EXTERNAL LEAK L	4.8E-08	5.7E+00	2.3E-07
301	CWSMVEL043C	M/V 043C EXTEANAL LEAK L	2.4E-08	5.7E+00	1.1E-07
302	CWSMVEL056C	M/V 056C EXTEANAL LEAK L	2.4E-08	5.7E+00	1.1E-07
303	EPSCF4CBTD6H-123	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.2E-06	5.7E+00	2.4E-05
304	CWSPNELCCWC1	PIPING NON-SERVICE WATER SYSTEM CCWC1 EXTERNAL LEAK L	7.9E-07	5.7E+00	3.7E-06
305	CWSXVELCCW0005C	X/V CCW0005C EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
306	CHIXVEL225B	X/V 225B EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
307	CHIXVEL224B	X/V 224B EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
308	CHIXVEL300B	X/V 300B EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
309	CHIXVEL226B	X/V 226B EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
310	CWSXVELCCW0006C	X/V CCW0006C EXTERNAL LEAK L	7.2E-08	5.7E+00	3.4E-07
311	RSSRXELRHEXC	CS/RHR HEAT EXCHANGER SHELL C EXTERNAL LEAK L	9.6E-08	5.6E+00	4.5E-07
312	RSSXVEL113C	X/V 113C EXTERNAL LEAK LARGE	7.2E-08	5.6E+00	3.3E-07
313	RSSXVEL107C	X/V 107C EXTERNAL LEAK LARGE	7.2E-08	5.6E+00	3.3E-07
314	RSSXVEL187C	X/V 187C EXTERNAL LEAK LARGE	7.2E-08	5.6E+00	3.3E-07
315	RSSXVELCCW0003C	X/V CCW0003C EXTERNAL LEAK LARGE	7.2E-08	5.6E+00	3.3E-07
316	RSSXVEL183C	X/V 183C EXTERNAL LEAK LARGE	7.2E-08	5.6E+00	3.3E-07

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 12 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
317	EPSCF4CBWR4I-23	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	5.6E+00	1.6E-07
318	EPSCF4CBWR4I-12	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	5.6E+00	1.6E-07
319	EPSCF4CBWR4I-123	EPS C/B 4IA,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	5.6E+00	1.4E-07
320	CWSORPR1224B	ORIFICE 1224B PLUG	2.4E-05	5.4E+00	1.1E-04
321	SWSSTPRST02A	STRAINER ST02A PLUG	1.7E-04	5.4E+00	7.4E-04
322	SWSORPROR24A	ORIFICE OR24A PLUG	2.4E-05	5.4E+00	1.1E-04
323	SWSORPRESS0003A	ORIFICE ESS0003A PLUG	2.4E-05	5.4E+00	1.1E-04
324	SWSFMPR2055A	FM 2055A BLOCKAGE	2.4E-05	5.4E+00	1.1E-04
325	SWSORPROR04A	ORIFICE OR04A PLUG	2.4E-05	5.4E+00	1.1E-04
326	CWSORPR1230A	ORIFICE 1230A PLUG	2.4E-05	5.4E+00	1.1E-04
327	CWSXVPR045A	X/V 045A PLUG	2.4E-06	5.4E+00	1.1E-05
328	SWSCVPR602A	C/V 602A PLUG	2.4E-06	5.4E+00	1.1E-05
329	SWSXVPR601A	X/V 601A PLUG	2.4E-06	5.4E+00	1.1E-05
330	SWSXVPR562A	X/V 562A PLUG	2.4E-06	5.4E+00	1.1E-05
331	SWSXVPR561A	X/V 561A PLUG	2.4E-06	5.4E+00	1.1E-05
332	SWSXVPR570A	X/V 570A PLUG	2.4E-06	5.4E+00	1.1E-05
333	SWSXVPR569A	X/V 569A PLUG	2.4E-06	5.4E+00	1.1E-05
334	CWSXVPR055A	X/V 055A PLUG	2.4E-06	5.4E+00	1.1E-05
335	CWSCVPR052A	C/V 052A PLUG	2.4E-06	5.4E+00	1.1E-05
336	CWSXVPR101A	X/V 101A PLUG	2.4E-06	5.4E+00	1.1E-05
337	CWSXVPR103A	X/V 103A PLUG	2.4E-06	5.4E+00	1.1E-05
338	CWSRIELCCWHXA2	HEAT EXCHANGER CCWHXA2 TUBE EXTERNAL LEAK L	7.2E-07	5.4E+00	3.2E-06
339	SWSPEELSWPA2	PIPING SERVICE WATER SYSTEM SWPA2 EXTERNAL	3.8E-07	5.4E+00	1.6E-06
340	SWSPEELSWPA3	PIPING SERVICE WATER SYSTEM SWPA3 EXTERNAL	2.1E-07	5.4E+00	9.3E-07
341	SWSPMELSWPA	M/P SWPA EXTERNAL LEAK L	1.9E-07	5.4E+00	8.4E-07
342	SWSXVEL601A	X/V 601A EXTEANAL LEAK L	7.2E-08	5.4E+00	3.2E-07
343	SWSXVEL561A	X/V 561A EXTEANAL LEAK L	7.2E-08	5.4E+00	3.2E-07
344	SWSXVEL562A	X/V 562A EXTEANAL LEAK L	7.2E-08	5.4E+00	3.2E-07
345	SWSCVEL602A	C/V 602A EXTERNAL LEAK L	4.8E-08	5.4E+00	2.1E-07
346	SWSPMYRSWPA-CG3	SWP-A FAIL TO RUN (RUNNING)	1.2E-04	5.4E+00	5.2E-04
347	CWSPCYRCCWPA-CG3	CCWP-A FAIL TO RUN (RUNNING)	6.7E-05	5.4E+00	2.9E-04

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 13 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
348	SWSSTPRST02B	STRAINER ST02B PLUG	1.7E-04	5.3E+00	7.3E-04
349	SWSORPROR24B	ORIFICE OR24B PLUG	2.4E-05	5.3E+00	1.0E-04
350	CWSORPR1230B	ORIFICE 1230B PLUG	2.4E-05	5.3E+00	1.0E-04
351	SWSFMPR2055B	FM 2055B BLOCKAGE	2.4E-05	5.3E+00	1.0E-04
352	SWSORPROR04B	ORIFICE OR04B PLUG	2.4E-05	5.3E+00	1.0E-04
353	SWSORPRESS0003B	ORIFICE ESS0003B PLUG	2.4E-05	5.3E+00	1.0E-04
354	CWSXVPR103B	X/V 103B PLUG	2.4E-06	5.3E+00	1.0E-05
355	SWSXVPR562B	X/V 562B PLUG	2.4E-06	5.3E+00	1.0E-05
356	CWSXVPR101B	X/V 101B PLUG	2.4E-06	5.3E+00	1.0E-05
357	CWSCVPR052B	C/V 052B PLUG	2.4E-06	5.3E+00	1.0E-05
358	SWSXVPR561B	X/V 561B PLUG	2.4E-06	5.3E+00	1.0E-05
359	SWSXVPR601B	X/V 601B PLUG	2.4E-06	5.3E+00	1.0E-05
360	CWSXVPR045B	X/V 045B PLUG	2.4E-06	5.3E+00	1.0E-05
361	SWSCVPR602B	C/V 602B PLUG	2.4E-06	5.3E+00	1.0E-05
362	SWSXVPR570B	X/V 570B PLUG	2.4E-06	5.3E+00	1.0E-05
363	CWSXVPR055B	X/V 055B PLUG	2.4E-06	5.3E+00	1.0E-05
364	SWSXVPR569B	X/V 569B PLUG	2.4E-06	5.3E+00	1.0E-05
365	CWSRIELCCWHXB2	HEAT EXCHANGER CCWHXB2 TUBE EXTERNAL LEAK L	7.2E-07	5.3E+00	3.1E-06
366	SWSPEELSWPB2	PIPING SERVICE WATER SYSTEM SWPB2 EXTERNAL	3.8E-07	5.3E+00	1.6E-06
367	SWSPEELSWPB3	PIPING SERVICE WATER SYSTEM SWPB3 EXTERNAL	2.1E-07	5.3E+00	9.2E-07
368	SWSPMELSWPB	M/P SWPB EXTERNAL LEAK L	1.9E-07	5.3E+00	8.3E-07
369	SWSXVEL562B	X/V 562B EXTEANAL LEAK L	7.2E-08	5.3E+00	3.1E-07
370	SWSXVEL601B	X/V 601B EXTEANAL LEAK L	7.2E-08	5.3E+00	3.1E-07
371	SWSXVEL561B	X/V 561B EXTEANAL LEAK L	7.2E-08	5.3E+00	3.1E-07
372	SWSCVEL602B	C/V 602B EXTERNAL LEAK L	4.8E-08	5.3E+00	2.1E-07
373	SWSPMYRSWPB-CG3	SWP-B FAIL TO RUN (RUNNING)	1.2E-04	5.3E+00	5.2E-04
374	CWSPCYRCCWPB-CG3	CCWP-B FAIL TO RUN (RUNNING)	6.7E-05	5.3E+00	2.9E-04
375	SWSPEELSWPA1	PIPING SERVICE WATER SYSTEM SWPA1 EXTERNAL	3.9E-06	5.2E+00	1.6E-05
376	SWSCVPR502A	C/V 502A PLUG	2.4E-06	5.2E+00	1.0E-05
377	SWSXVPR509A	X/V 509A PLUG	2.4E-06	5.2E+00	1.0E-05
378	SWSXVPR503A	X/V 503A PLUG	2.4E-06	5.2E+00	1.0E-05

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 14 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
379	SWSXVPR507A	X/V 507A PLUG	2.4E-06	5.2E+00	1.0E-05
380	SWSXVEL503A	X/V 503A EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
381	SWSXVEL509A	X/V 509A EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
382	SWSXVEL507A	X/V 507A EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
383	SWSXVELESS0002A	X/V ESS0002A EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
384	SWSXVELESS0001A	X/V ESS0001A EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
385	SWSCVEL502A	C/V 502A EXTERNAL LEAK L	4.8E-08	5.2E+00	2.0E-07
386	SWSPEELSWPB1	PIPING SERVICE WATER SYSTEM SWPB1 EXTERNAL	3.9E-06	5.2E+00	1.6E-05
387	SWSXVPR503B	X/V 503B PLUG	2.4E-06	5.2E+00	1.0E-05
388	SWSXVPR507B	X/V 507B PLUG	2.4E-06	5.2E+00	1.0E-05
389	SWSCVPR502B	C/V 502B PLUG	2.4E-06	5.2E+00	1.0E-05
390	SWSXVPR509B	X/V 509B PLUG	2.4E-06	5.2E+00	1.0E-05
391	SWSXVEL507B	X/V 507B EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
392	SWSXVEL503B	X/V 503B EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
393	SWSXVELESS0002B	X/V ESS0002B EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
394	SWSXVEL509B	X/V 509B EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
395	SWSXVELESS0001B	X/V ESS0001B EXTEANAL LEAK L	7.2E-08	5.2E+00	3.0E-07
396	SWSCVEL502B	C/V 502B EXTERNAL LEAK L	4.8E-08	5.2E+00	2.0E-07
397	EPSCF4IVFFINV-12	INVERTER-A,B,C,D FAIL TO OPERATE	1.0E-06	5.1E+00	4.1E-06
398	EPSCF4CBWRVIT4-12	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	5.1E+00	1.4E-07
399	CWSRHPRCCWHXA1-CG3	HEAT EXCHANGER PLUG / FOUL (CCW OR RHR)	1.4E-06	5.1E+00	5.6E-06
400	CWSRHPRCCWHXB1-CG3	HEAT EXCHANGER PLUG / FOUL (CCW OR RHR)	1.4E-06	5.1E+00	5.6E-06
401	EPSCF3DLLRDG-13	DG-A,B,C FAIL TO RUN (>1H) CCF	5.1E-04	4.9E+00	2.0E-03
402	EPSCF3DLADDG-23	DG-A,B,C FAIL TO START CCF	9.6E-05	4.9E+00	3.8E-04
403	EPSCF3DLSRDG-23	DG-A,B,C FAIL TO RUN (<1H) CCF	8.0E-05	4.9E+00	3.1E-04
404	EPSCF3SEFFDG-13	EPS SG SEQUENCER FAIL TO OPERATE CCF	3.8E-05	4.9E+00	1.5E-04
405	EPSCF3CBTDDG-13	BREAKER DGBA,DGBB,DGBC FAIL TO CLOSE CCF	1.0E-05	4.9E+00	4.0E-05
406	EPSCF3CBWRDGB-13	DGBA,DGBB,DGBC BREAKER FAIL OPERATE CCF	8.5E-08	4.9E+00	3.3E-07
407	EPSCF4IVFFINV-123	INVERTER-A,B,C,D FAIL TO OPERATE	5.0E-07	4.9E+00	1.9E-06
408	EPSCF4CBWRVIT4-123	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	4.9E+00	1.1E-07
409	RSSRIELRHEXC	CS/RHR HEAT EXCHANGER C LEAK LARGE	7.2E-07	4.3E+00	2.4E-06

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 15 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
410	RSSPMELCSPC	CS/RHR PUMP C EXTERNAL LEAK L	1.9E-07	4.3E+00	6.3E-07
411	RSSXVELRHR04C	X/V RHR04C EXTERNAL LEAK LARGE	7.2E-08	4.3E+00	2.4E-07
412	RSSXVEL9009C	X/V 9009C EXTERNAL LEAK LARGE	7.2E-08	4.3E+00	2.4E-07
413	RSSCVEL9008C	C/V 9008C EXTERNAL LEAK L	4.8E-08	4.3E+00	1.6E-07
414	RSSMVEL9015C	M/V 9015C EXTERNAL LEAK L	2.4E-08	4.3E+00	7.8E-08
415	RSSMVEL9011C	M/V 9011C EXTERNAL LEAK L	2.4E-08	4.3E+00	7.8E-08
416	RSSAVELRHR01C	A/V RHR01C EXTERNAL LEAK L	2.2E-08	4.3E+00	7.1E-08
417	RSSAVELRHR02C	A/V RHR02C EXTERNAL LEAK L	2.2E-08	4.3E+00	7.1E-08
418	RSSPNEL04C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	2.6E-07	3.9E+00	7.4E-07
419	RSSPNEL05C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	5.8E-08	3.9E+00	1.7E-07
420	RSSPNEL12C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	2.6E-08	3.9E+00	7.3E-08
421	RSSPNEL03C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	6.7E-09	3.9E+00	1.9E-08
422	RSSPNEL08C	PIPING NON-SERVICE WATER SYSTEM EXTERNAL LEAK	1.8E-09	3.9E+00	5.1E-09
423	RWSOO04XV027	HUMAN ERROR (RECOVERY FAILURE)	8.0E-04	3.8E+00	2.3E-03
424	RWSXVOD026	X/V 026 FAIL TO OPEN	7.0E-04	3.8E+00	2.0E-03
425	RWSXVOD028	X/V 028 FAIL TO OPEN	7.0E-04	3.8E+00	2.0E-03
426	RWSORPR025	ORIFICE 025 PLUG	2.4E-05	3.8E+00	6.8E-05
427	RWSXVPR028	X/V 028 PLUG	2.4E-06	3.8E+00	6.8E-06
428	RWSXVPR027	X/V 027 PLUG	2.4E-06	3.8E+00	6.8E-06
429	RWSXVPR026	X/V 026 PLUG	2.4E-06	3.8E+00	6.8E-06
430	RWSXVEL028	X/V 028 EXTERNAL LEAK L	7.2E-08	3.8E+00	2.0E-07
431	RWSXVEL027	X/V 027 EXTERNAL LEAK L	7.2E-08	3.8E+00	2.0E-07
432	EPSCF4IVFFINV-13	INVERTER-A,B,C,D FAIL TO OPERATE	1.0E-06	3.7E+00	2.7E-06
433	EPSCF4CBWRVIT4-13	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	3.7E+00	9.2E-08
434	RWSXVPR001	X/V 001 PLUG	2.4E-06	3.7E+00	6.4E-06
435	RWSMVPR002	M/V 002 PLUG	2.4E-06	3.7E+00	6.4E-06
436	RWSMVPR003	M/V 003 PLUG	2.4E-06	3.7E+00	6.4E-06
437	RWSMVCM002	M/V 002 MIS-CLOSE	9.6E-07	3.7E+00	2.6E-06
438	RWSMVCM003	M/V 003 MIS-CLOSE	9.6E-07	3.7E+00	2.6E-06
439	RWSSTRWSP	RWSP FAILUER	1.0E-15	3.7E+00	2.7E-15
440	EPSCF2DLLRDGP-ALL	EPS DG FAIL TO RUN (>1H) CCF	1.5E-03	3.6E+00	3.8E-03

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 16 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
441	EPSCF2DLADDGP-ALL	DGP1,DGP2 FAIL TO START CCF	3.1E-04	3.6E+00	7.9E-04
442	EPSCF2DLSRDGP-ALL	DGP1, DGP2 FAIL TO RUN (<1H) CCF	2.3E-04	3.6E+00	6.0E-04
443	EPSCF2SEFFDG-ALL	EPS SG SEQUENCER P1,P2 FAIL TO OPERATE CCF	1.4E-04	3.6E+00	3.7E-04
444	EPSCF2CBTDDGBP-ALL	BREAKER DGBP1,DGBP2 FAIL TO CLOSE CCF	2.8E-05	3.6E+00	7.4E-05
445	EPSCF2CBTD4A-ALL	TIELINE BREAKER 4AA,B FAIL TO CLOSE CCF	2.8E-05	3.6E+00	7.4E-05
446	EPSCF2CBTDSWW-ALL	SELECTOR SWITCH A,D FAIL TO CLOSE CCF	2.8E-05	3.6E+00	7.4E-05
447	EPSCF2IVFFINV-ALL	EPS INV P1,P2 FAIL TO OPERATE CCF	5.6E-06	3.6E+00	1.5E-05
448	EPSCF2CBWRSWW-ALL	SELECTOR SWITCH A,D FAIL TO OPERATE CCF	2.8E-07	3.6E+00	7.4E-07
449	EPSCF2CBWRVIT4P-ALL	EPS C/B VIT4P1,P2 FAIL TO REMAIN CLOSED CCF	2.8E-07	3.6E+00	7.4E-07
450	EPSCF2CBWR4A-ALL	TIELINE BREAKER 4AA,4AD FAIL OPERATE CCF	2.4E-07	3.6E+00	6.2E-07
451	EPSCF2CBWRDGBP-ALL	DGBP1,DGBP2 BREAKER FAIL OPERATE CCF	2.4E-07	3.6E+00	6.2E-07
452	EPSCF2BYFFP-ALL	BATTERY A,B FAIL TO OPERATE CCF	8.4E-08	3.6E+00	2.2E-07
453	EPSCF3DLLRDG-23	DG-A,B,C FAIL TO RUN (>1H) CCF	5.1E-04	3.6E+00	1.3E-03
454	EPSCF3DLADDG-12	DG-A,B,C FAIL TO START CCF	9.6E-05	3.6E+00	2.5E-04
455	EPSCF3DLSRDG-12	DG-A,B,C FAIL TO RUN (<1H) CCF	8.0E-05	3.6E+00	2.1E-04
456	EPSCF3SEFFDG-23	EPS SG SEQUENCER FAIL TO OPERATE CCF	3.8E-05	3.6E+00	9.7E-05
457	EPSCF3CBTDDG-23	BREAKER DGBA,DGBB,DGBC FAIL TO CLOSE CCF	1.0E-05	3.6E+00	2.6E-05
458	EPSCF3CBWRDGB-23	DGBA,DGBB,DGBC BREAKER FAIL OPERATE CCF	8.5E-08	3.6E+00	2.2E-07
459	EPSOO02RDG	(HUMAN ERROR) FAIL TO CONNECT RESERVE POWER GENERATOR	2.1E-02	3.6E+00	5.5E-02
460	EPSCF4CBTD6H-12	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.0E-06	3.5E+00	1.2E-05
461	EPSCF4IVFFINV-24	INVERTER-A,B,C,D FAIL TO OPERATE	1.0E-06	3.2E+00	2.2E-06
462	EPSCF4CBWRVIT4-24	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	3.2E+00	7.5E-08
463	EPSCF4IVFFINV-234	INVERTER-A,B,C,D FAIL TO OPERATE	5.0E-07	3.2E+00	1.1E-06
464	EPSCF4CBWRVIT4-234	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	2.9E-08	3.2E+00	6.3E-08
465	RSSMVEL114C	M/V 114C EXTERNAL LEAK L	2.4E-08	3.0E+00	4.7E-08
466	RSSCF3PMADCPABC-ALL	CS/RHR PUMP A,B,C FAIL TO RESTART CCF	1.1E-04	2.7E+00	1.9E-04
467	RSSCF3PMYRCPABC-ALL	CS/RHR PUMP A,B,C FAIL TO RUN CCF	6.1E-06	2.6E+00	9.6E-06
468	RSSCF3RHPRRHEX-ALL	HEAT EXCHANGER CS/RHR A,B,C PLUG / FOUL CCF	5.2E-06	2.5E+00	7.8E-06
469	RSSCF3CVOD9008-ALL	CS/RHR C/V 9008 A,B,C FAIL TO OPEN CCF	6.7E-07	2.5E+00	1.0E-06
470	EPSCF4CBTD6H-13	6HA,B,C,D BREAKER FAIL TO OPEN CCF	5.0E-06	2.4E+00	7.2E-06

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 17 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
471	EPSBSFF6ESBA	6.9KV SAFETY A BUS FAILURE	5.8E-06	2.3E+00	7.5E-06
472	RSSMVCD9007C	M/V 9007C FAIL TO CLOSE	1.0E-03	2.3E+00	1.3E-03
473	RSSMVOD114C	M/V 114C FAIL TO OPEN	1.0E-03	2.3E+00	1.3E-03
474	RSSMVFC9007C	M/V 9007C FAIL TO CONTROL	7.2E-05	2.3E+00	9.1E-05
475	RSSMVFC114C	M/V 114C FAIL TO CONTROL	7.2E-05	2.3E+00	9.1E-05
476	RSSORPR1244C	ORIFICE 1244C PLUG	2.4E-05	2.3E+00	3.0E-05
477	RSSORPR1242C	ORIFICE 1242C PLUG	2.4E-05	2.3E+00	3.0E-05
478	RSSORPR1246C	ORIFICE 1246C PLUG	2.4E-05	2.3E+00	3.0E-05
479	CWSORPR1224C	ORIFICE 1224C PLUG	2.4E-05	2.3E+00	3.0E-05
480	RSSMVPR114C	M/V 114C PLUG	2.4E-06	2.3E+00	3.0E-06
481	RSSXVPRCCW003C	X/V CCW003C PLUG	2.4E-06	2.3E+00	3.0E-06
482	RSSXVPR187C	X/V 187C PLUG	2.4E-06	2.3E+00	3.0E-06
483	RSSXVPR183C	X/V 183C PLUG	2.4E-06	2.3E+00	3.0E-06
484	RSSMVOM9007C	M/V 9007C MIS-OPENING	9.6E-07	2.3E+00	1.2E-06
485	RSSMVOM9011C	M/V 9011C MIS-OPENING	9.6E-07	2.3E+00	1.2E-06
486	RSSMVCM114C	M/V 114C MIS-CLOSE	9.6E-07	2.3E+00	1.2E-06
487	RSSMVOD9001C	M/V 9001C FAIL TO OPEN	1.0E-03	2.3E+00	1.3E-03
488	RSSMVOD9000C	M/V 9000C FAIL TO OPEN	1.0E-03	2.3E+00	1.3E-03
489	RSSMVOD9015C	M/V 9015C FAIL TO OPEN	1.0E-03	2.3E+00	1.3E-03
490	RSSMVOD9014C	M/V 9014C FAIL TO OPEN	1.0E-03	2.3E+00	1.3E-03
491	RSSMVFC9000C	M/V 9000C FAIL TO CONTROL	7.2E-05	2.3E+00	9.1E-05
492	RSSMVFC9001C	M/V 9001C FAIL TO CONTROL	7.2E-05	2.3E+00	9.1E-05
493	RSSMVFC9015C	M/V 9015C FAIL TO CONTROL	7.2E-05	2.3E+00	9.1E-05
494	RSSMVFC9014C	M/V 9014C FAIL TO CONTROL	7.2E-05	2.3E+00	9.1E-05
495	RSSSVOM9021C	S/V 9021C MIS-OPENING	4.8E-06	2.3E+00	6.0E-06
496	RSSAVOMRHR03C	A/V RHR03C MIS-OPENING	4.8E-06	2.3E+00	6.0E-06
497	RSSAVCMRHR01C	A/V RHR01C MIS-CLOSE	4.8E-06	2.3E+00	6.0E-06
498	RSSAVOMRHR02C	A/V RHR02C MIS-OPENING	4.8E-06	2.3E+00	6.0E-06
499	RSSMVPR9000C	M/V 9000C PLUG	2.4E-06	2.3E+00	3.0E-06
500	RSSMVPR9001C	M/V 9001C PLUG	2.4E-06	2.3E+00	3.0E-06
501	RSSMVPR9015C	M/V 9015C PLUG	2.4E-06	2.3E+00	3.0E-06

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-90 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 18 of 18)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
502	RSSCVPR9007C	C/V 9007C PLUG	2.4E-06	2.3E+00	3.0E-06
503	RSSMVPR9014C	M/V 9014C PLUG	2.4E-06	2.3E+00	3.0E-06
504	RSSCVPR9006C	C/V 9006C PLUG	2.4E-06	2.3E+00	3.0E-06
505	RSSCVPRACC01C	C/V ACC01C PLUG	2.4E-06	2.3E+00	3.0E-06
506	RSSAVPRRHR01C	A/V RHR01C PLUG	2.4E-06	2.3E+00	3.0E-06
507	RSSMVCM9000C	M/V 9000C MIS-CLOSE	9.6E-07	2.3E+00	1.2E-06
508	RSSMVCM9001C	M/V 9001C MIS-CLOSE	9.6E-07	2.3E+00	1.2E-06
509	RSSMVCM9015C	M/V 9015C MIS-CLOSE	9.6E-07	2.3E+00	1.2E-06
510	RSSMVOM9815C	M/V 9815C MIS-OPENING	9.6E-07	2.3E+00	1.2E-06
511	RSSMVCM9014C	M/V 9014C MIS-CLOSE	9.6E-07	2.3E+00	1.2E-06
512	EPSCF4BYFF-14	BATTERY A,B,C,D FAIL TO OPERATE CCF	1.9E-08	2.2E+00	2.3E-08
513	RSSORPR006C	ORIFICE 006C PLUG	2.4E-05	2.2E+00	2.9E-05
514	RSSORPR908C	ORIFICE 908C PLUG	2.4E-05	2.2E+00	2.9E-05
515	RSSORPR007C	ORIFICE 007C PLUG	2.4E-05	2.2E+00	2.9E-05
516	RSSXVPRRHR04C	X/V RHR04C PLUG	2.4E-06	2.2E+00	2.9E-06
517	RSSCVPR9008C	C/V 9008C PLUG	2.4E-06	2.2E+00	2.9E-06
518	RSSXVPR113C	X/V 113C PLUG	2.4E-06	2.1E+00	2.7E-06
519	RSSXVPR107C	X/V 107C PLUG	2.4E-06	2.1E+00	2.7E-06
520	EPSCF4IVFFINV-34	INVERTER-A,B,C,D FAIL TO OPERATE	1.0E-06	2.1E+00	1.1E-06
521	EPSCF4CBWRVIT4-34	EPS C/B VIT4A,B,C,D FAIL TO REMAIN CLOSED CCF	3.4E-08	2.1E+00	3.6E-08
522	CHIOO02CV212-DP3	FIELD SITE OPERATION (HUMAN ERROR)	1.6E-01	2.0E+00	2.0E-01
523	RSSCF3CVOD9006-ALL	CS/RHR C/V 9006 A,B,C FAIL TO OPEN CCF	6.7E-07	2.0E+00	6.7E-07
524	RSSCF3CVODACC01-ALL	CS/RHR C/V ACC01A,B,C FAIL TO OPEN CCF	6.7E-07	2.0E+00	6.7E-07
525	RSSCF3CVOD9007-ALL	CS/RHR C/V 9007 A,B,C FAIL TO OPEN CCF	6.7E-07	2.0E+00	6.7E-07

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-91 Common Cause Failure FV Importance of POS 8-1 for LPSD PRA

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF3DLLRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C) FAIL TO RUN (>1H) CCF	1.1E-03	4.1E-02	3.7E+01
2	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	2.9E-02	1.4E+03
3	EPSBTSWCCF	EPS SOFTWARE CCF	1.0E-05	1.5E-02	1.5E+03
4	EPSCF3DLADDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C) FAIL TO START CCF	2.4E-04	8.6E-03	3.7E+01
5	EPSCF3DLSRDG-ALL	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C) FAIL TO RUN (<1H) CCF	1.8E-04	6.4E-03	3.7E+01
6	ESWCF3PMBDSWPABC-ALL	ESW PUMP A,B,C FAIL TO RE-START CCF	6.0E-05	5.3E-03	8.9E+01
7	EPSCF3DLLRDG-12	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C) FAIL TO RUN (>1H) CCF	5.1E-04	4.1E-03	9.0E+00
8	EPSCF2DLLRDGP-ALL	AAC GAS TURBINE GENERATOR (GTG P1,2) FAIL TO RUN (>1H) CCF	1.5E-03	3.8E-03	3.6E+00
9	CWSCF3PCBDCWPABC-ALL	CCW PUMP A,B,C FAIL TO RE-START CCF	3.3E-05	2.9E-03	8.9E+01
10	CHICF2PMBDCHP-ALL	CHP-A,B FAIL TO START CCF	2.0E-04	2.8E-03	1.5E+01

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-92 Common Cause Failure RAW of POS 8-1 for LPSD PRA

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
1	SWSCF3PMYRSWPABC-ALL	ESW PUMP A,B,C FAIL TO RUN CCF	1.2E-07	5.0E+03	6.0E-04
2	CWSCF3PCYRCWPABC-ALL	CCW PUMP A,B,C FAIL TO RUN CCF	6.7E-08	5.0E+03	3.4E-04
3	CWSCF3RHPRHXABC1-ALL	CCW HEAT EXCHANGER A,B,C PLUG (CCW) CCF	3.6E-08	5.0E+03	1.8E-04
4	EPSBTSWCCF	EPS SOFTWARE CCF	1.0E-05	1.5E+03	1.5E-02
5	EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	2.0E-05	1.4E+03	2.9E-02
6	RTPBTSWCCF	SUPPORT SOFTWARE CCF	1.0E-07	1.3E+02	1.3E-05
7	CWSCF3RHPRHXABC1-12	CCW HEAT EXCHANGER A,B,C PLUG (CCW) CCF	1.8E-08	1.1E+02	1.9E-06
8	EPSCF4CBTD6H-124	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	5.2E-06	1.1E+02	5.4E-04
9	EPSCF4CBTD6H-134	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF	5.2E-06	9.9E+01	5.1E-04
10	ESWCF3PMBDSWPABC-ALL	ESW PUMP A,B,C FAIL TO RE-START CCF	6.0E-05	8.9E+01	5.3E-03

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-93 Human Error FV Importance of POS 8-1 for LPSD PRA

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	HPIOO02S-DP2	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	5.5E-02	6.3E-01	1.2E+01
2	CHIOO02CV21	OPERATOR FAILS TO START STANDBY CHARGING PUMP (HE)	2.6E-03	3.1E-01	1.2E+02
3	RSSOO02RHR2	OPERATOR FAILS TO START STANDBY RHR PUMP (HE)	6.2E-03	2.8E-01	4.6E+01
4	CHIOO02CV212-DP3	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWSAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO TASKS (HE)	1.6E-01	2.0E-01	2.0E+00
5	ACWOO02SC	OPERATOR FAILS TO ESTABLISH THE ALTERNATIVE CCWS BY FIRE SUPPRESSION SYSTEM (HE)	3.1E-02	1.8E-01	6.5E+00
6	CHIOO02CV2-DP3	OPERATOR FAILS TO CONNECT THE RWSAT MAKEUP LINE UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO TASKS (HE)	1.6E-01	1.2E-01	1.6E+00
7	HPIOO02S	OPERATOR FAILS TO START STANDBY SI PUMP (HE)	4.9E-03	5.8E-02	1.3E+01
8	EPSOO02RDG	OPERATOR FAILS TO CONNECT THE ALTERNATIVE POWER TO EMERGENCY POWER BUS (HE)	2.1E-02	5.5E-02	3.6E+00
9	CHIOO02CV212-DP2	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWSAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	7.3E-02	4.8E-02	1.6E+00
10	LOAOO02LC	OPERATOR FAILS TO ISOLATE THE LEAKAGE RHR TRAIN (HE)	2.6E-03	4.8E-02	2.0E+01

Table 19.1-94 Human Error RAW of POS 8-1 for LPSD PRA

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
1	CHIOO02CV21	OPERATOR FAILS TO START STANDBY CHARGING PUMP (HE)	2.6E-03	1.2E+02	3.1E-01
2	RSSOO02RHR2	OPERATOR FAILS TO START STANDBY RHR PUMP (HE)	6.2E-03	4.6E+01	2.8E-01
3	LOAOO02LC	OPERATOR FAILS TO ISOLATE THE LEAKAGE RHR TRAIN (HE)	2.6E-03	2.0E+01	4.8E-02
4	HPIOO02S	OPERATOR FAILS TO START STANDBY SI PUMP (HE)	4.9E-03	1.3E+01	5.8E-02
5	HPIOO02S-DP2	OPERATOR FAILS TO START STANDBY SI PUMP UNDER THE CONDITION OF FAILING THEIR PREVIOUS TASK (HE)	5.5E-02	1.2E+01	6.3E-01
6	ACWOO02SC	OPERATOR FAILS TO ESTABLISH THE ALTERNATIVE CCWS BY FIRE SUPPRESSION SYSTEM (HE)	3.1E-02	6.5E+00	1.8E-01
7	RWSOO04XV027	OPERATOR FAILS TO RECOVER MANUAL VALVE ON THE REFUELING WATER RECIRCULATION LINE AFTER TEST & MAINTENANCE (HE)	8.0E-04	3.8E+00	2.3E-03
8	EPSOO02RDG	OPERATOR FAILS TO CONNECT THE ALTERNATIVE POWER TO EMERGENCY POWER BUS (HE)	2.1E-02	3.6E+00	5.5E-02
9	CHIOO02CV212-DP3	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWSAT MAKEUP LINE) UNDER THE CONDITION OF FAILING THEIR PREVIOUS TWO TASKS (HE)	1.6E-01	2.0E+00	2.0E-01
10	LOAOO02OD	OPERATOR FAILS TO ISOLATE THE LOW PRESSURE LETDOWN LINE (HE)	3.8E-03	2.0E+00	3.8E-03

Table 19.1-95 Hardware Single Failure FV Importance of POS 8-1 for LPSD PRA

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSDLLRDGA-CG3	EMERGENCY GAS TURBINE GENERATOR (GTG A) FAIL TO RUN (>1H)	1.7E-02	7.8E-03	1.5E+00
2	EPSDLLRDGB-CG3	EMERGENCY GAS TURBINE GENERATOR (GTG B) FAIL TO RUN (>1H)	1.7E-02	5.5E-03	1.3E+00
3	EPSDLLRDGP2-L2	AAC GAS TURBINE GENERATOR (GTG P2) FAIL TO RUN (>1H)	1.8E-02	3.8E-03	1.2E+00
4	EPSDLLRDGC-CG3	EMERGENCY GAS TURBINE GENERATOR (GTG C) FAIL TO RUN (>1H)	1.7E-02	3.6E-03	1.2E+00
5	EPSDLLRDGP1-L2	AAC GAS TURBINE GENERATOR (GTG P1) FAIL TO RUN (>1H)	1.8E-02	2.2E-03	1.1E+00
6	EPSDLADDGA-CG3	EMERGENCY GAS TURBINE GENERATOR (GTG A) FAIL TO START	4.6E-03	2.1E-03	1.5E+00
7	RWSXVOD026	REFUELING WATER AUXILIARY TANK SUCTION LINE MANUAL VALVE X/V 026 FAIL TO OPEN	7.0E-04	2.0E-03	3.8E+00
8	RWSXVOD028	REFUELING WATER AUXILIARY TANK INLET LINE MANUAL VALVE X/V 028 FAIL TO OPEN	7.0E-04	2.0E-03	3.8E+00
9	HPILSFF8820B	CONTAINMENT ISOLATION MOTOR OPERATED VALVE LIMIT SWITCH 8820B FAIL	4.8E-03	1.6E-03	1.3E+00
10	HPILSFF8805B	CONTAINMENT ISOLATION MOTOR OPERATED VALVE LIMIT SWITCH 8805B FAIL	4.8E-03	1.6E-03	1.3E+00

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-96 Hardware Single Failure RAW of POS 8-1 for LPSD PRA

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
1	RWSXVEL001	REFUELING WATER AUXILIARY TANK LINE X/V (001) LARGE EXTERNAL LEAK	7.2E-08	1.9E+02	1.3E-05
2	RWSMVEL002	RWSP DISCHARGE LINE CONTAINMENT ISOLATION M/V VLV-001 LARGE EXTERNAL LEAK	2.4E-08	1.9E+02	4.4E-06
3	CWSPNELCCWB	CCW TRAIN B PIPE LARGE EXTERNAL LEAK	1.1E-06	1.2E+02	1.3E-04
4	CWSRIELCCWHXB1	CCW HEAT EXCHANGER B LARGE EXTERNAL LEAK	7.2E-07	1.2E+02	8.8E-05
5	CWSPMELCCWPB	CCW PUMP B LARGE EXTERNAL LEAK	1.9E-07	1.2E+02	2.3E-05
6	HPIXVEL133B	SI PUMP B COOLING LINE X/V 133B LARGE EXTERNAL LEAK	7.2E-08	1.2E+02	8.8E-06
7	CWSXVEL103B	CCW PUMP B COOLIONG LINE X/V 103B LARGE EXTEANAL LEAK	7.2E-08	1.2E+02	8.8E-06
8	HPIXVEL160B	SI PUMP B COOLING LINE X/V 160B LARGE EXTERNAL LEAK	7.2E-08	1.2E+02	8.8E-06
9	HPIXVELCCW0002B	SI PUMP B COOLING LINE X/V CCW0002B LARGE EXTERNAL LEAK	7.2E-08	1.2E+02	8.8E-06
10	HPIXVEL132B	SI PUMP B COOLING LINE X/V 132B LARGE EXTERNAL LEAK	7.2E-08	1.2E+02	8.8E-06

Component identifiers used in this table are specific to PRA.

Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-97 Important Operator Actions in POS 8-1

No	System	Operator Action Description
1	LOW PRESSURE LETDOWN LINE	OPERATOR FAILS TO ISOLATE THE LOW PRESSURE LETDOWN LINE (HE)
2	RESIDUAL HEATA REMOVAL SYSTEM	OPERATOR FAILS TO ISOLATE THE LEAKAGE RHR TRAIN (HE)
3	RESIDUAL HEATA REMOVAL SYSTEM	OPERATOR FAILS TO START STANDBY RHR PUMP (HE)
4	HIGH HEAD INJECTION SYSTEM	OPERATOR FAILS TO START STANDBY SI PUMP (HE)
5	CHEMICAL VOLUME CONTROL SYSTEM	OPERATOR FAILS TO START STANDBY CHARGING PUMP (HE)
6	CHEMICAL VOLUME CONTROL SYSTEM	OPERATOR FAILS TO CONNECT THE RWAT MAKEUP LINE (HE)
7	CHEMICAL VOLUME CONTROL SYSTEM	OPERATOR FAILS TO ESTABLISH CHARGING INJECTION (START STANDBY CHARGING PUMP AND CONNECT THE RWAT MAKEUP LINE)
8	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	OPERATOR FAILS TO CONNECT THE ALTERNATIVE POWER TO EMERGENCY POWER BUS (HE)
9	ALTERNATIVE COMPONENT COOLING WATER SYSTEM	OPERATOR FAILS TO ESTABLISH THE ALTERNATIVE CCWS BY FIRE SUPPRESSION SYSTEM (HE)

Table19.1-98 Differences of Important Operator Action between POS 3 and POS 8-1

No	System	Operator Action Description	Remarks
1	LOW PRESSURE LETDOWN LINE	N/A	This system would be modeled as a mitigation system which prevents reduction of a RCS water level only at the time of mid-loop operation. Therefore, this system is not modeled in POS 3.
2	EMERGENCY FEED WATER SYSTEM	OPERATOR FAILS TO START STANDBY EFW PUMP (HE)	This system is unavailable in POS 8-1 because SG is isolated from the RCS. But it is available in POS 3.

Operator actions other than systems mentioned above are the same as POS 8-1.

Table19.1-99 Differences of Important Operator Action between POS 4-1 and POS 8-1

No	System	Operator Action Description	Remarks
1	EMERGENCY FEED WATER SYSTEM	OPERATOR FAILS TO START STANDBY EFW PUMP (HE)	This system is unavailable in POS 8-1 because SG is isolated from the RCS. But it is available in POS 4-1.

Operator actions other than systems mentioned above are the same as POS 8-1.

Table19.1-100 Differences of Important Operator Action between POS 4-2 and POS 8-1

No	System	Operator Action Description	Remarks
1	GRAVITATIONAL INJECTION SYSTEM	OPERATOR FAILS TO ESTABLISH GRAVITATIONAL INJECTION (HE)	This system is unavailable in POS 8-1 because the RCS is not under atmospheric pressure. But it is available in POS 4-2.

Operator actions other than systems mentioned above are the same as POS 8-1.

Table19.1-101 Differences of Important Operator Action between POS 4-3 and POS 8-1

No	System	Operator Action Description	Remarks
1	None	None	None

All operator actions in POS 4-3 are the same as POS 8-1.

Table19.1-102 Differences of Important Operator Action between POS 8-2 and POS 8-1

No	System	Operator Action Description	Remarks
1	GRAVITATIONAL INJECTION SYSTEM	OPERATOR FAILS TO ESTABLISH GRAVITATIONAL INJECTION (HE)	This system is unavailable in POS 8-1 because the RCS is not under atmospheric pressure. But it is available in POS 8-2.

Operator actions other than systems mentioned above are the same as POS 8-1.

Table19.1-103 Differences of Important Operator Action between POS 8-3 and POS 8-1

No	System	Operator Action Description	Remarks
1	EMERGENCY FEED WATER SYSTEM	OPERATOR FAILS TO START STANDBY EFW PUMP (HE)	This system is unavailable in POS 8-1 because SG is isolated from the RCS. But it is available in POS 8-3.

Operator actions other than systems mentioned above are the same as POS 8-1.

Table19.1-104 Differences of Important Operator Action between POS 9 and POS 8-1

No	System	Operator Action Description	Remarks
1	LOW PRESSURE LETDOWN LINE	N/A	This system would be modeled as a mitigation system which prevents reduction of a RCS water level only at the time of mid-loop operation. Therefore, this system is not modeled in POS 9.
2	EMERGENCY FEED WATER SYSTEM	OPERATOR FAILS TO START STANDBY EFW PUMP (HE)	This system is unavailable in POS 8-1 because SG is isolated from the RCS. But it is available in POS 9.

Operator actions other than systems mentioned above are the same as POS 8-1.

Table19.1-105 Differences of Important Operator Action between POS 11 and POS 8-1

No	System	Operator Action Description	Remarks
1	LOW PRESSURE LETDOWN LINE	N/A	This system would be modeled as a mitigation system which prevents reduction of a RCS water level only at the time of mid-loop operation. Therefore, this system is not modeled in POS 11.
2	EMERGENCY FEED WATER SYSTEM	OPERATOR FAILS TO START STANDBY EFW PUMP (HE)	This system is unavailable in POS 8-1 because SG is isolated from the RCS. But it is available in POS 11.

Operator actions other than systems mentioned above are the same as POS 8-1.

Table19.1-106 Important SSCs of each System in POS 8-1

No	System	Description	Remarks
1	LOW PRESSURE LETDOWN LINE	LOW PRESSURE LETDOWN LINE ISOLATION VALVES (A,D) LOW PRESSURE LETDOWN LINE AIR OPERATED VALVE	
2	RESIDUAL HEATA REMOVAL SYSTEM	RHR PUMP SUCTION MOTOR OPERATED ISOLATION VALVES (9000A,B,C, 9001A,B,C) RHR PUMP (A,B,C) RHR LINE CONTAINMNET ISOLATION MOTOR OPERATED VALVES (9015A,B,C) RCS COLD LEG INJECTION LINE MOTOR OPERATED VALVES (9014A,B,C)	RHR D-train is outage.
3	EMERGENCY FEED WATER SYSTEM	N/A	This system is unavailable in POS 8-1.
4	HIGH HEAD INJECTION SYSTEM	SI PUMP (A,B)	SI pump C,D are outage.
5	CHEMICAL VOLUME CONTROL SYSTEM	CHARGING PUMP A,B VOLUME CONTROL TANK DISCHARGE LINE MOTOR OPERATED VALVES (121B,C) CHARGING PUMP RWAT SUCTION ISOLATION VALVES MOTOR OPERATED (121D,E) REFUELING WATER AUXILIARY TANK SUCTION LINE MANUAL VALVE FAIL TO OPEN (026) REFUELING WATER AUXILIARY TA	
6	GRAVITATIONAL INJECTION SYSTEM	N/A	This system is unavailable in POS 8-1.
7	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	EMERGENCY GAS TURBINE GENERATOR (GTG A,B,C) 6.9KV AC BUS INCOMER CIRCUIT BREAKER (6H A,B,C) AAC GAS TURBINE GENERATOR (GTG P1,2)	GTG D-train is outage.
8	COMPONENT COOLING WATER SYSTEM	CCW PUMP (A,B,C) CCW HEAT EXCHANGER (A,B,C)	CCW D-train is outage.
9	ESSENTIAL SERVICE WATER SYSTEM	ESW PUMP (A,B,C,D)	
10	ALTERNATE COMPONENT COOLING WATER SYSTEM	MOTOR DRIVEN / DEISEL DRIVEN FIRE SUPPRESSION PUMP ALTERNATE COMPONENT COOLING WATER LINE MOTOR OPERATED VALVES (ACWCH1B,ACWCH2B,ACWCH3B,ACWCH4B) CHARGING PUMP COOLING LINE ISOLATION MOTOR OPERATED VALVES (ACWCH6B)	

Table19.1-107 Differences of Important SSCs between POS 3 and POS 8-1

No	System	Description	Remarks
1	LOW PRESSURE LETDOWN LINE	N/A	This system would be modeled as a mitigation system which prevents reduction of a RCS water level only at the time of mid-loop operation. Therefore, this system is not modeled in POS 3.
2	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 3: B,C,D trains.	RHR A-train is outage.
3	EMERGENCY FEED WATER SYSTEM	MOTOR DRIVEN EFW PUMP C	This system is unavailable in POS 8-1 because SG is isolated from the RCS. But it is available in POS 3. Motor driven EFW pump B is outage.
4	HIGH HEAD INJECTION SYSTEM	Main active components of HHIS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B trains, POS 3: C,D trains.	SI pump A,B are outage.
5	CHEMICAL VOLUME CONTROL SYSTEM	Main active components of CVCS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B charging pumps, POS 3: B charging pump.	Charging pump A is outage.
6	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	Main active components of EPS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 3: A,B,C,D trains.	
7	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 3: B,C,D trains.	CCW A-train is outage.

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-108 Differences of Important SSCs between POS 4-1 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-1: B,C,D trains.	RHR A-train is outage.
2	EMERGENCY FEED WATER SYSTEM	MOTOR DRIVEN EFW PUMP C	This system is unavailable in POS 8-1 because SG is isolated from the RCS.But it is available in POS 3. Motor driven EFW pump B is outage.
3	HIGH HEAD INJECTION SYSTEM	Main active components of HHIS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B trains, POS 4-1: C,D trains.	SI pump A,B are outage.
4	CHEMICAL VOLUME CONTROL SYSTEM	Main active components of CVCS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B charging pumps, POS 4-1: B charging pump.	Charging pump A is outage.
5	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	Main active components of EPS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-1: B,C,D trains.	GTG A-train is outage.
6	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-1: B,C,D trains.	CCW A-train is outage.

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-109 Differences of Important SSCs between POS 4-2 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-2: B,C,D trains.	RHR A-train is outage.
2	HIGH HEAD INJECTION SYSTEM	Main active components are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B trains, POS 4-2: C,D trains.	SI pump A,B are outage.
3	CHEMICAL VOLUME CONTROL SYSTEM	Main active components of CVCS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B charging pumps, POS 4-2: B charging pump.	Charging pump A is outage.
4	GRAVITATIONAL INJECTION SYSTEM	SPENT FUEL PIT CS/RHR-SPENT FUEL PIT BOUNDARY MANUAL VALVES (SUCTION LINE) (SFP01A,D, 020A,D) REFUELING WATER RECIRCULATION PUNP (A,B) SPENT FUEL PIT SUCTION LINE FROM REFUELING WATER STORAGE PIT	This system is unavailable in POS 8-1 because the RCS is not under atmospheric pressure. But it is available in POS 4-2.
5	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	Main active components of EPS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-2: B,C,D trains.	GTG A-train is outage.
6	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-2: B,C,D trains.	CCW A-train is outage.

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-110 Differences of Important SSCs between POS 4-3 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-3: B,C,D trains.	RHR A-train is outage.
2	HIGH HEAD INJECTION SYSTEM	Main active components are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B trains, POS 4-3: C,D trains.	SI pump A,B are outage.
3	CHEMICAL VOLUME CONTROL SYSTEM	Main active components of CVCS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B charging pumps, POS 4-3: B charging pump.	Charging pump A is outage.
4	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	Main active components of EPS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-3: B,C,D trains.	GTG A-train is outage.
5	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 4-3: B,C,D trains.	CCW A-train is outage.

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-111 Differences of Important SSCs between POS 8-2 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 8-2: A,B,C,D trains.	
2	GRAVITATIONAL INJECTION SYSTEM	SPENT FUEL PIT CS/RHR-SPENT FUEL PIT BOUNDARY MANUAL VALVES (SUCTION LINE) REFUELING WATER RECIRCULATION PUNP (A,B) SPENT FUEL PIT SUCTION LINE FROM REFUELING WATER STORAGE PIT	
3	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 8-2:A,B,C,D trains.	

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-112 Differences of Important SSCs between POS 8-3 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 8-3: A,B,C,D trains.	
2	EMERGENCY FEED WATER SYSTEM	MOTOR DRIVEN EFW PUMP B	This system is unavailable in POS 8-1 because SG is isolated from the RCS.But it is available in POS 8-3. Motor driven EFW pump C is outage.
3	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 8-3:A,B,C,D trains.	

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-113 Differences of Important SSCs between POS 9 and POS 8-1

No	System	Description	Remarks
1	LOW PRESSURE LETDOWN LINE	N/A	This system would be modeled as a mitigation system which prevents reduction of a RCS water level only at the time of mid-loop operation. Therefore, this system is not modeled in POS 9.
2	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 9: A,B,C,D trains.	
3	EMERGENCY FEED WATER SYSTEM	MOTOR DRIVEN EFW PUMP B	This system is unavailable in POS 8-1 because SG is isolated from the RCS.But it is available in POS 9. Motor driven EFW pump C is outage.
4	HIGH HEAD INJECTION SYSTEM	Main active components of HHIS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B trains, POS 9: A,B,C,D trains.	
5	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 9:A,B,C,D trains.	

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table19.1-114 Differences of Important SSCs between POS 10 and POS 8-1

No	System	Description	Remarks
1	LOW PRESSURE LETDOWN LINE	N/A	This system would be modeled as a mitigation system which prevents reduction of a RCS water level only at the time of mid-loop operation. Therefore, this system is not modeled in POS 11.
2	RESIDUAL HEATA REMOVAL SYSTEM	Main active components of RHRS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 11: A,B,C,D trains.	
3	EMERGENCY FEED WATER SYSTEM	MOTOR DRIVEN EFW PUMP B	This system is unavailable in POS 8-1 because SG is isolated from the RCS.But it is available in POS 11. Motor driven EFW pump C is outage.
4	HIGH HEAD INJECTION SYSTEM	Main active components of HHIS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B trains, POS 11: A,B,C,D trains.	
5	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	Main active components of EPS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 11: A,B,C,D trains.	
6	COMPONENT COOLING WATER SYSTEM	Main active components of CCWS are the same as POS 8-1. However, trains which are available differ from POS 8-1 as follows;. POS 8-1: A,B,C trains, POS 11:A,B,C,D trains.	

Component identifiers used in this table are specific to PRA.
Corresponding components for the identifiers can be identified in Figure 19.1-2.

Table 19.1-115 Key Assumptions (Sheet 1 of 4)

Key assumptions
Operator actions Operator actions modeled in the PRA are based on symptom oriented procedures. Risk significant operator actions identified in the PRA will be address in the EOP. **Operator actions during at power events** a. In the case of loss of CCW event, operators will connect the non-essential chilled water system or the fire suppression system to the CCWS in order to cool the charging pump and maintain RCP seal water injection. b. If emergency feed water pumps cannot feed water to two intact SGs, operators will attempt to open the cross tie-line of EFW pump discharge line in order to feed water to two more than SGs by one pump. c. The CS/RHR System has the function to inject the water from RWSP into the cold leg piping by switching over the CS/RHR pump lines to the cold leg piping if all safety injection systems failed (Alternate core cooling operation). Alternate core cooling operation may be required under conditions where containment protection signal is valid. In such cases, alternate core cooling operation is prioritized over containment spray, because prevention of core damage would have higher priority than prevention of containment vessel rupture.

Table 19.1-115 Key Assumptions (Sheet 2 of 4)

Key assumptions
Operator actions during LPSD events a. When the RCS is under atmospheric pressure, gravity injection from SFP is effective. Operator will perform the gravity injection by opening the injection flow path from SFP to RCS cold legs, and supplying water from RWSP to SFP. b. In the case of loss of CCW/ESW, operator will perform alternate charging pump cooling in order to maintain RCS injection by establishing the injection flow path from fire suppression tank to charging pump and from charging pump to fire suppression tank, and starting the fire suppression pump. c. In case LOCA occurs in RHR line, operator will perform isolation of the RHR hot legs suction isolation valves. d. In case the RCS water level decreases during mid-loop operation and the failure of automatic isolation valve occurs, operator will perform the manual isolation of low-pressure letdown line. **Operator actions during severe accidents** a. Operators manually initiate active severe accident mitigation systems except for the containment isolation system and combustible gas control system which start up automatically with signals. b. In the loss of support system sequences, operators will attempt to recover CCW/ESW or ac power while suppressing containment overpressure with firewater injection into spray header.

Table 19.1-115 Key Assumptions (Sheet 3 of 4)

Key assumptions
Design features a. Common cause failure between class 1E GTG and non-class 1E GTG supply is minimized by design characteristics. Different rating GTGs with diverse starting system, independent and separate auxiliary and support systems are provided to minimize common cause failure. b. Instrumentations for detecting core damage with high reliability are provided. c. Hydrogen control system that consists of igniters is provided to limit the combustible gas concentration. The igniters start with the safety injection signal and are powered by two non-class 1E buses with non-class 1E GTGs. d. RCS depressurization system dedicated for severe accident is provided to prevent high pressure melt ejection. The location of release point from the valve is in containment dome area. This operation is implemented after onset of core damage and before reactor vessel breach. e. Reactor cavity flooding system by firewater injection is provided to enhance heat removal from molten core ejected into the reactor cavity. This system is available as a countermeasure against severe accidents even in case of fire. This operation is implemented after onset of core damage and before reactor vessel breach. f. Alternate containment cooling system using the containment fan cooler units is provided to prevent containment over pressure even in case of containment spray system failure. This operation is implemented after containment pressure reaches the design pressure. g. Reactor cavity has a core debris trap area to prevent entrainment of the molten core to the upper part of the containment. h. The other cavity flooding system is a set of drain lines from SG compartment to the reactor cavity. Spray water which flows into the SG compartment drains to the cavity and cools down the molten core after reactor vessel breach. i. Reactor cavity is designed to ensure thinly spreading debris by providing sufficient floor area and appropriate depth. j. Reactor cavity floor concrete is provided to protect against challenge to liner plate melt through. k. Main penetrations through containment vessel are isolated automatically with the containment penetration signal even in case of SBO. l. Main equipments and instrumentations used for severe accident mitigation are designed to perform their function in the environmental conditions such as containment overpressure and temperature rise following hydrogen combustion.

Table 19.1-115 Key Assumptions (Sheet 4 of 4)

Key assumptions
Flood protection a. Drain systems are designed to compensate with flood having flow rate below 100 gpm. Flood with flow rate below 100 gpm will not propagate to other areas due to the drain systems. b. R/B is separated in two divisions (i.e. east area and west area). This design is prevents loss of all safety systems though postulated major floods that leak water over the capacities of flood mitigation systems. c. The first floor of the electrical equipment room of T/B is designed to be water proof. And the first floor of T/B is equipped with relief panels. These measures prevent loss of offsite power due to flood in the T/B. d. Watertight doors are provided for the boundaries between R/B and A/B in the bottom floor and between R/B and T/B in flood area 1F. This measure prevents flood propagation from non-safety building to R/B. e. Flooding of ESW system can to be isolated within 15 minutes and flooding of fire protection system can be isolated within 30 minutes. f. Flood propagation from the flood areas which enclosed by water tight doors are considered if the flood water is much and high water level in the area. g. 4 trains of ESW system have physical separations and flooding in one train does not propagate to other trains. **Fire protection** a. Fire protection seals are provided for walls, floors, and ceilings, which compose the fire area boundaries. b. All fire doors provided to the fire barriers between the redundant safety train fire compartments are normally closed. c. Bus ducts and circuit breaker panels of safety ac system and alternative ac system in the T/B Electric Room are segregated into two groups by qualified fire barriers.

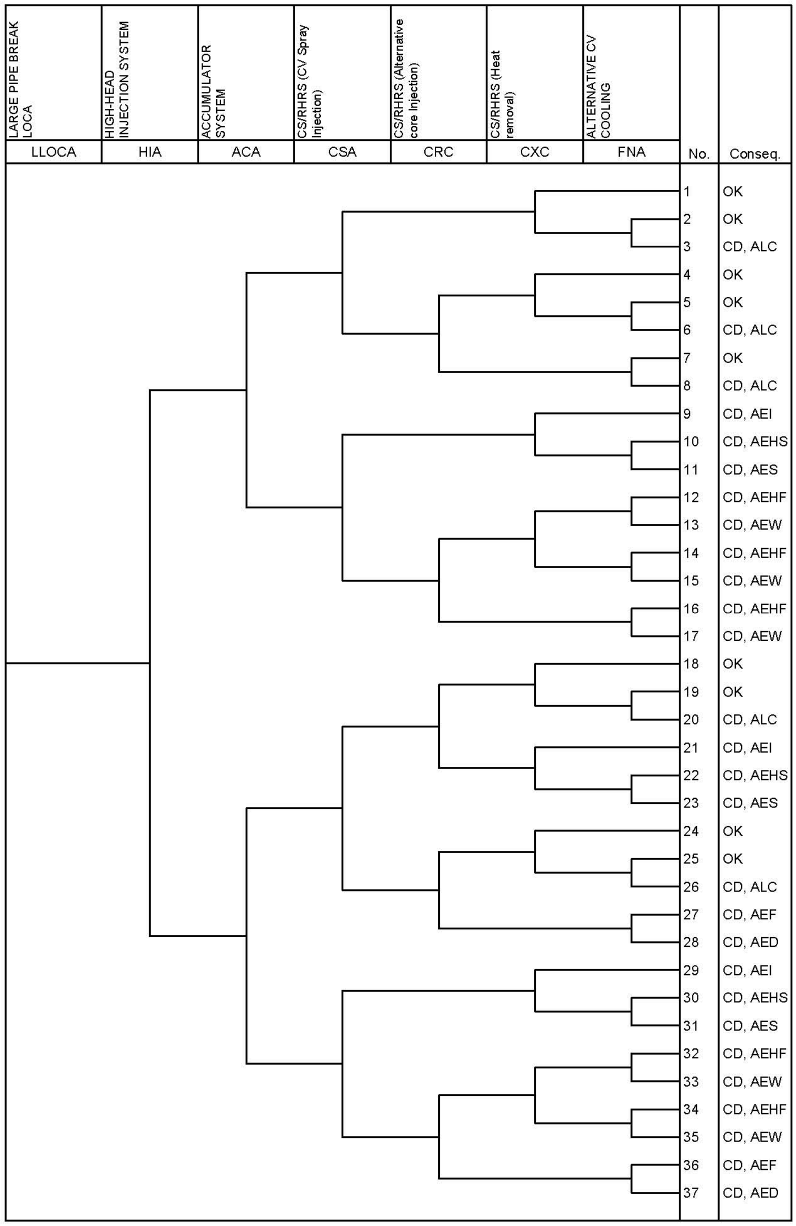


Figure 19.1-1 Event Tree (Sheet 1 of 19) (Large LOCA)

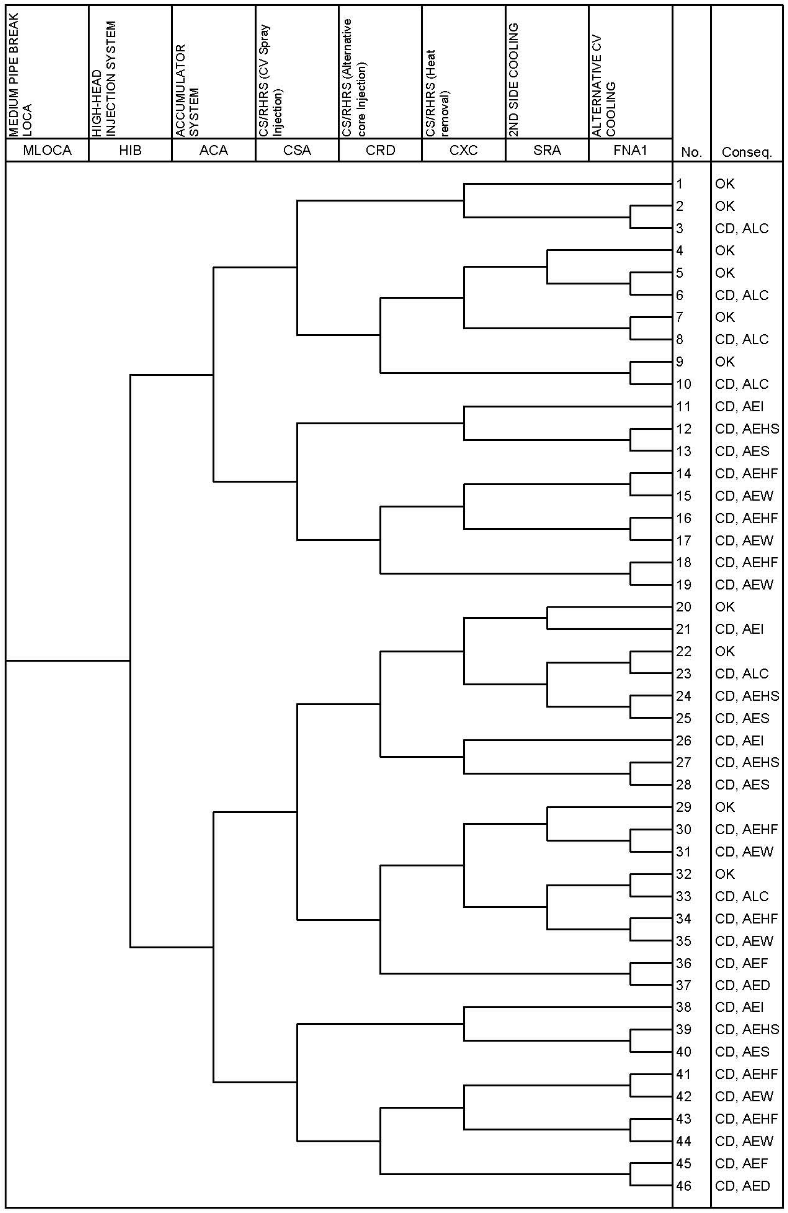


Figure 19.1-1 Event Tree (Sheet 2 of 19) (Medium LOCA)

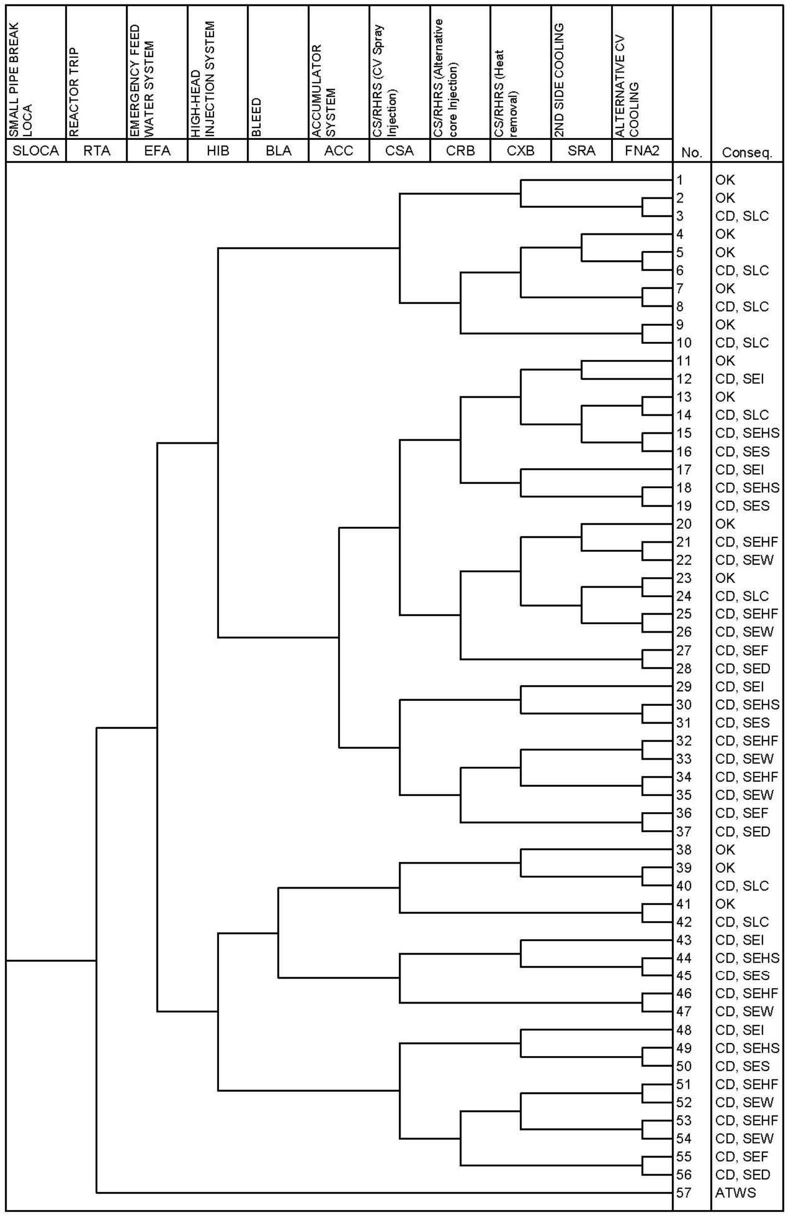


Figure 19.1-1 Event Tree (Sheet 3 of 19) (Small LOCA)

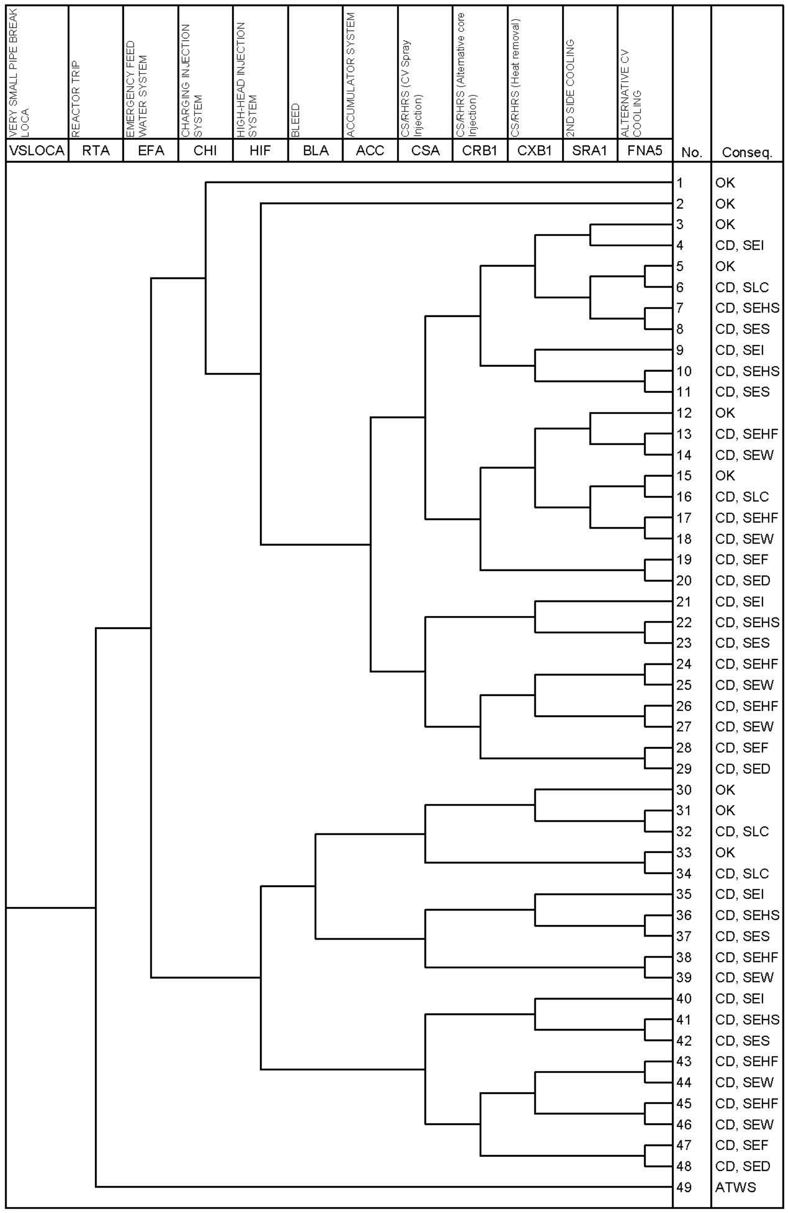


Figure 19.1-1 Event Tree (Sheet 4 of 19) (Very Small LOCA)

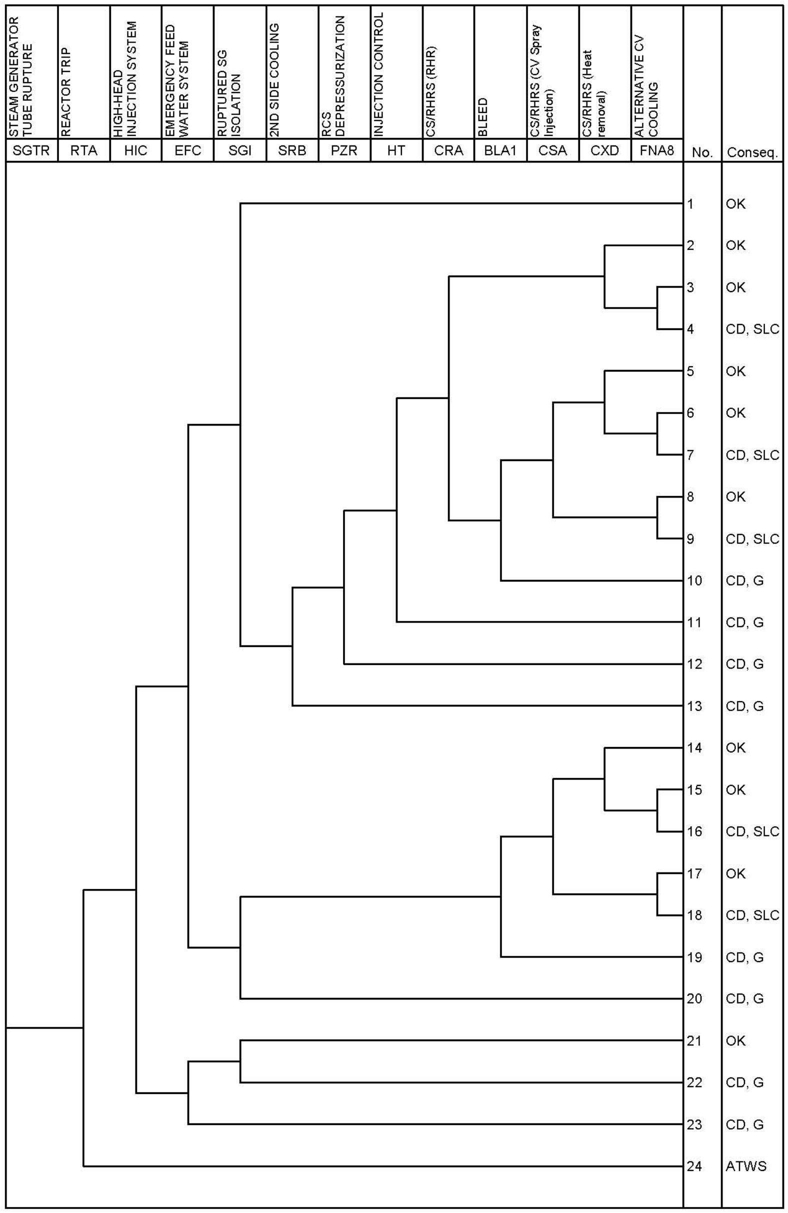


Figure 19.1-1 Event Tree (Sheet 5 of 19) (SGTR)

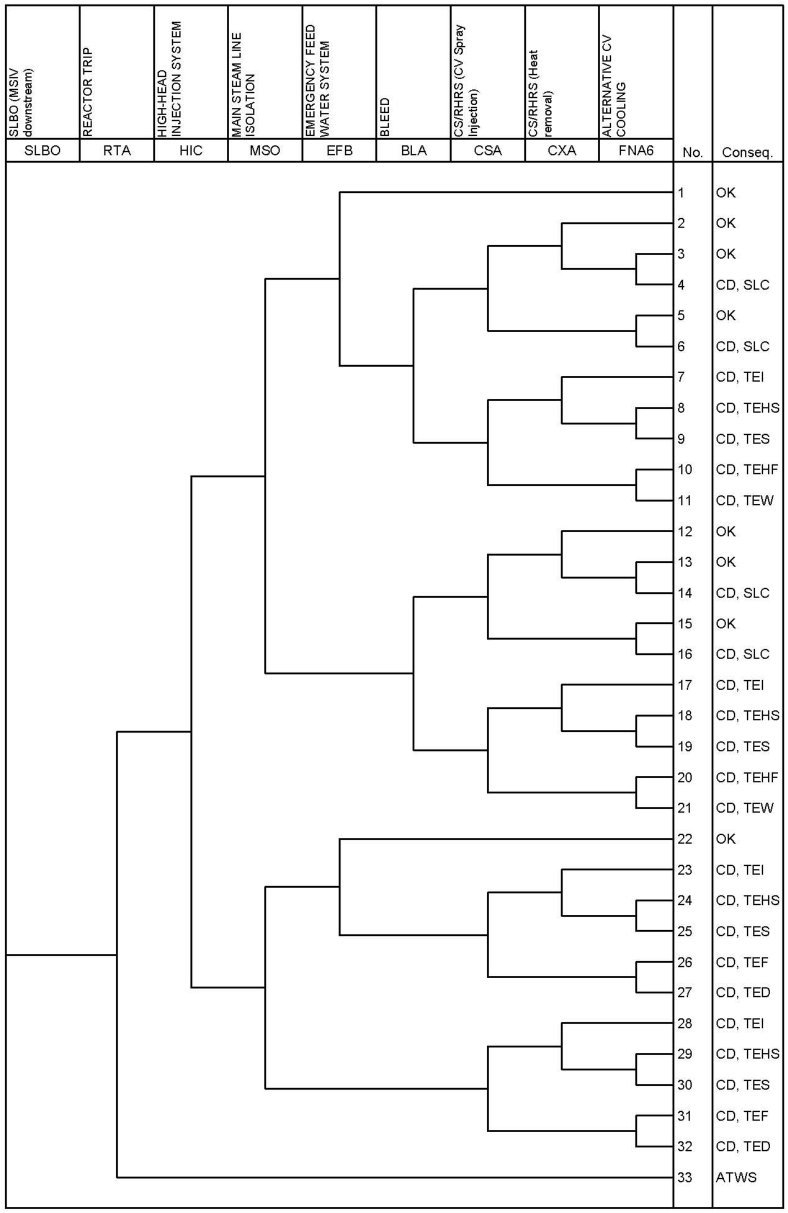


Figure 19.1-1 Event Tree (Sheet 6 of 19) (Steam Line Break Downstream MSIV)

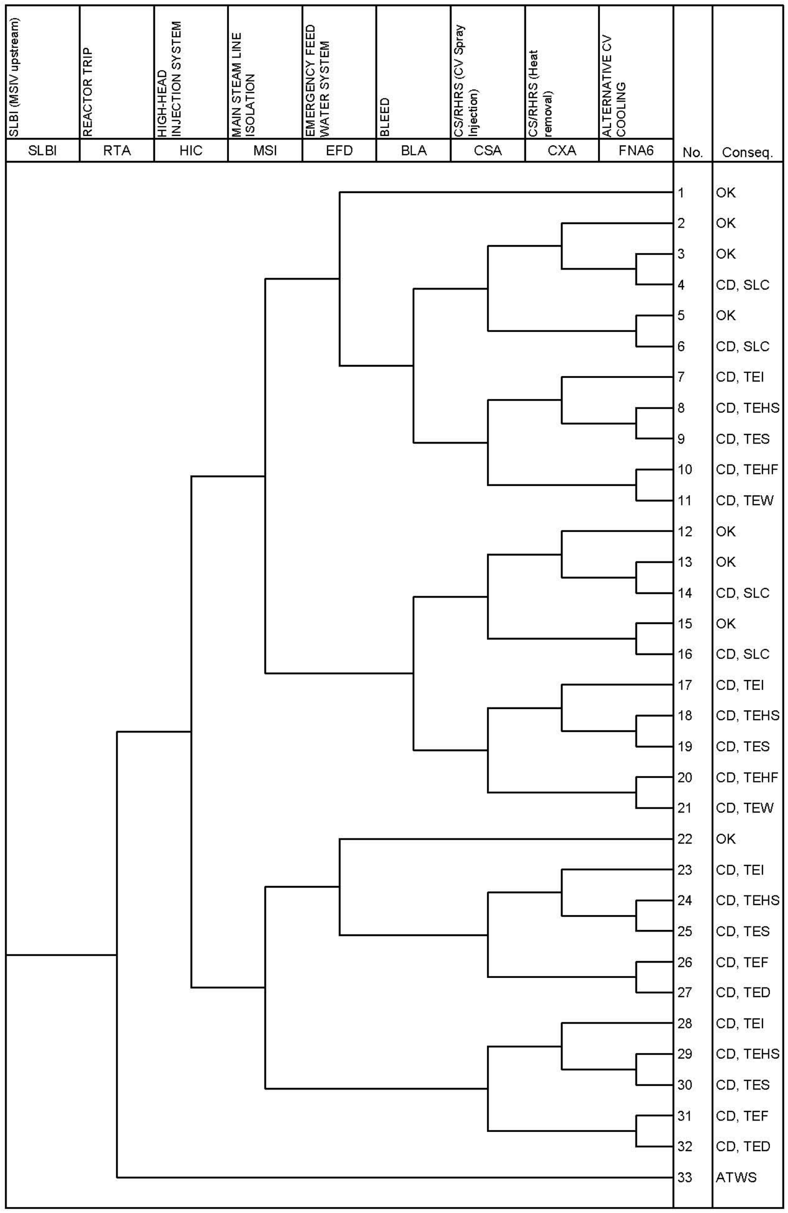


Figure 19.1-1 Event Tree (Sheet 7 of 19) (Steam Line Break Upstream MSIV)

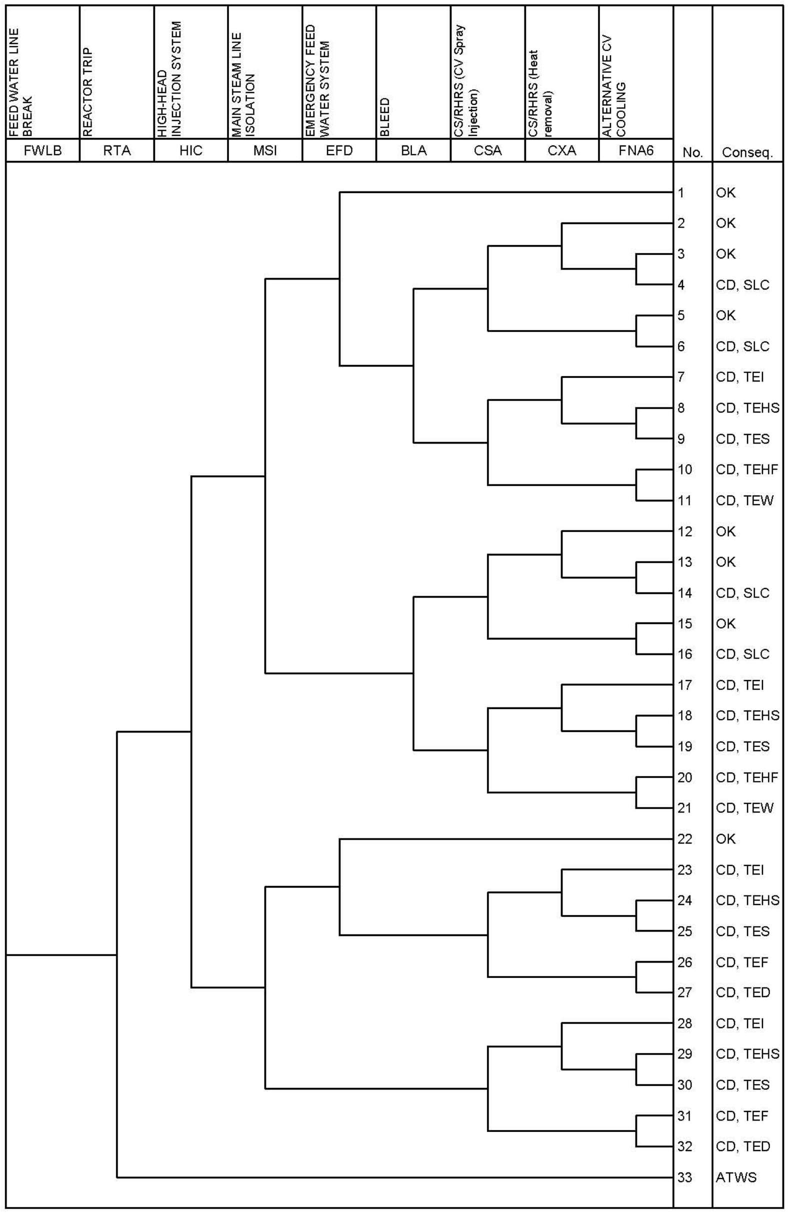


Figure 19.1-1 Event Tree (Sheet 8 of 19) (Feed Water Line Break)

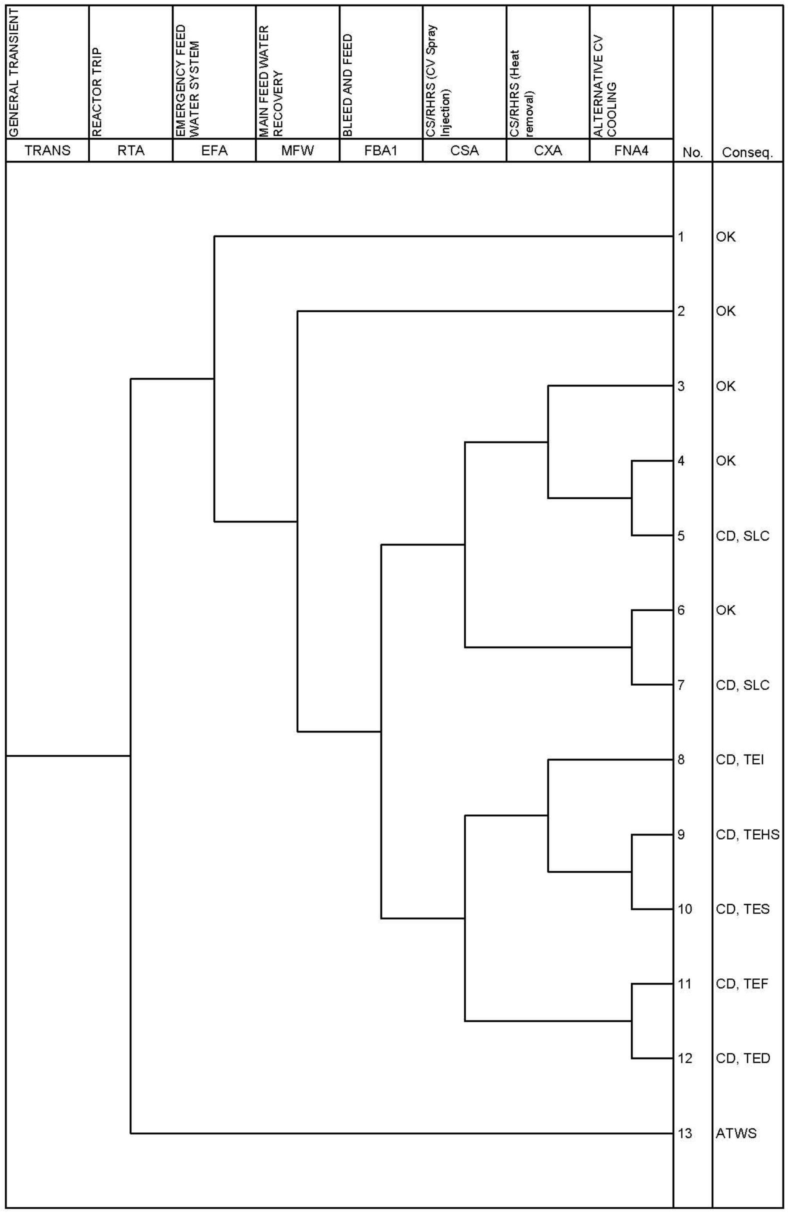


Figure 19.1-1 Event Tree (Sheet 9 of 19) (General Transient)

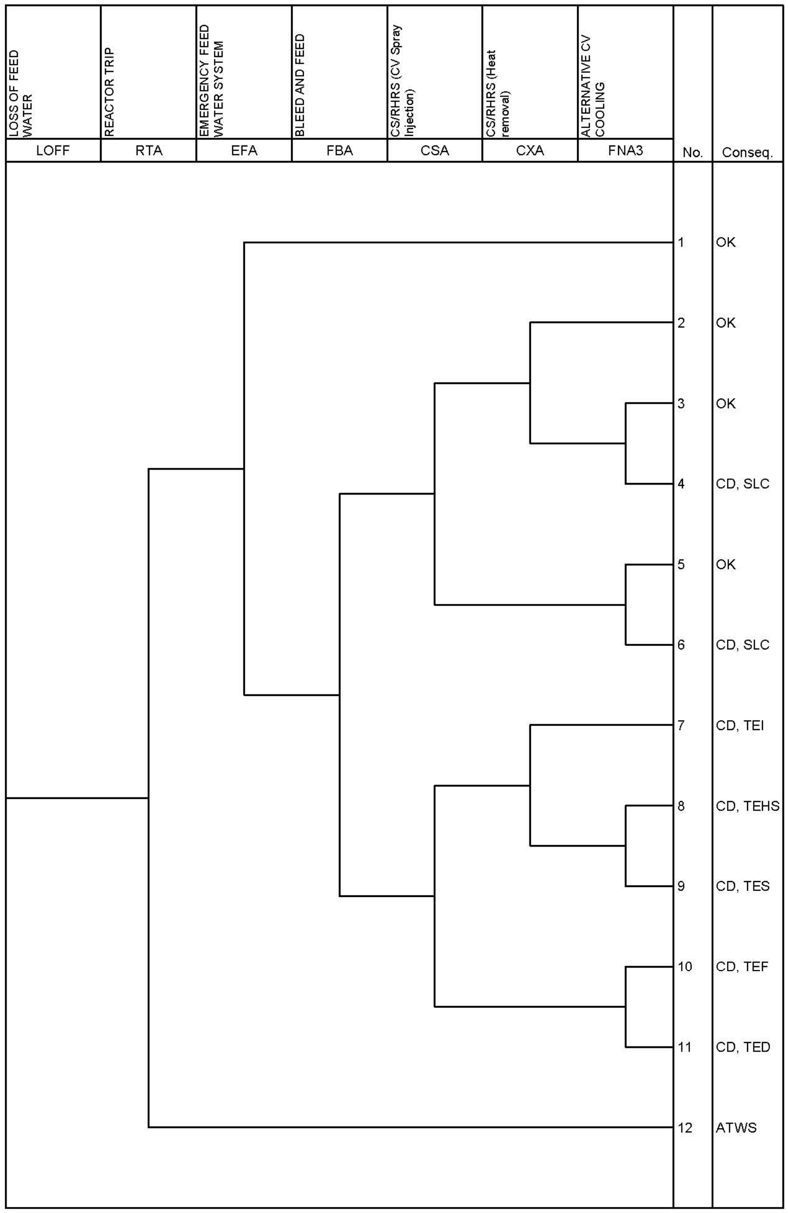


Figure 19.1-1 Event Tree (Sheet 10 of 19) (Loss of Feed Water)

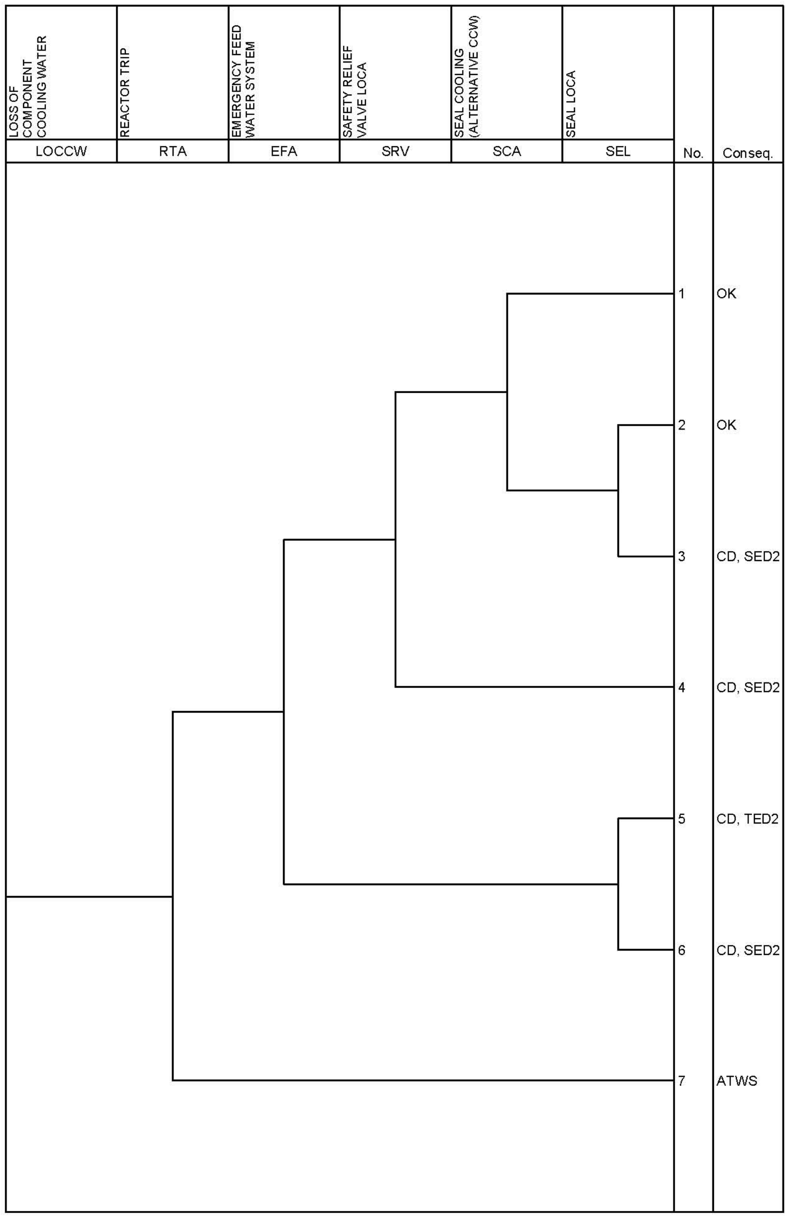


Figure 19.1-1 Event Tree (Sheet 11 of 19) (Loss of Component Cooling Water)

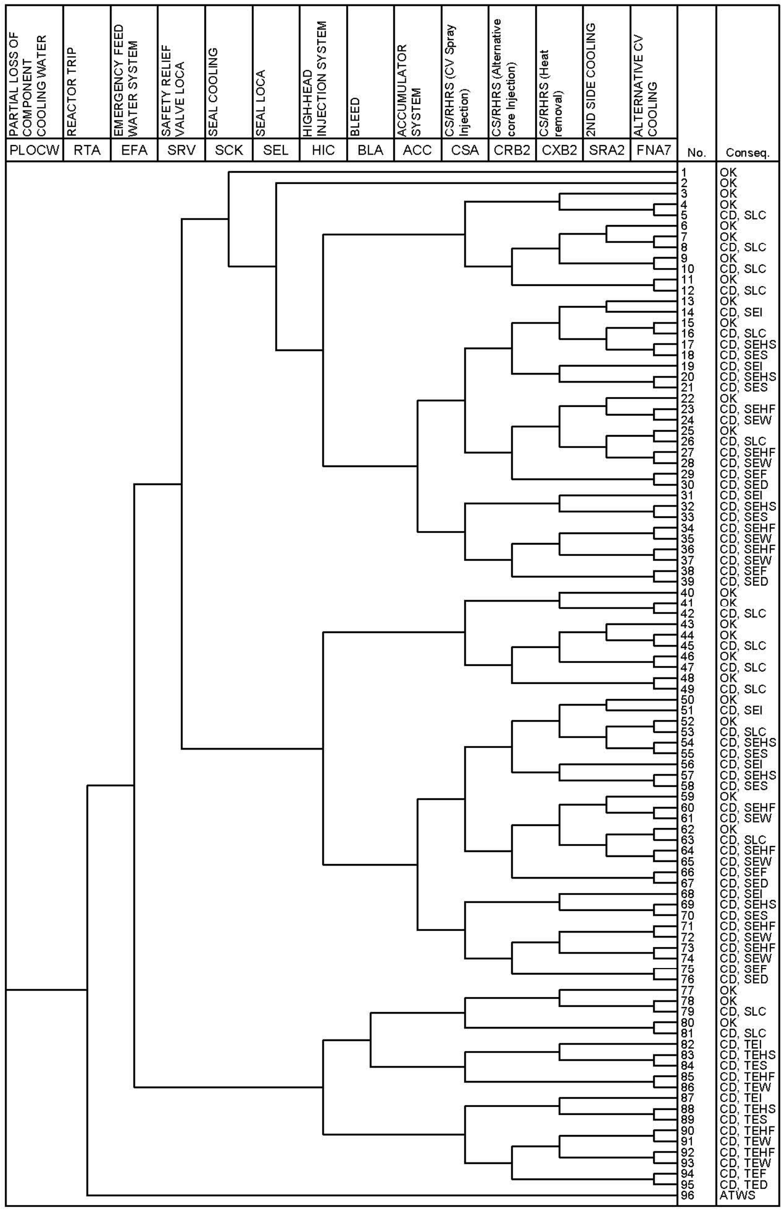


Figure 19.1-1 Event Tree (Sheet 12 of 19)
(Partial Loss of Component Cooling Water)

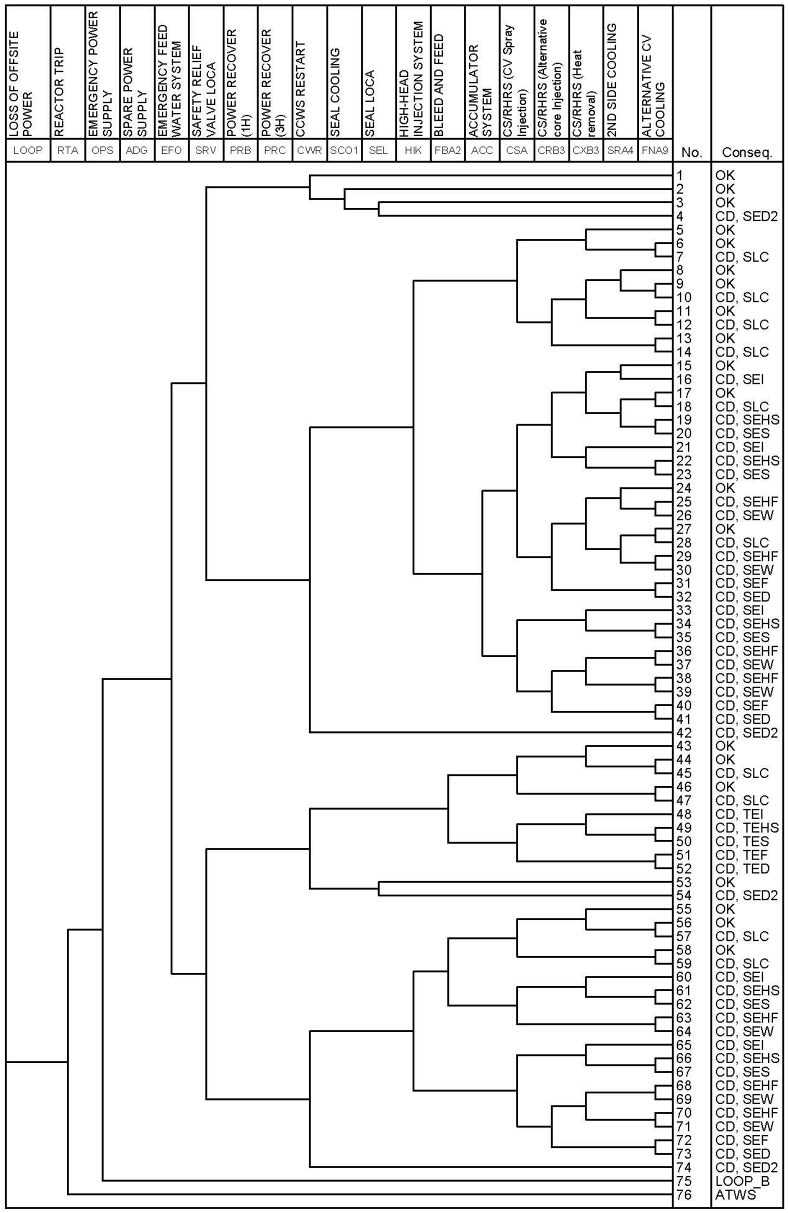


Figure 19.1-1 Event Tree (Sheet 13 of 19) (Loss of Offsite Power [1/4])

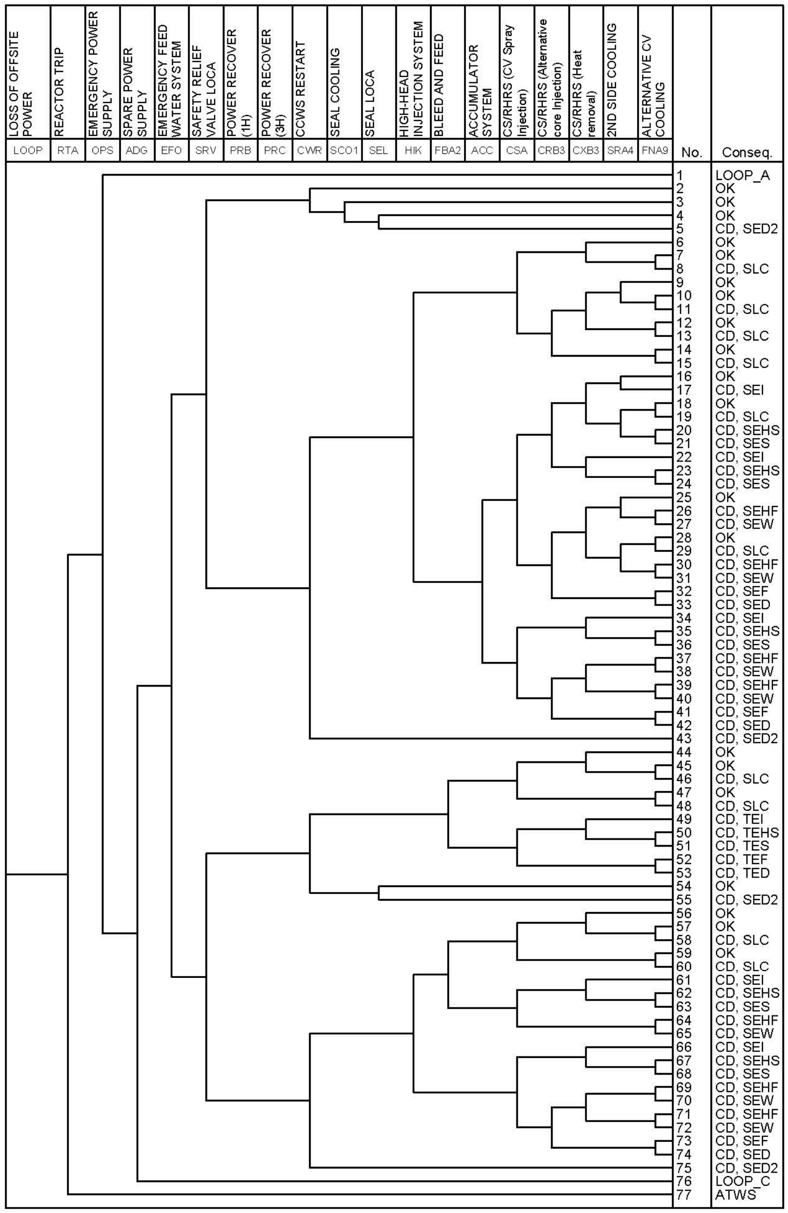


Figure 19.1-1 Event Tree (Sheet 14 of 19) (Loss of Offsite Power [2/4])

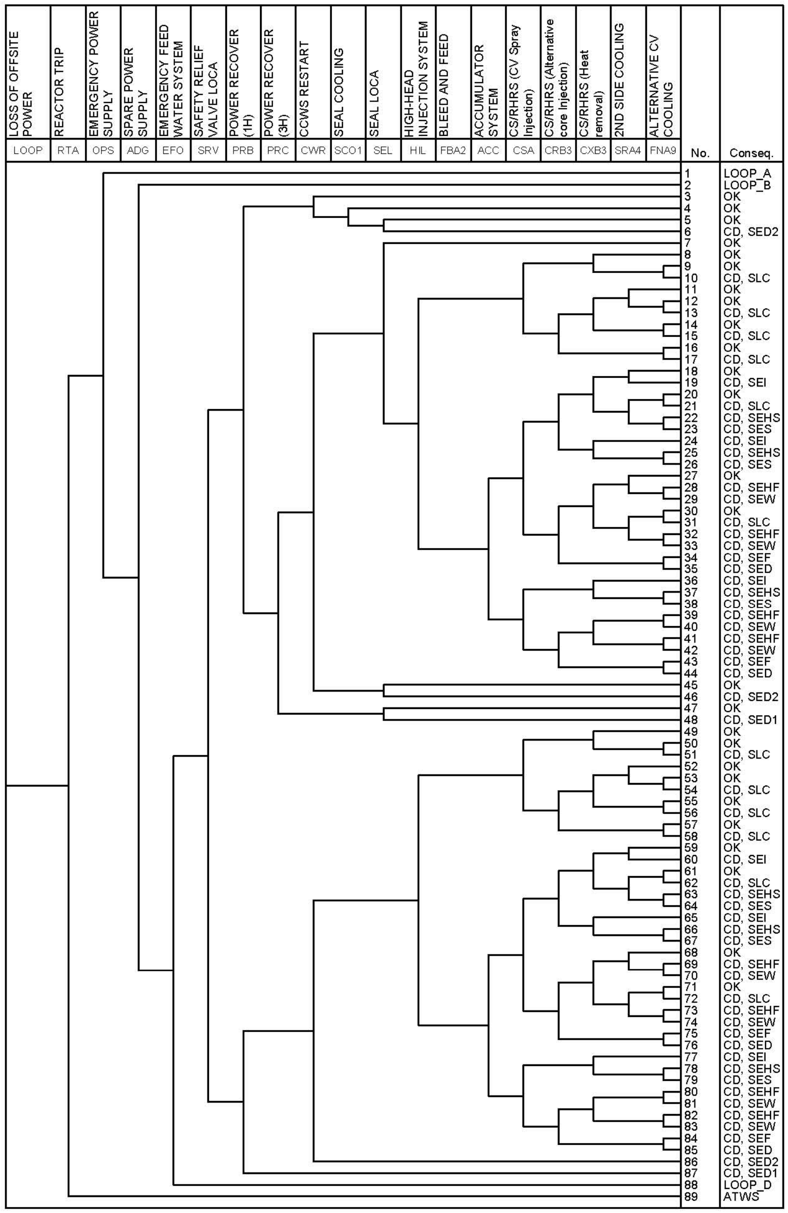


Figure 19.1-1 Event Tree (Sheet 15 of 19) (Loss of Offsite Power [3/4])

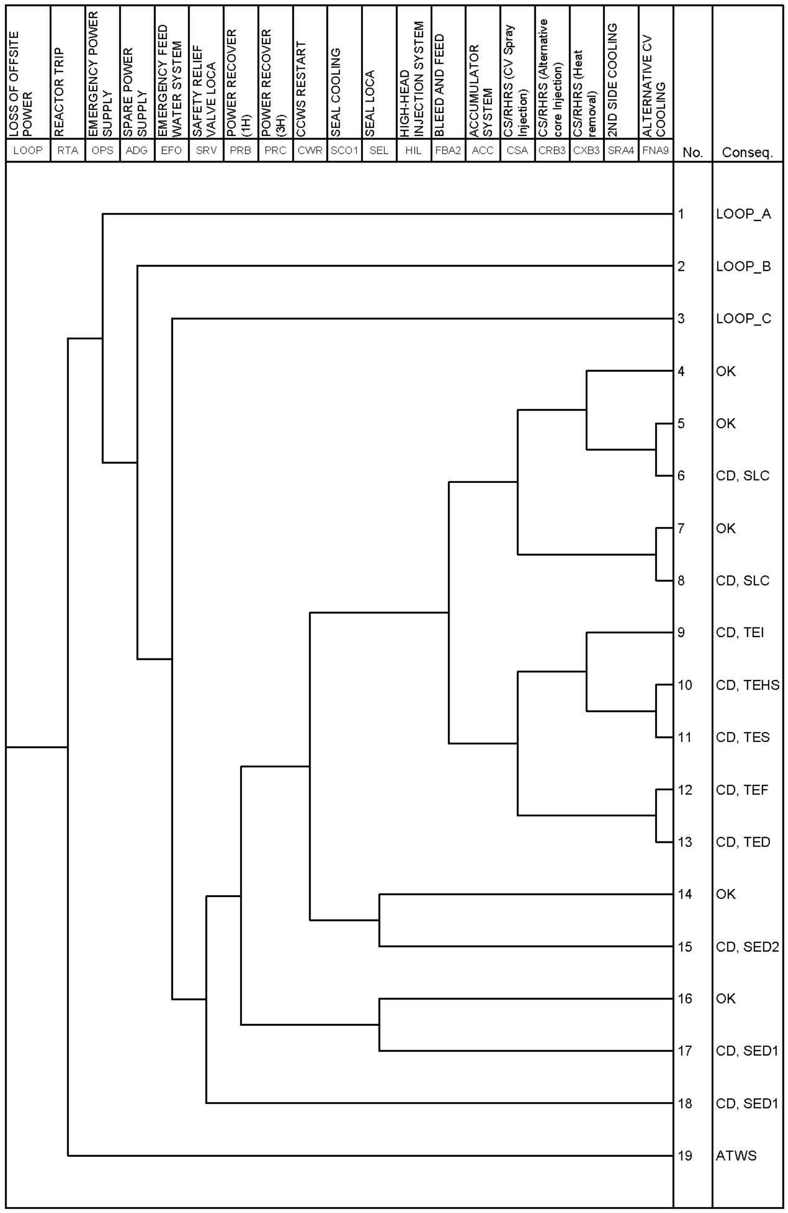


Figure 19.1-1 Event Tree (Sheet 16 of 19) (Loss of Offsite Power [4/4])

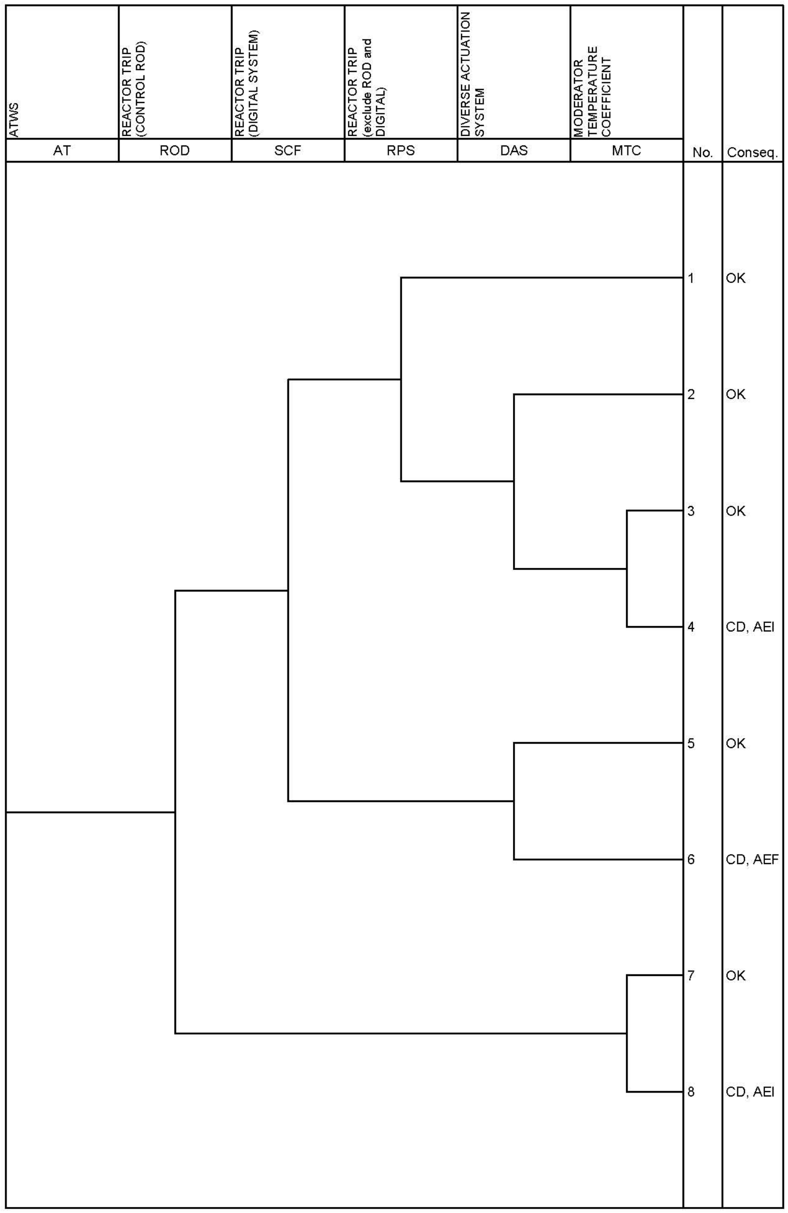


Figure 19.1-1 Event Tree (Sheet 17 of 19) (ATWS)

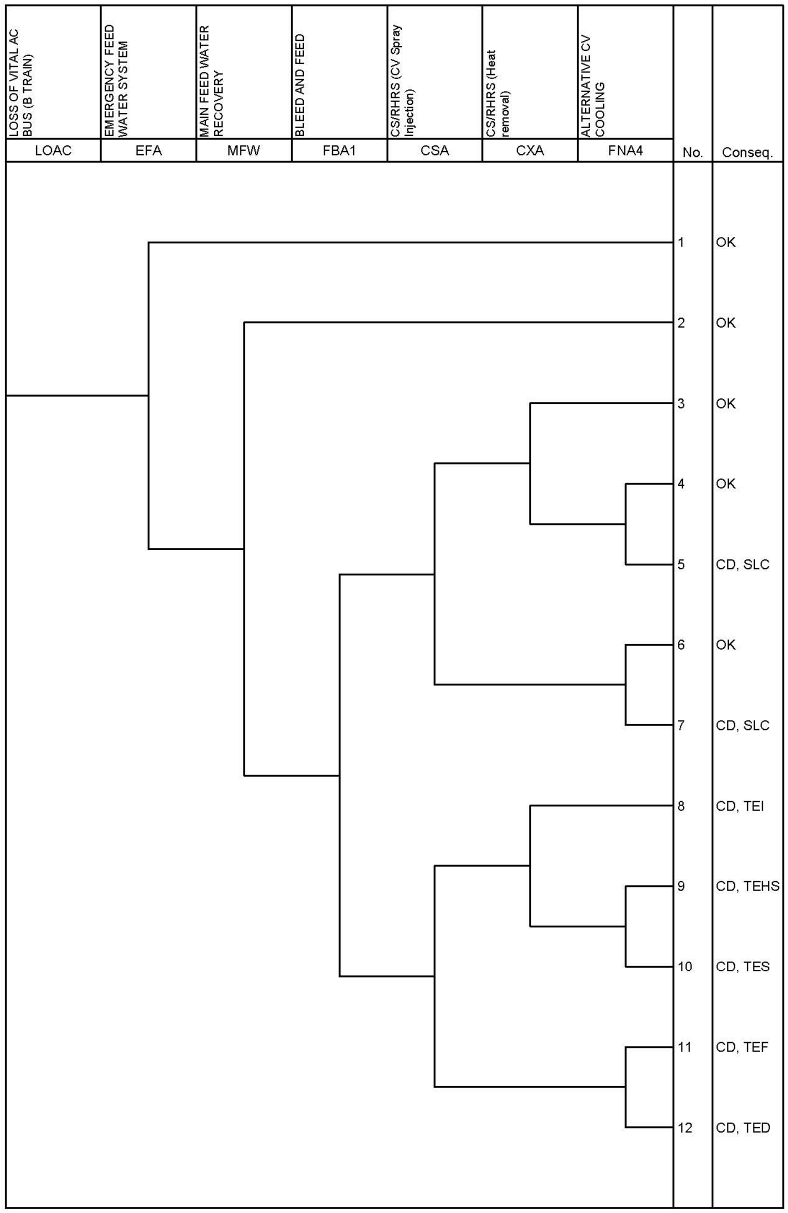


Figure 19.1-1 Event Tree (Sheet 18 of 19) (Loss of Vital AC)

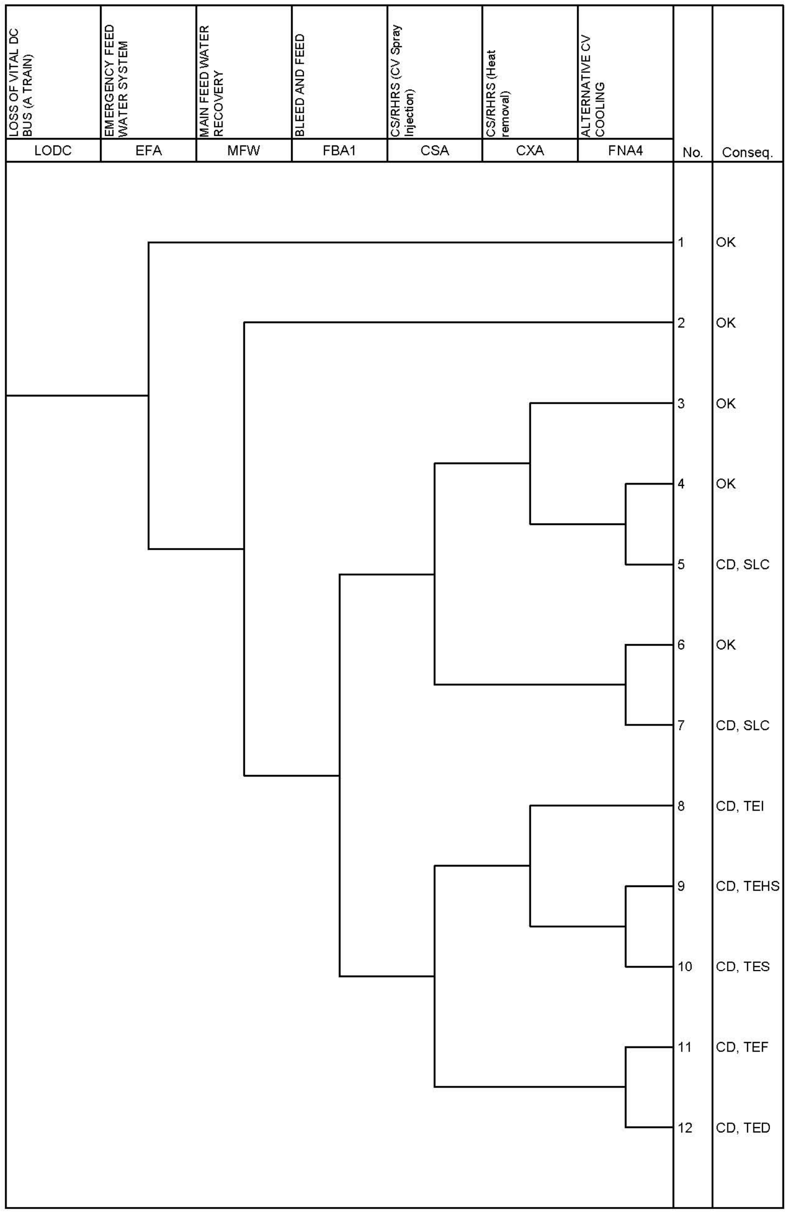


Figure 19.1-1 Event Tree (Sheet 19 of 19) (Loss of Vital DC)

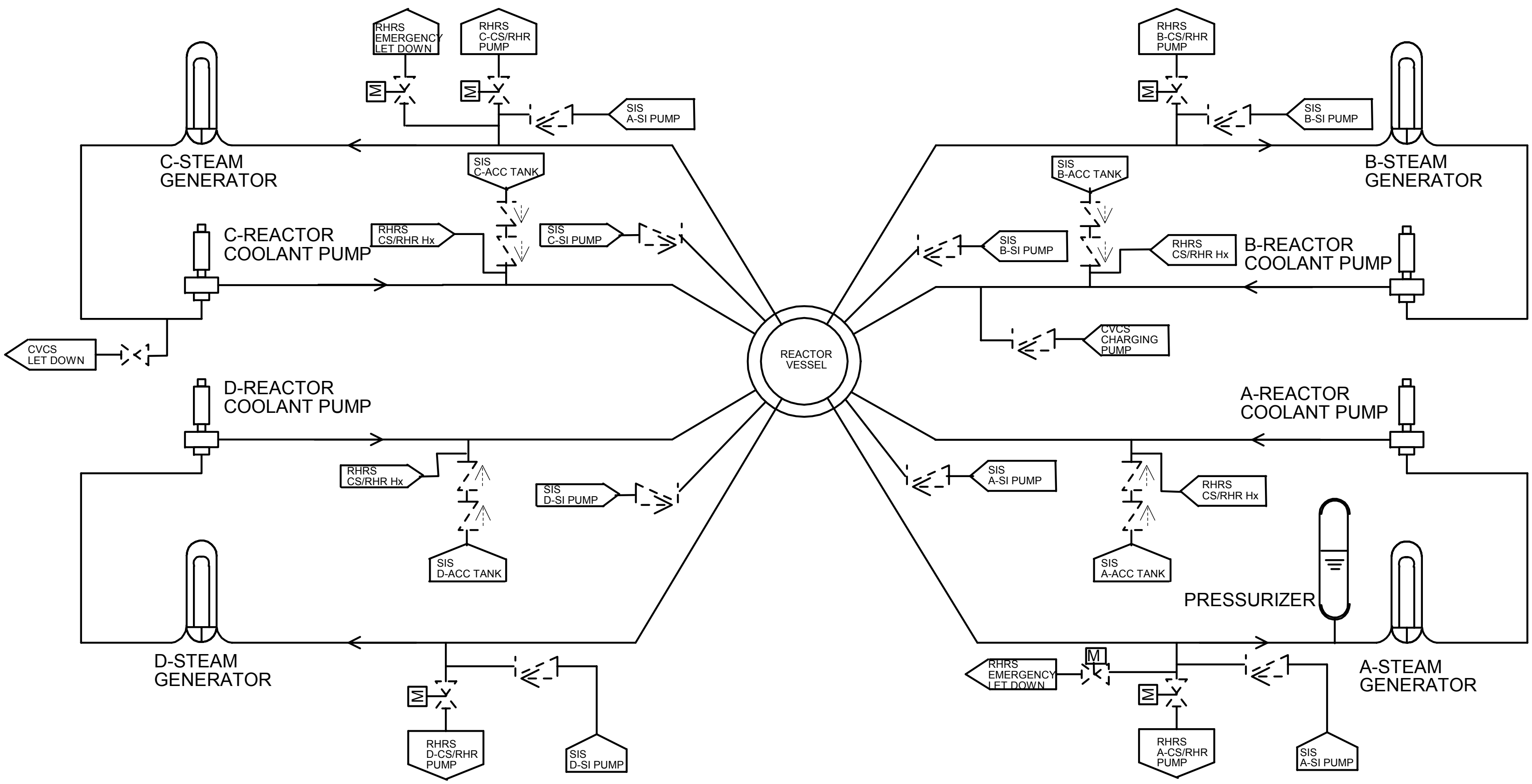


Figure 19.1-2 Simplified System Diagram (Sheet 1 of 36) (Reactor Coolant System)

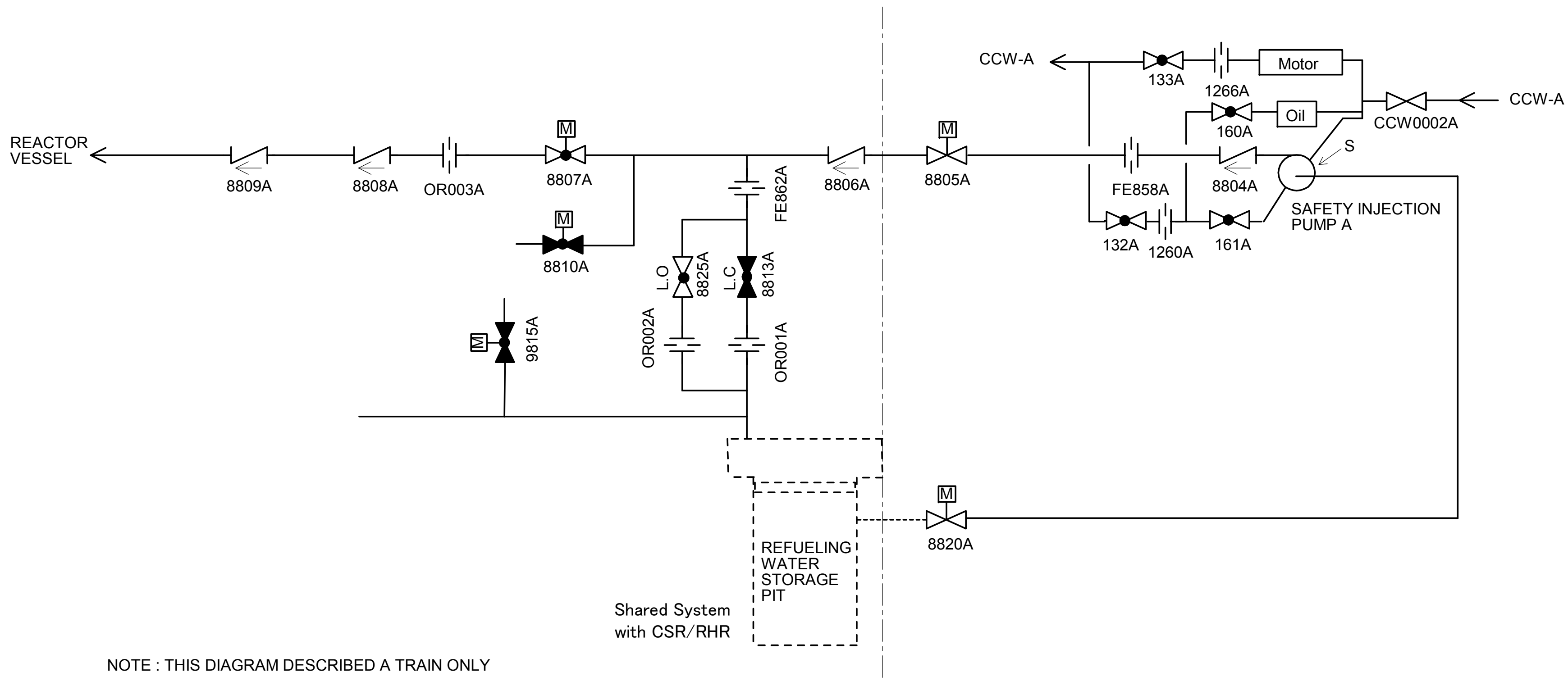


Figure 19.1-2 Simplified System Diagram (Sheet 2 of 36) (Safety Injection System)

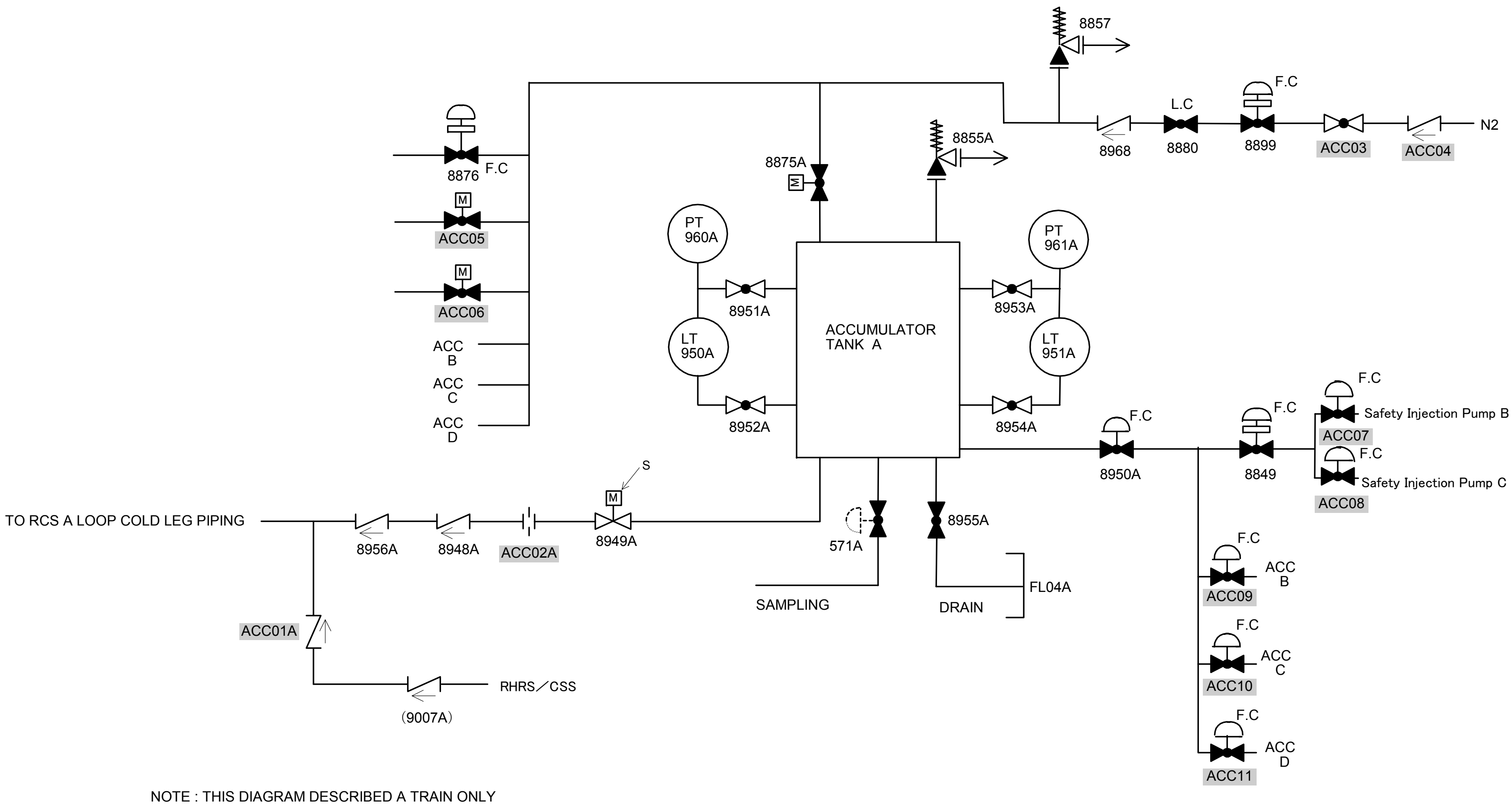


Figure 19.1-2 Simplified System Diagram (Sheet 3 of 36) (Accumulator Injection System)

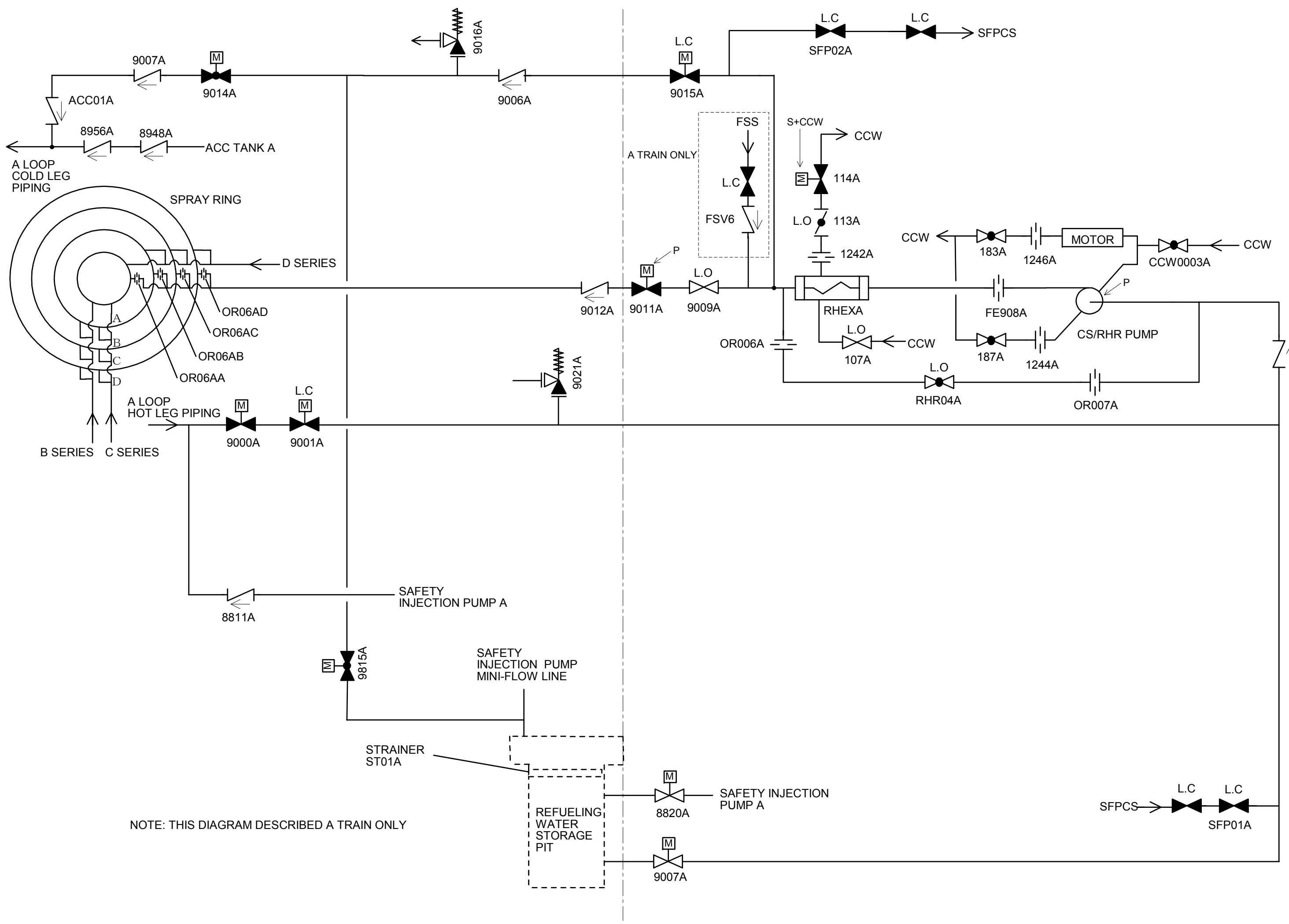


Figure 19.1-2 Simplified System Diagram (Sheet 4 of 36) (Containment Spray System/Residual Heat Removal System [Train A&D])

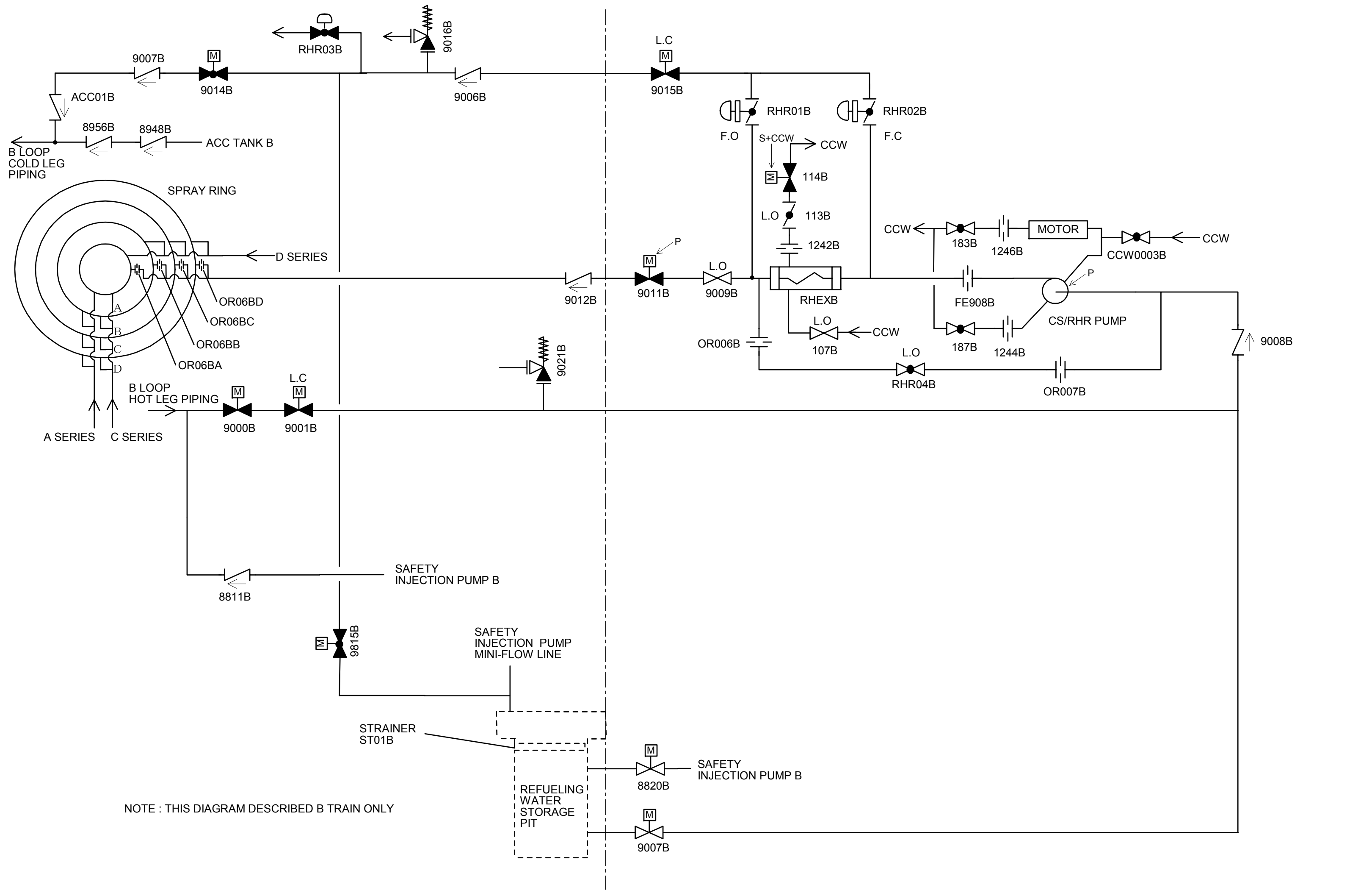


Figure 19.1-2 Simplified System Diagram (Sheet 5 of 36) (Containment Spray System/Residual Heat Removal System [Train C&B])

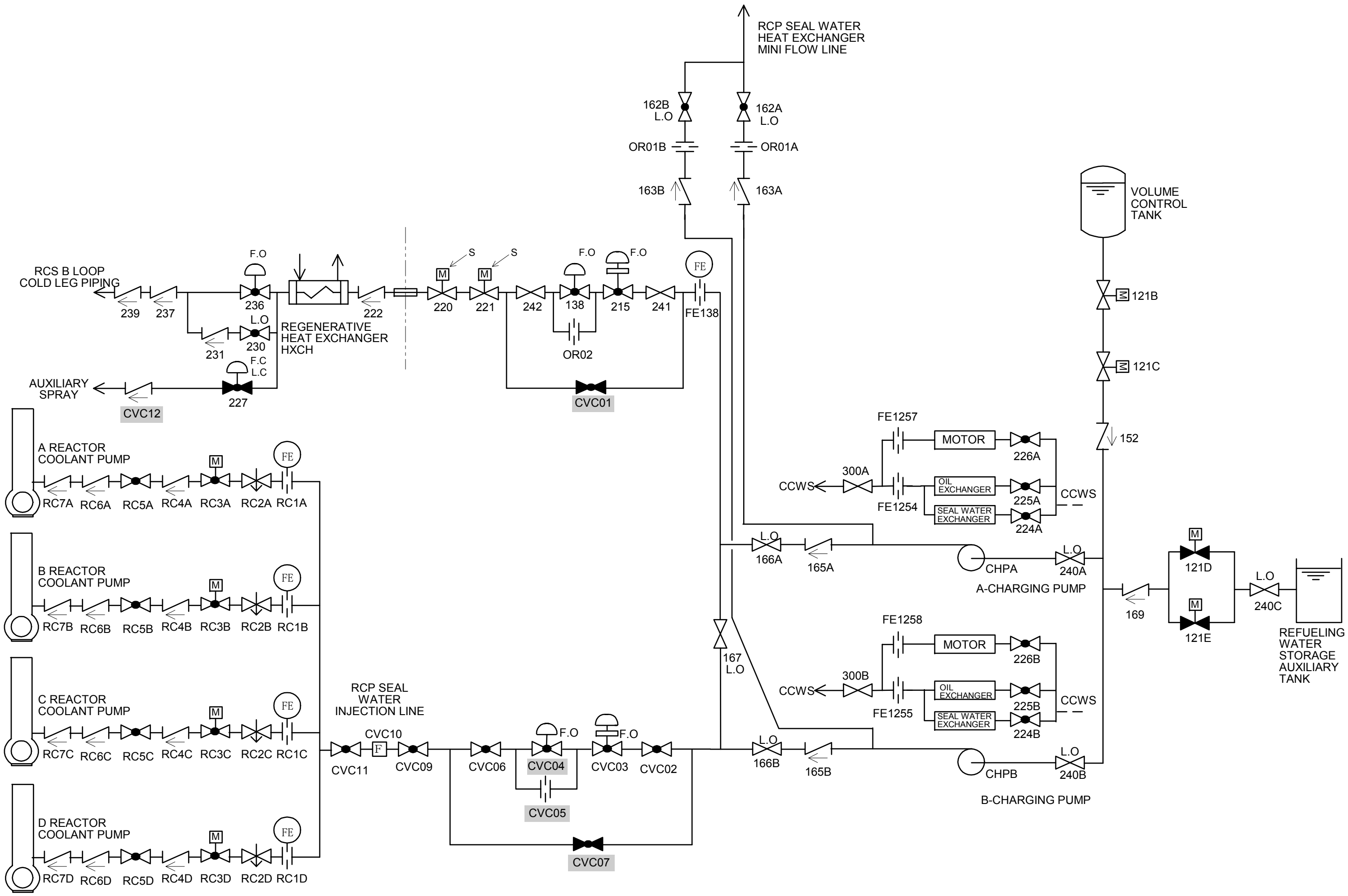


Figure 19.1-2 Simplified System Diagram (Sheet 6 of 36) (Charging Injection System)

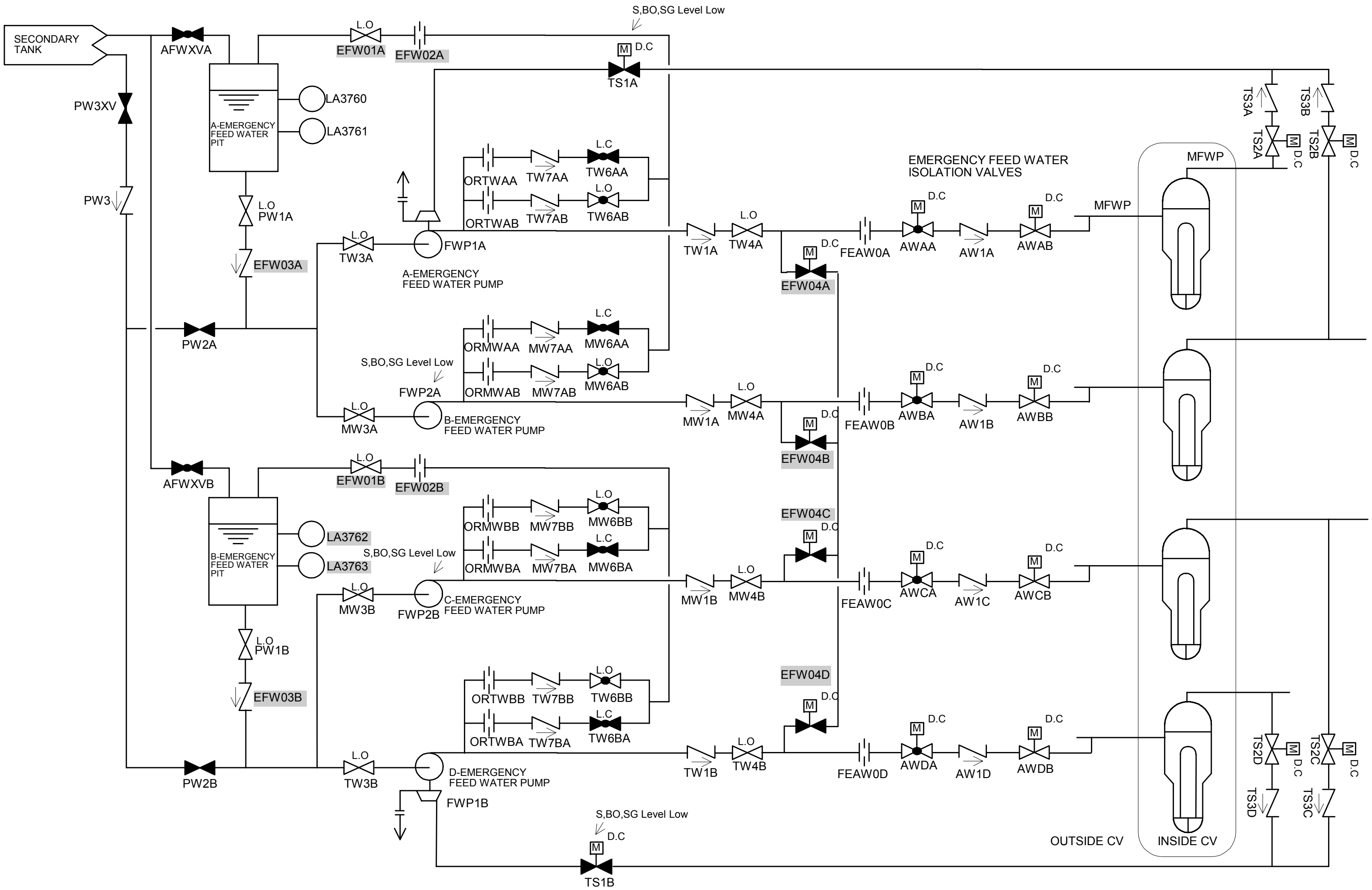


Figure 19.1-2 Simplified System Diagram (Sheet 7 of 36) (Emergency Feedwater System)

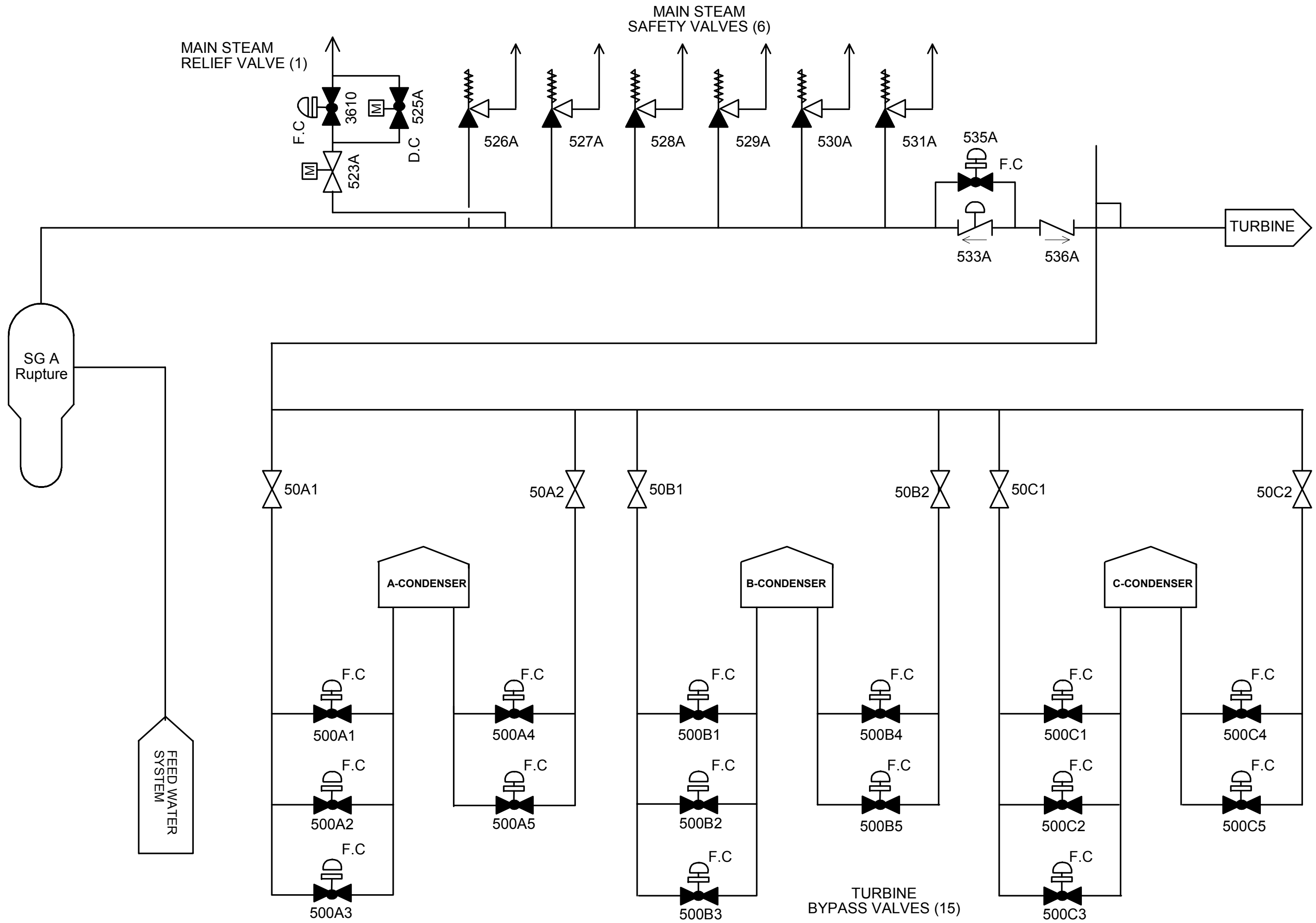


Figure 19.1-2 Simplified System Diagram (Sheet 8 of 36)
(Main Steam Pressure Control System [for Ruptured Steam Generator Isolation])

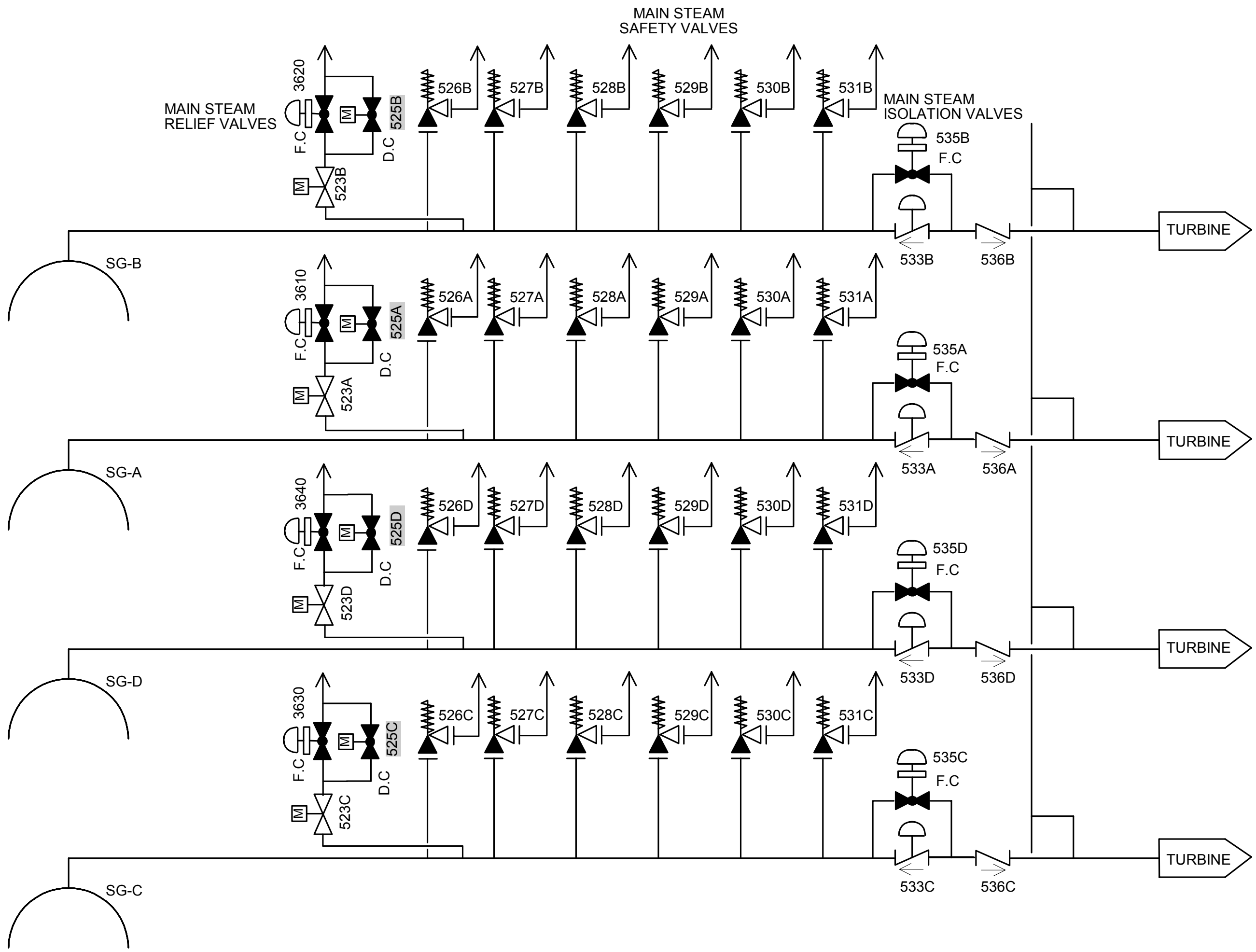


Figure 19.1-2 Simplified System Diagram (Sheet 9 of 36)
(Main Steam Pressure Control System [for Main Steam Relief])

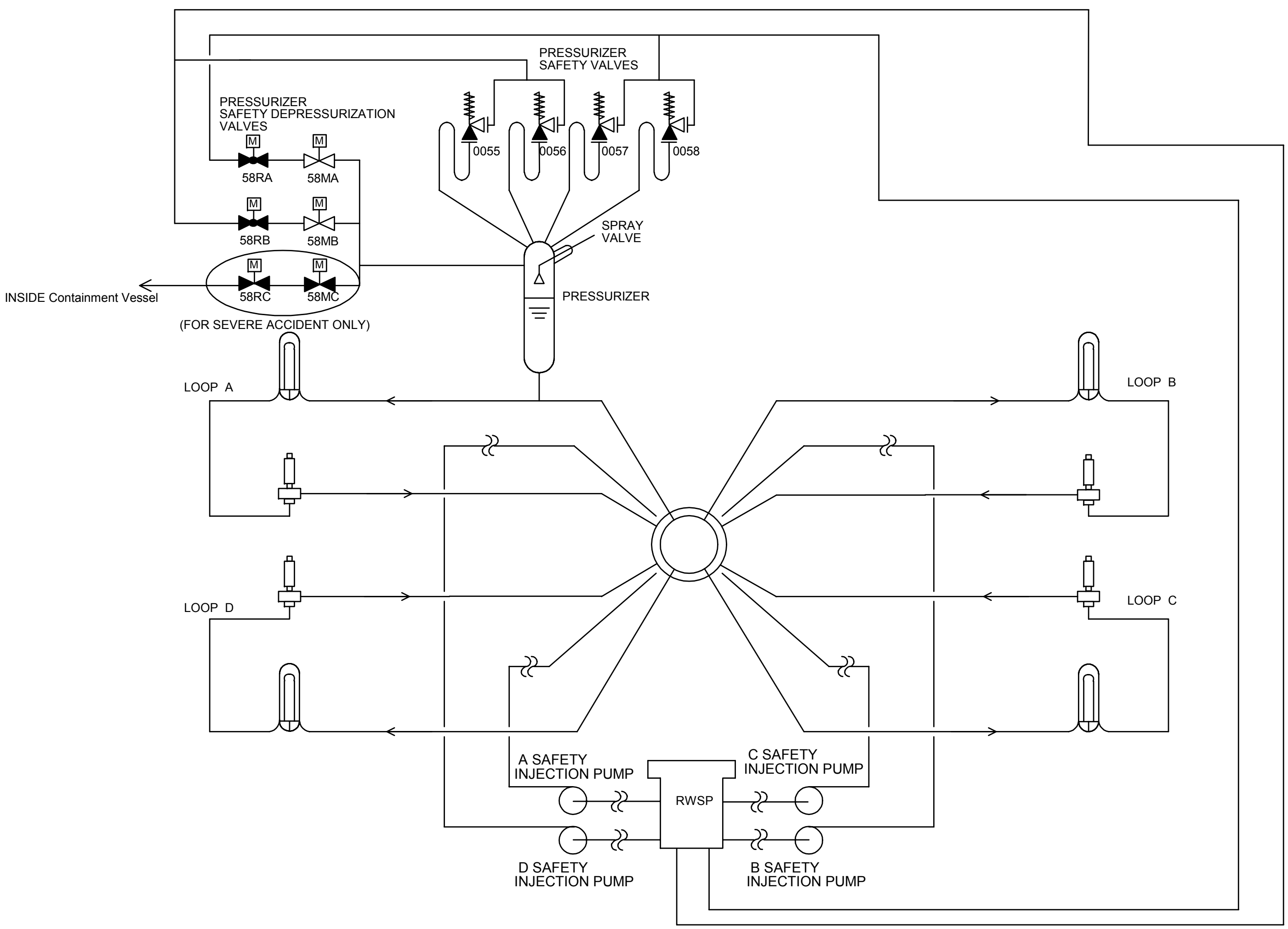


Figure 19.1-2 Simplified System Diagram (Sheet 10 of 36) (Pressurizer Pressure Control System)

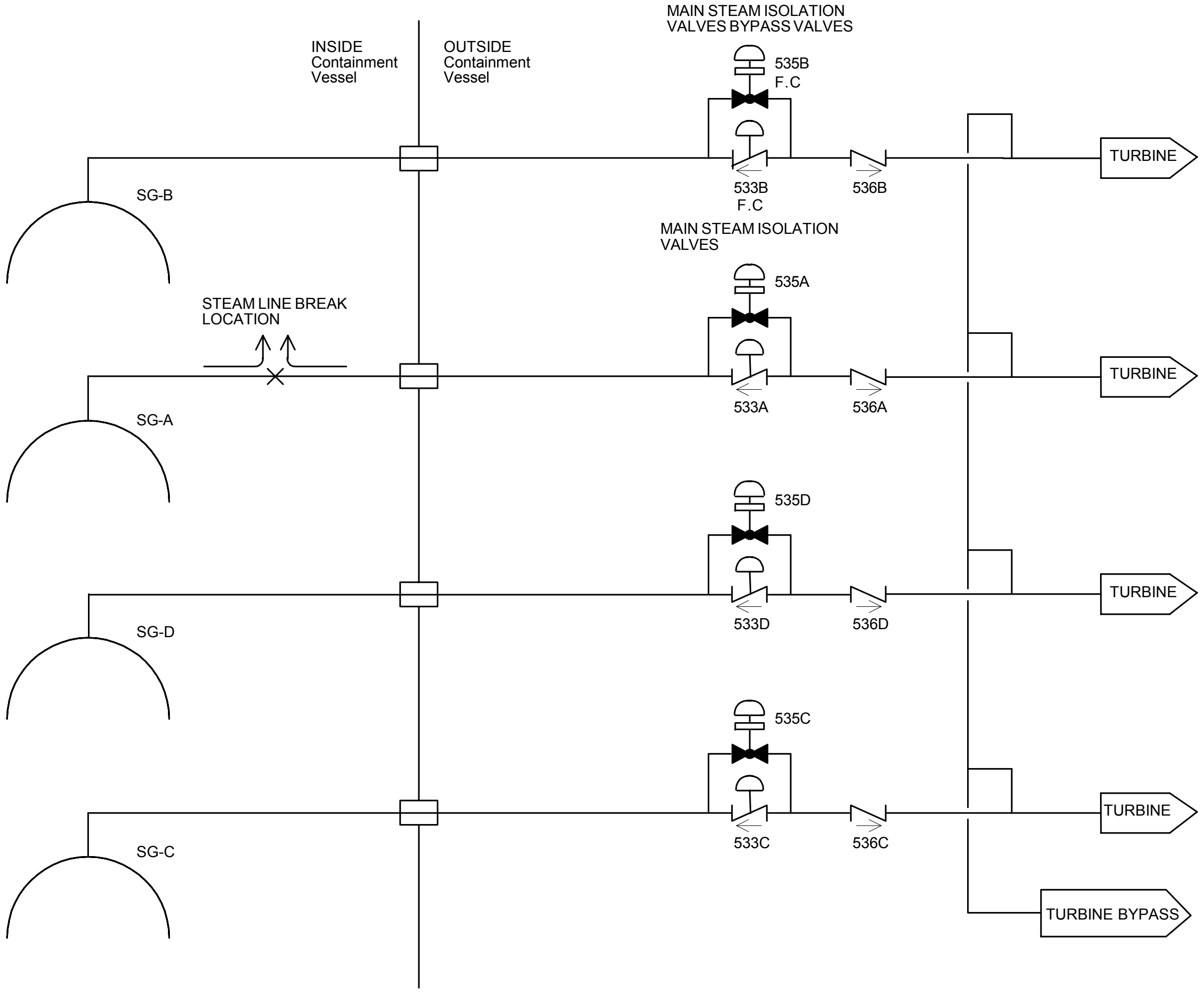


Figure 19.1-2 Simplified System Diagram (Sheet 11 of 36) (Main Steam Isolation System [Steam Line Break inside C/V])

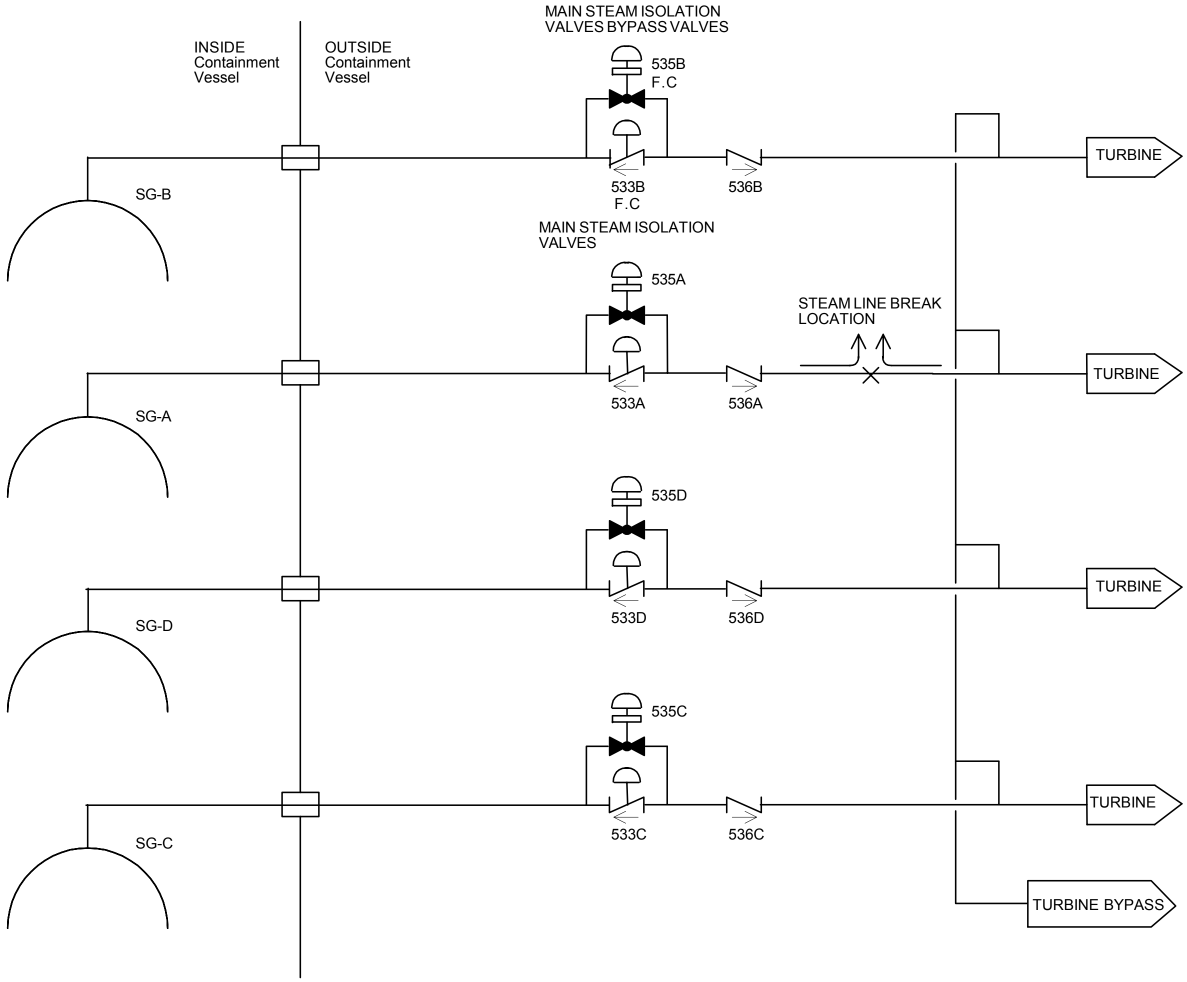


Figure 19.1-2 Simplified System Diagram (Sheet 12 of 36) (Main Steam Isolation System [Steam Line Break outside C/V])

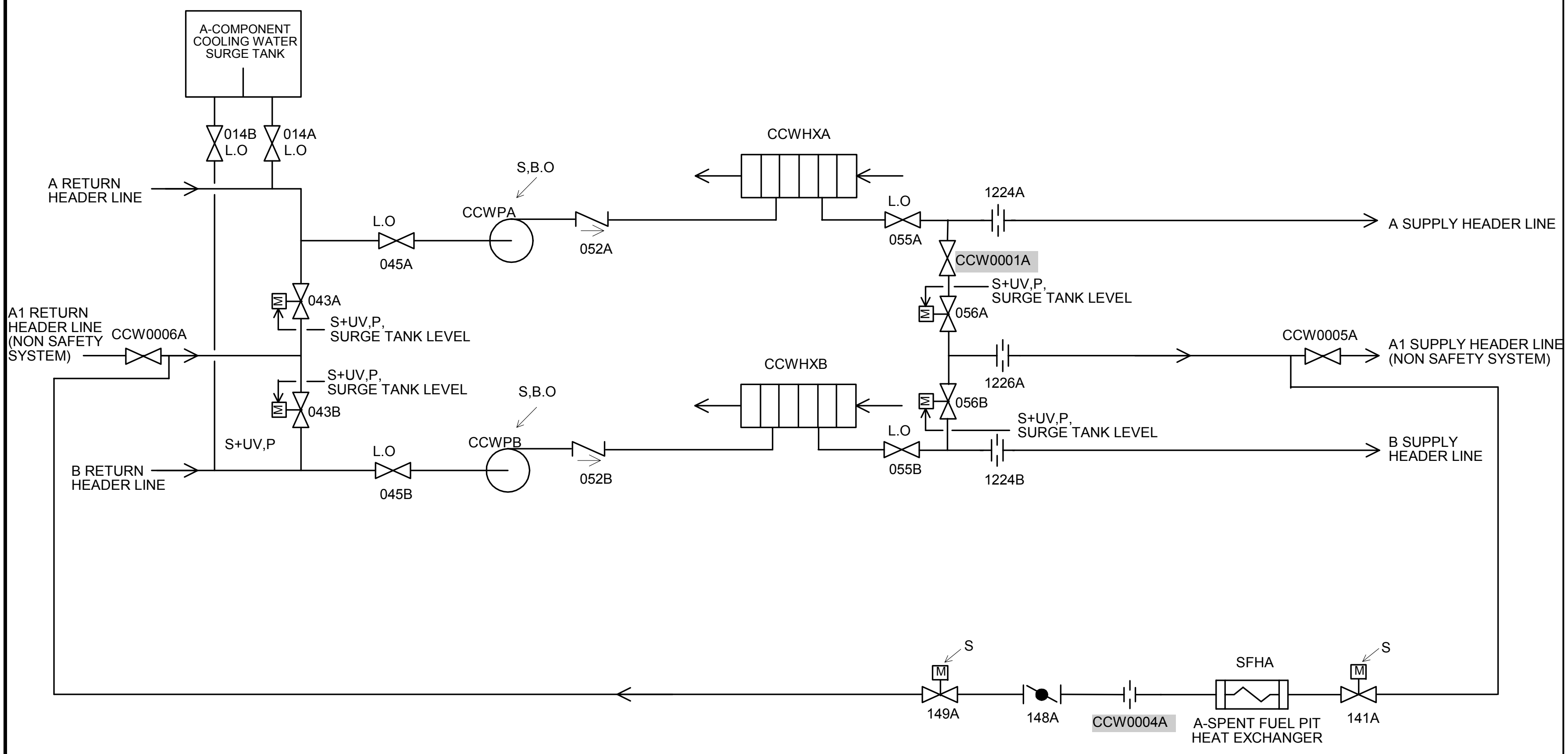


Figure 19.1-2 Simplified System Diagram (Sheet 13 of 36) (Component Cooling Water System [1of4])

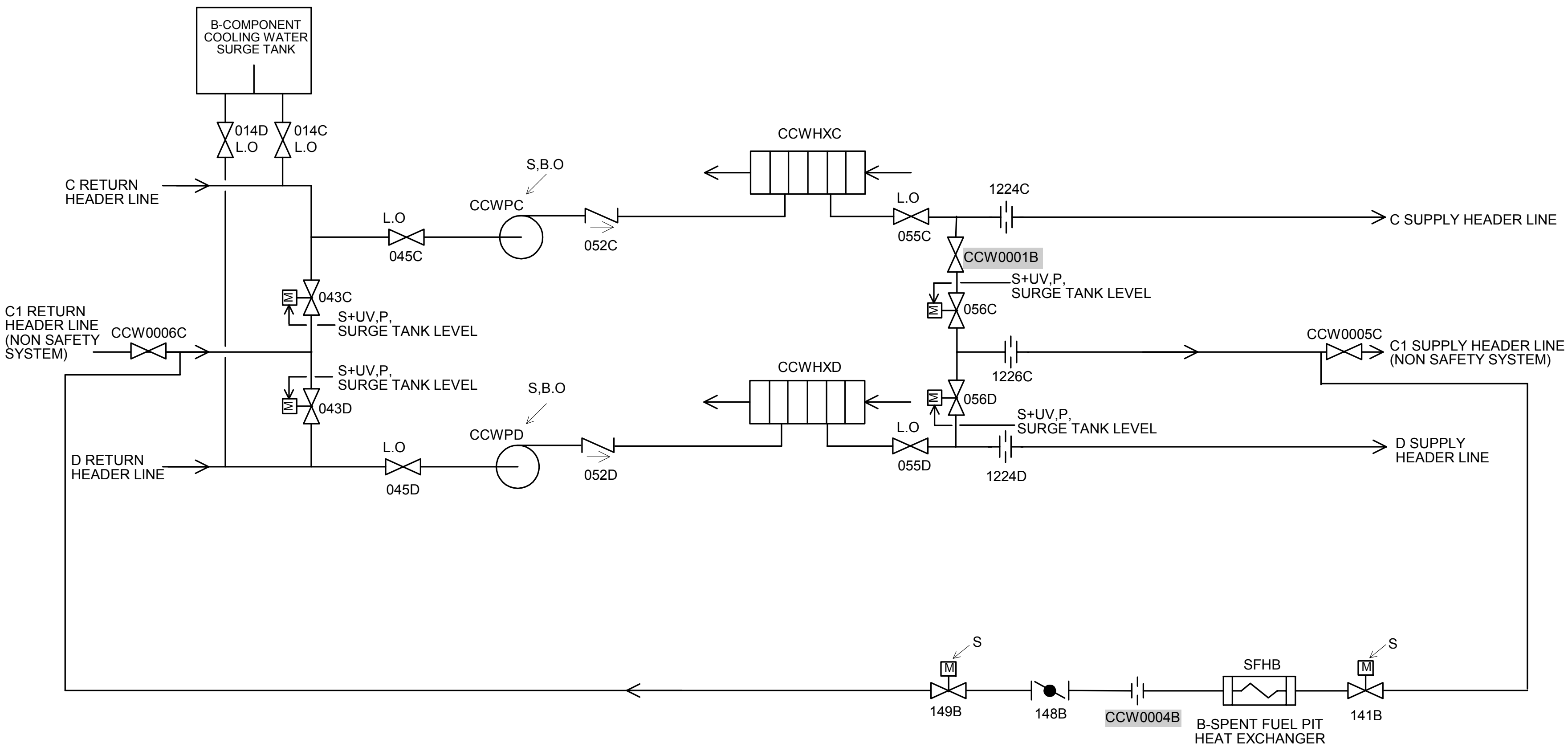


Figure 19.1-2 Simplified System Diagram (Sheet 14 of 36) (Component Cooling Water System [2of4])

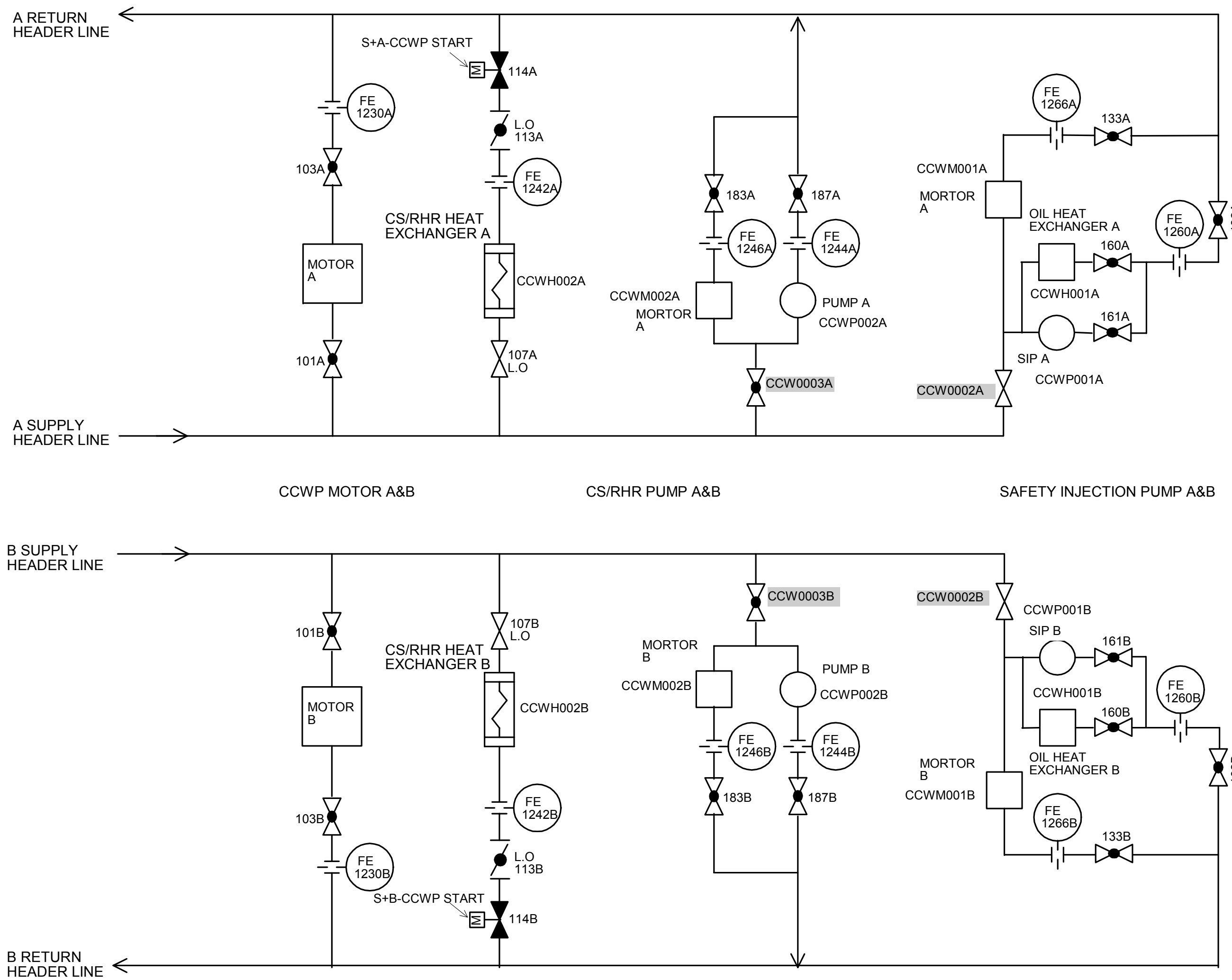


Figure 19.1-2 Simplified System Diagram (Sheet 15 of 36) (Component Cooling Water System [3of4])

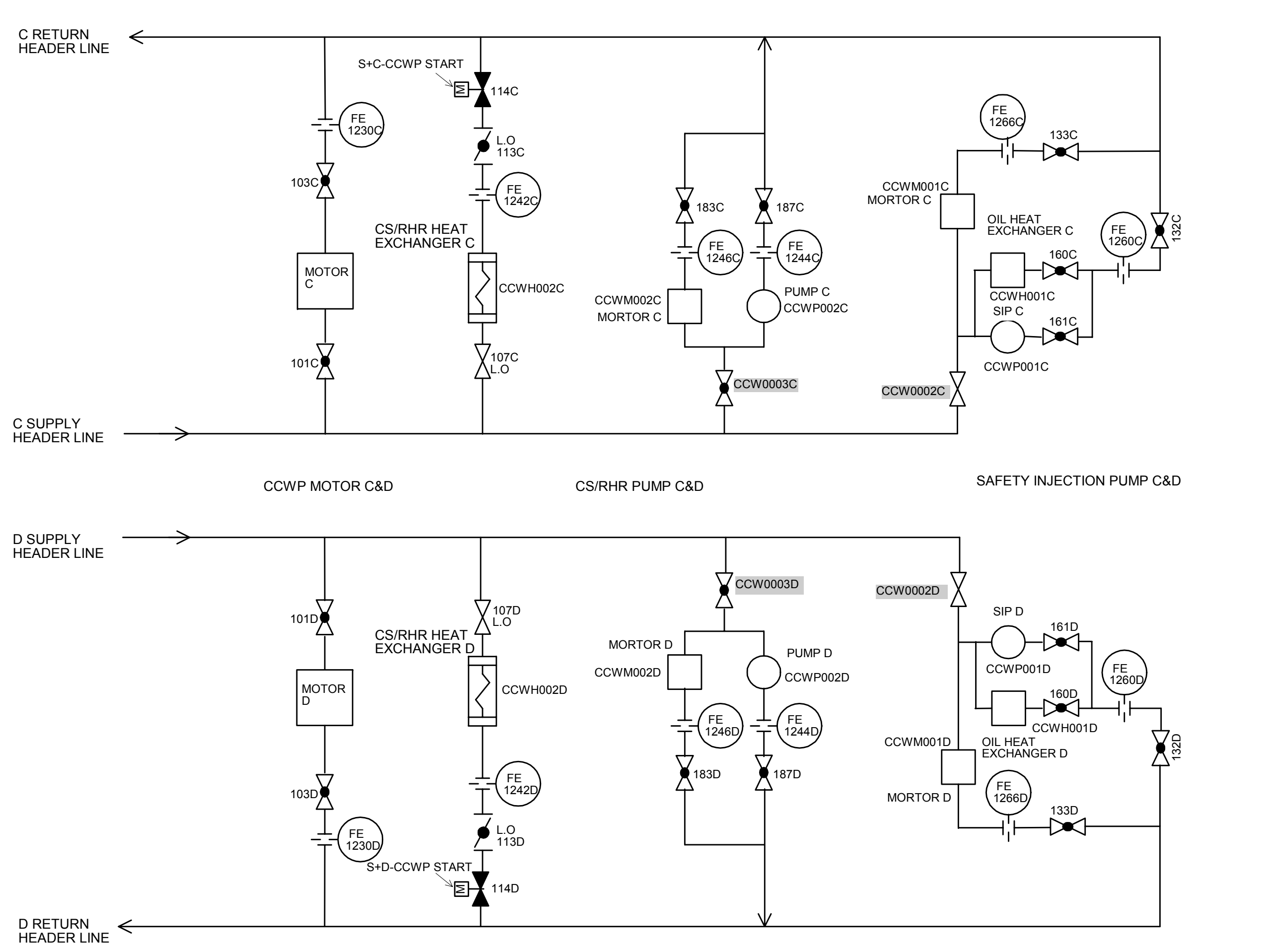


Figure 19.1-2 Simplified System Diagram (Sheet 16 of 36) (Component Cooling Water System [4of4])

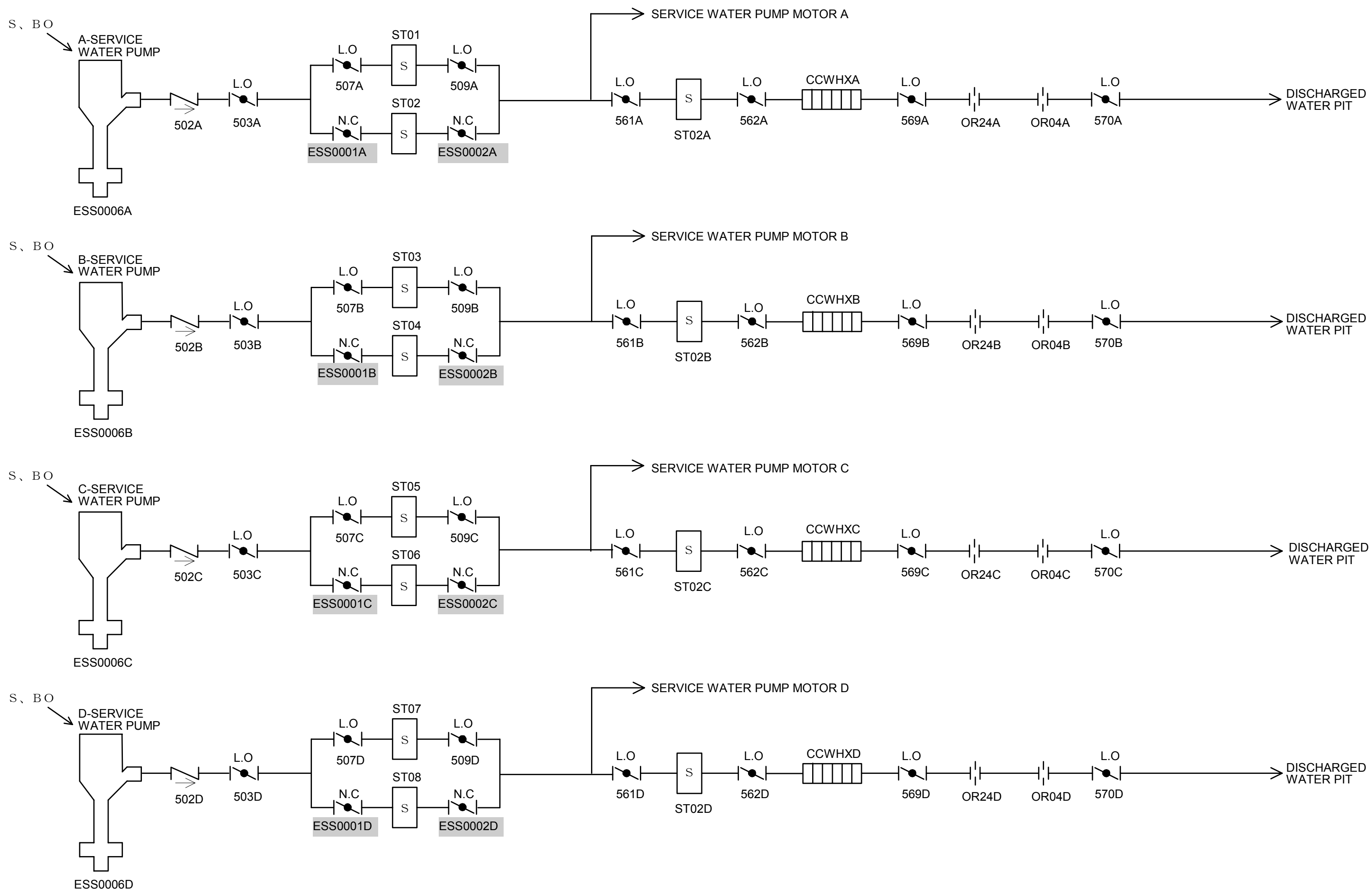


Figure 19.1-2 Simplified System Diagram (Sheet 17 of 36) (Essential Service Water System [1of2])

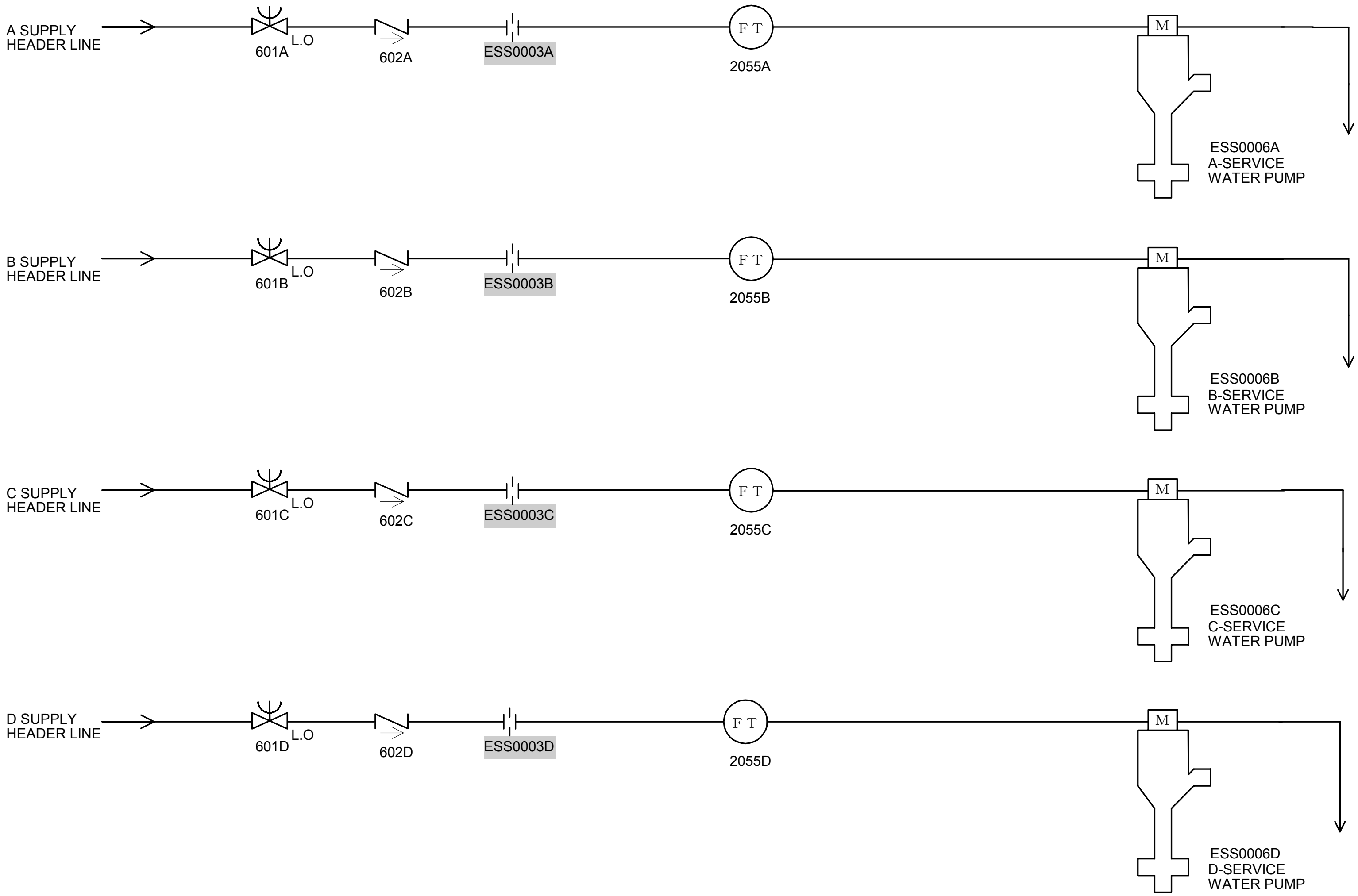


Figure 19.1-2 Simplified System Diagram (Sheet 18 of 36) (Essential Service Water System [2of2])

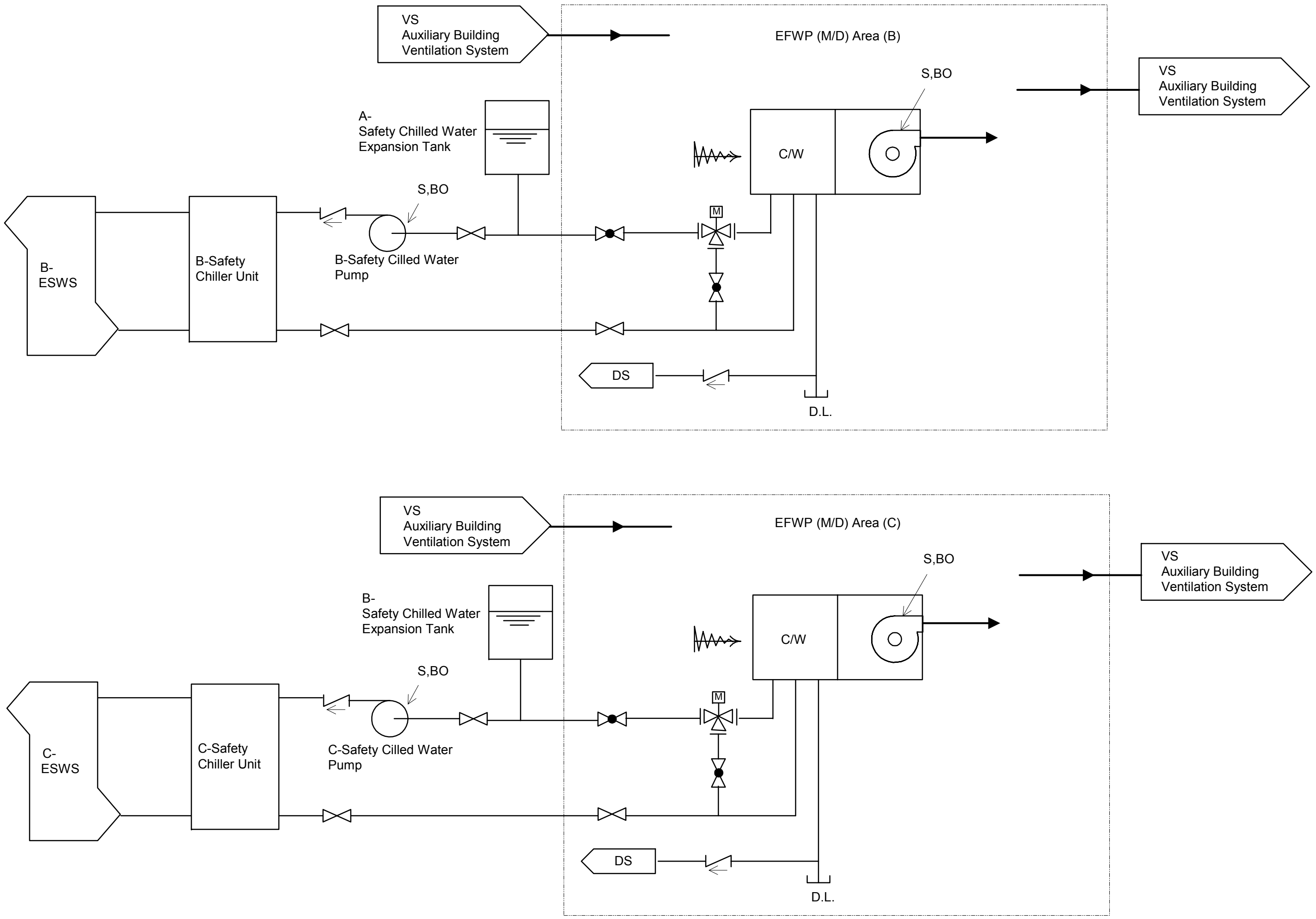


Figure 19.1-2 Simplified System Diagram (Sheet 19 of 36) (Heating, Ventilating and Air Conditioning System)

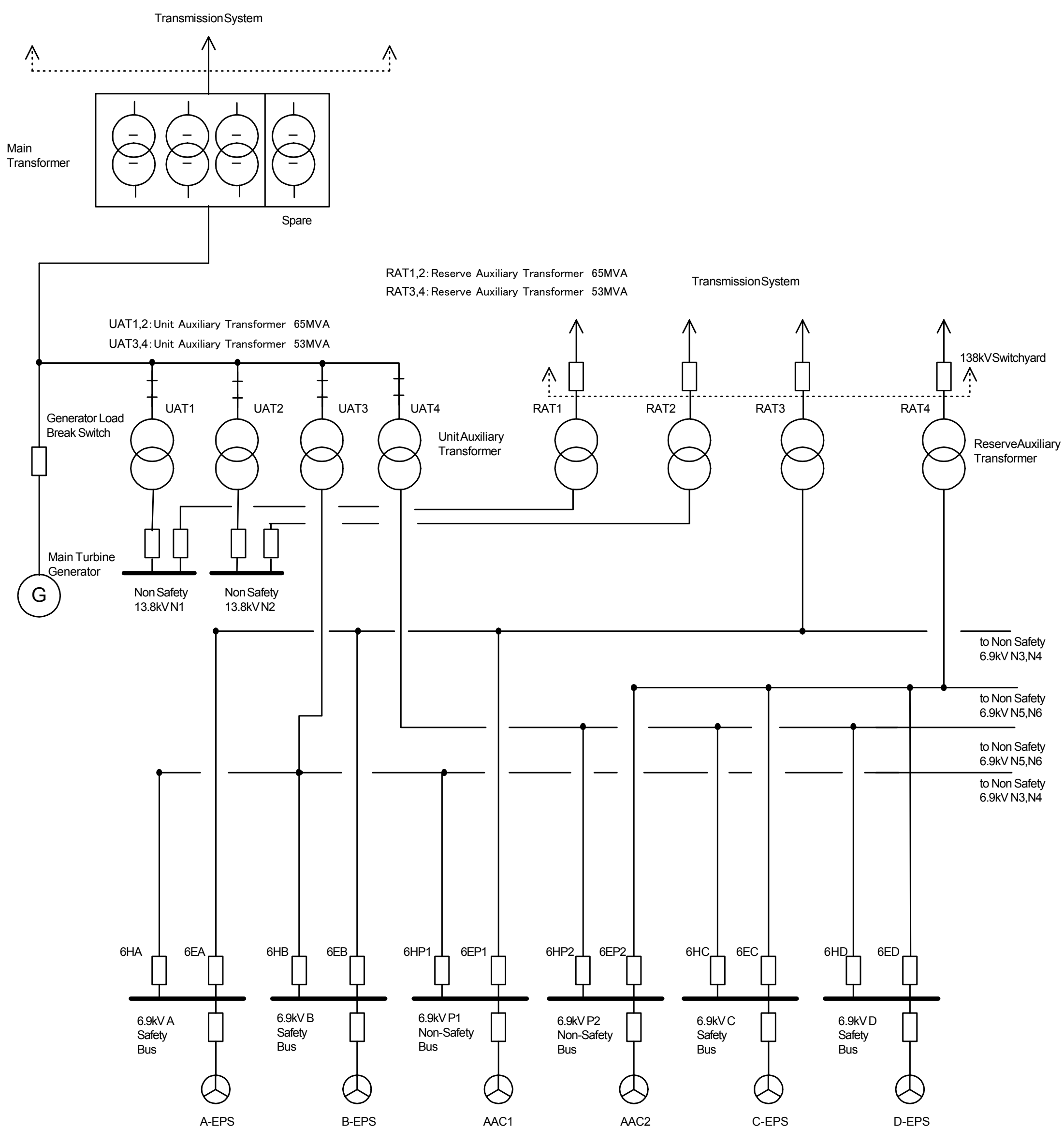


Figure 19.1-2 Simplified System Diagram (Sheet 20 of 36)

(Safety System Electric Bus [1/2])

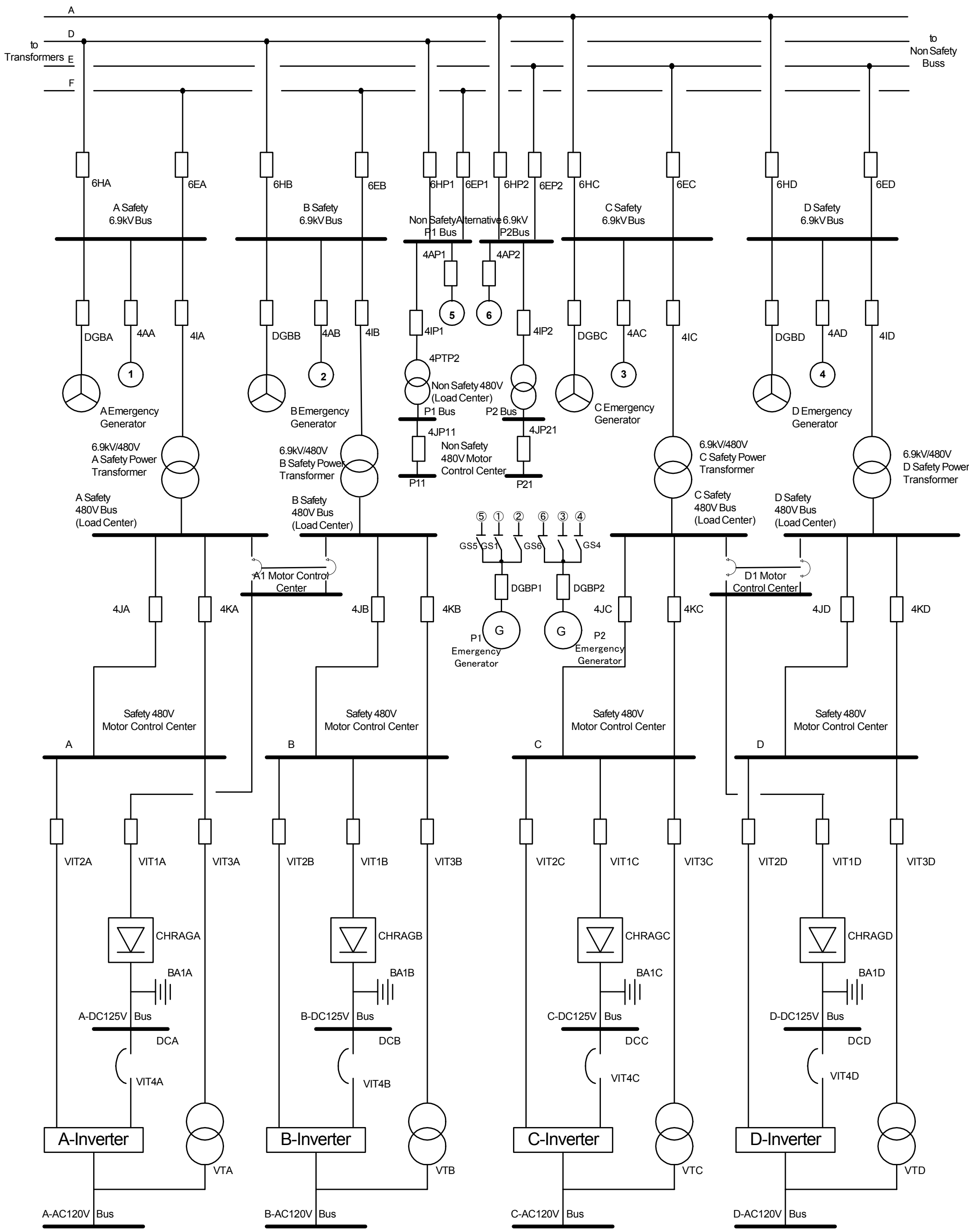


Figure 19.1-2 Simplified System Diagram (Sheet 21 of 36)

(Safety System Electric Bus [2/2])

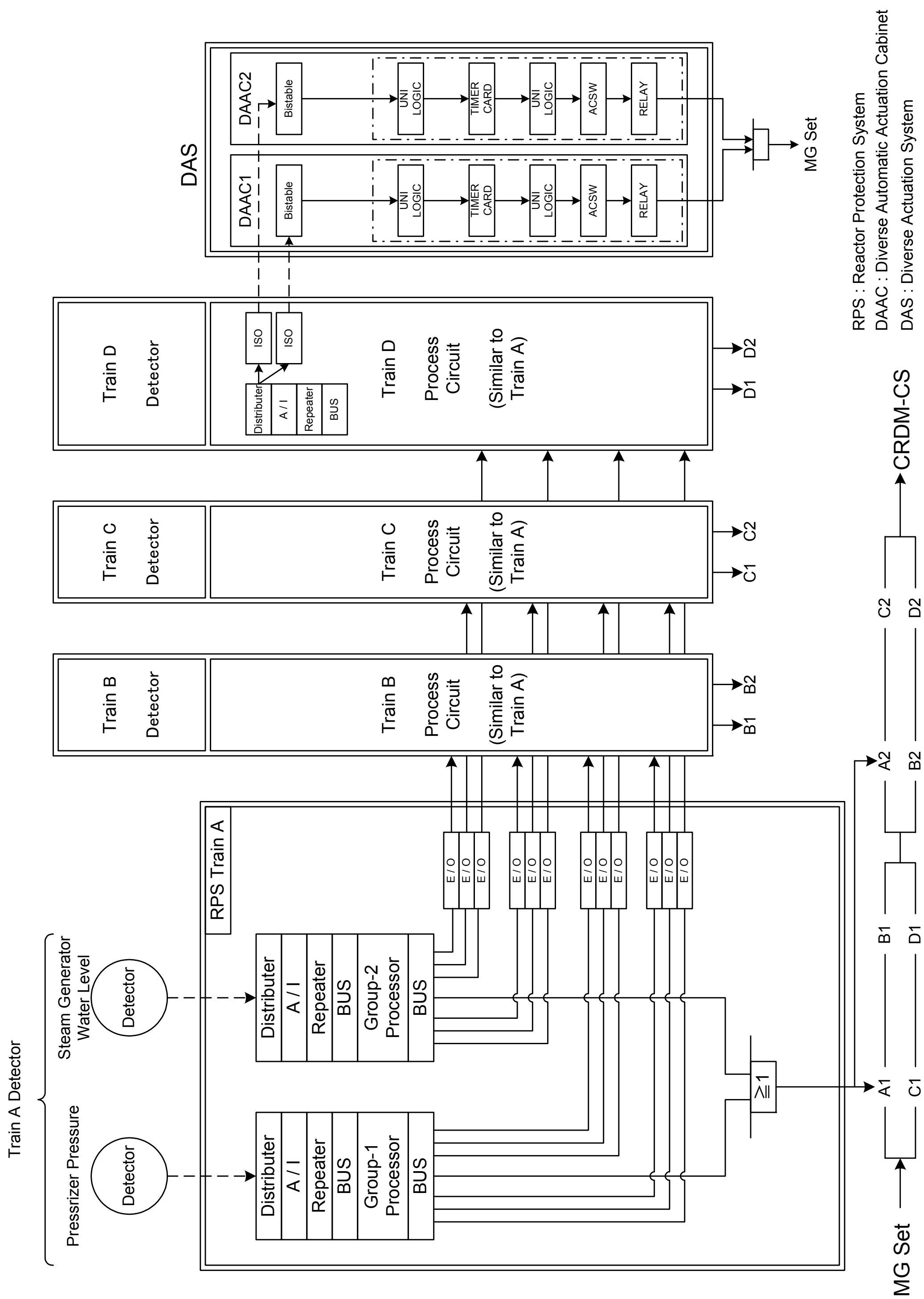


Figure 19.1-2 Simplified System Diagram (Sheet 22 of 36) (Reactor Trip System)

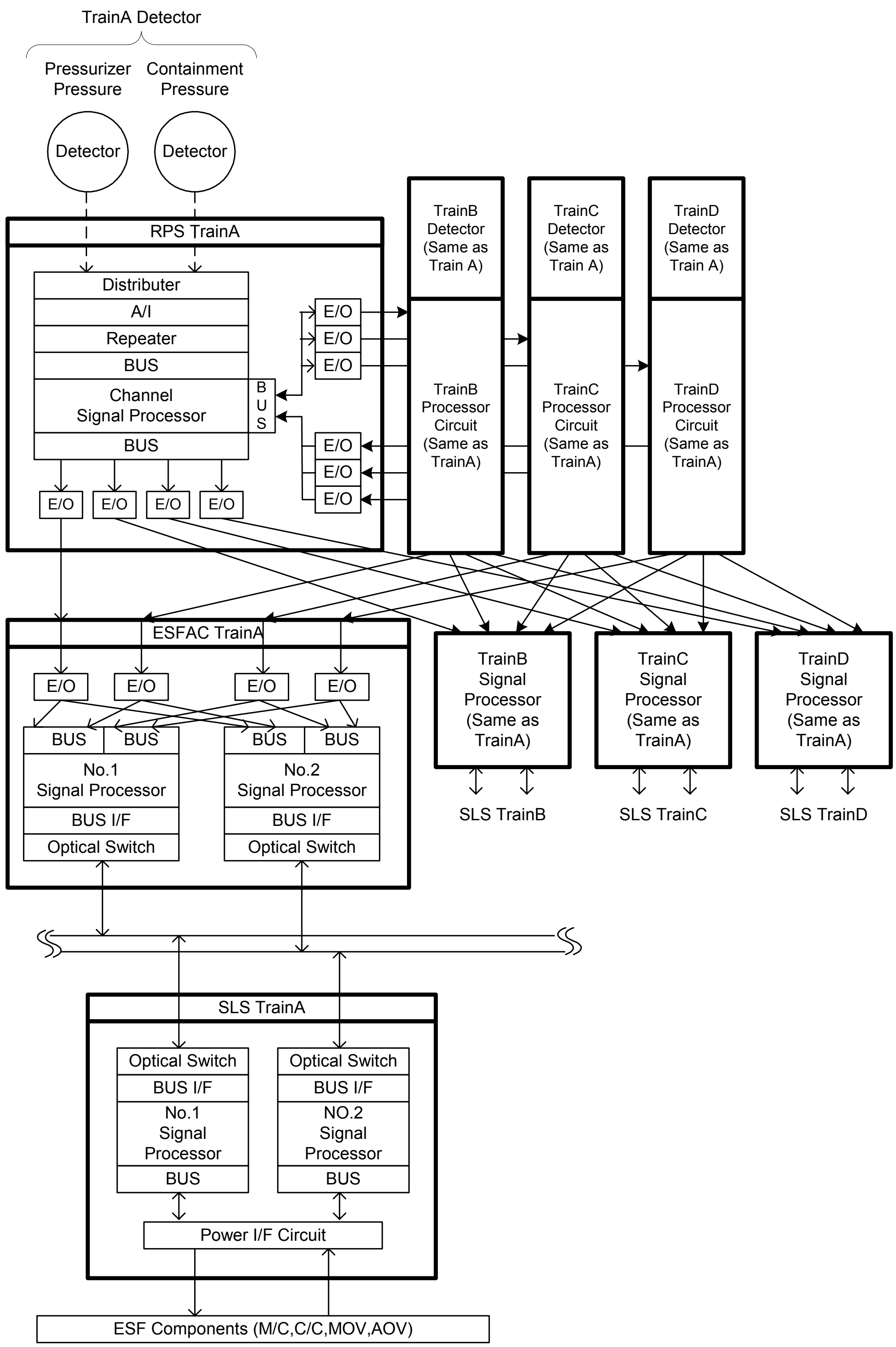


Figure 19.1-2 Simplified System Diagram (Sheet 23 of 36)

(ESF System - ESS Actuation Signals)

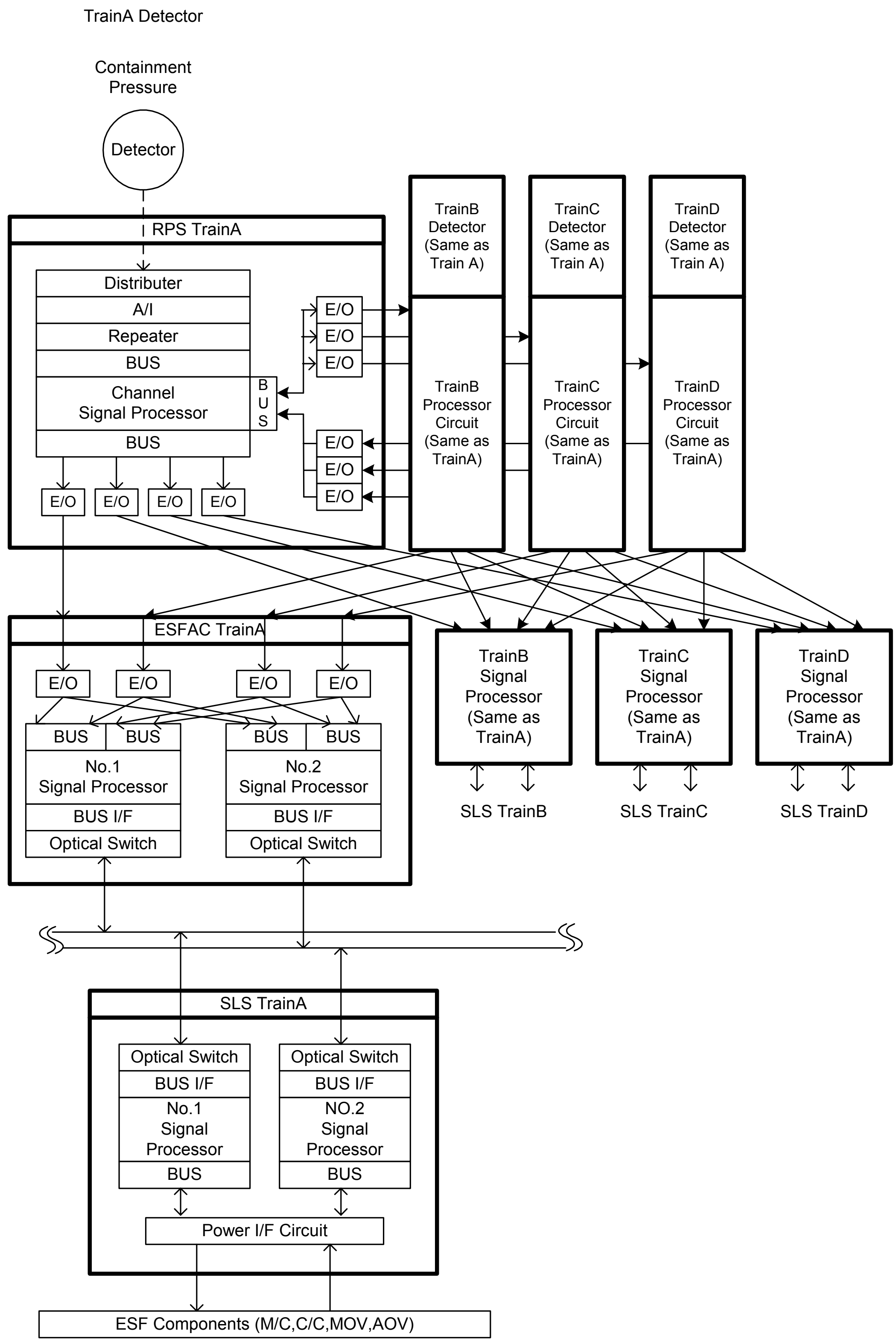


Figure 19.1-2 Simplified System Diagram (Sheet 24 of 36)

(ESF System -Containment Spray Actuation Signals)

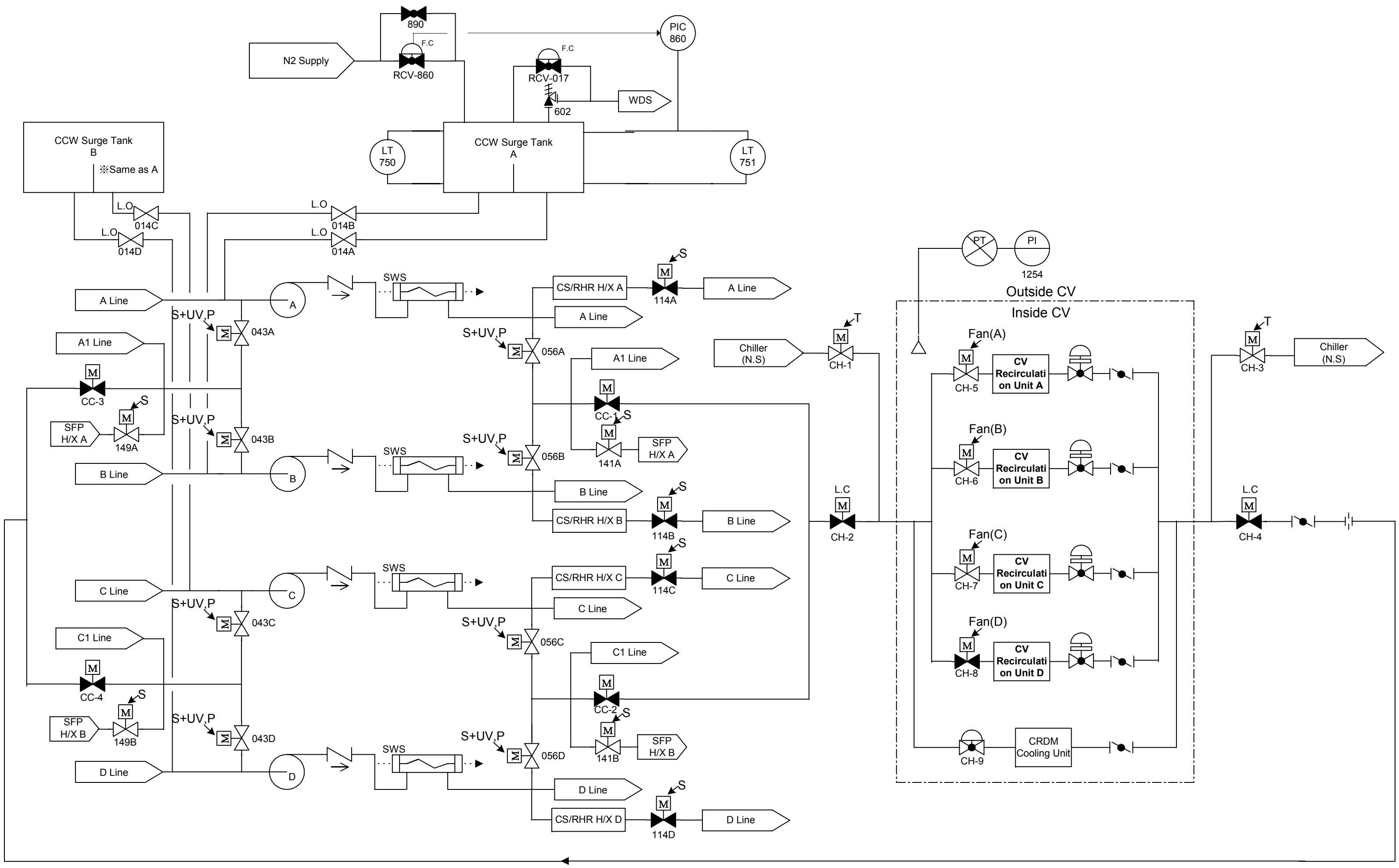


Figure 19.1-2 Simplified System Diagram (Sheet 25 of 36)

(Alternate Containment Cooling by Containment Fan Cooler System - Normal Operation)

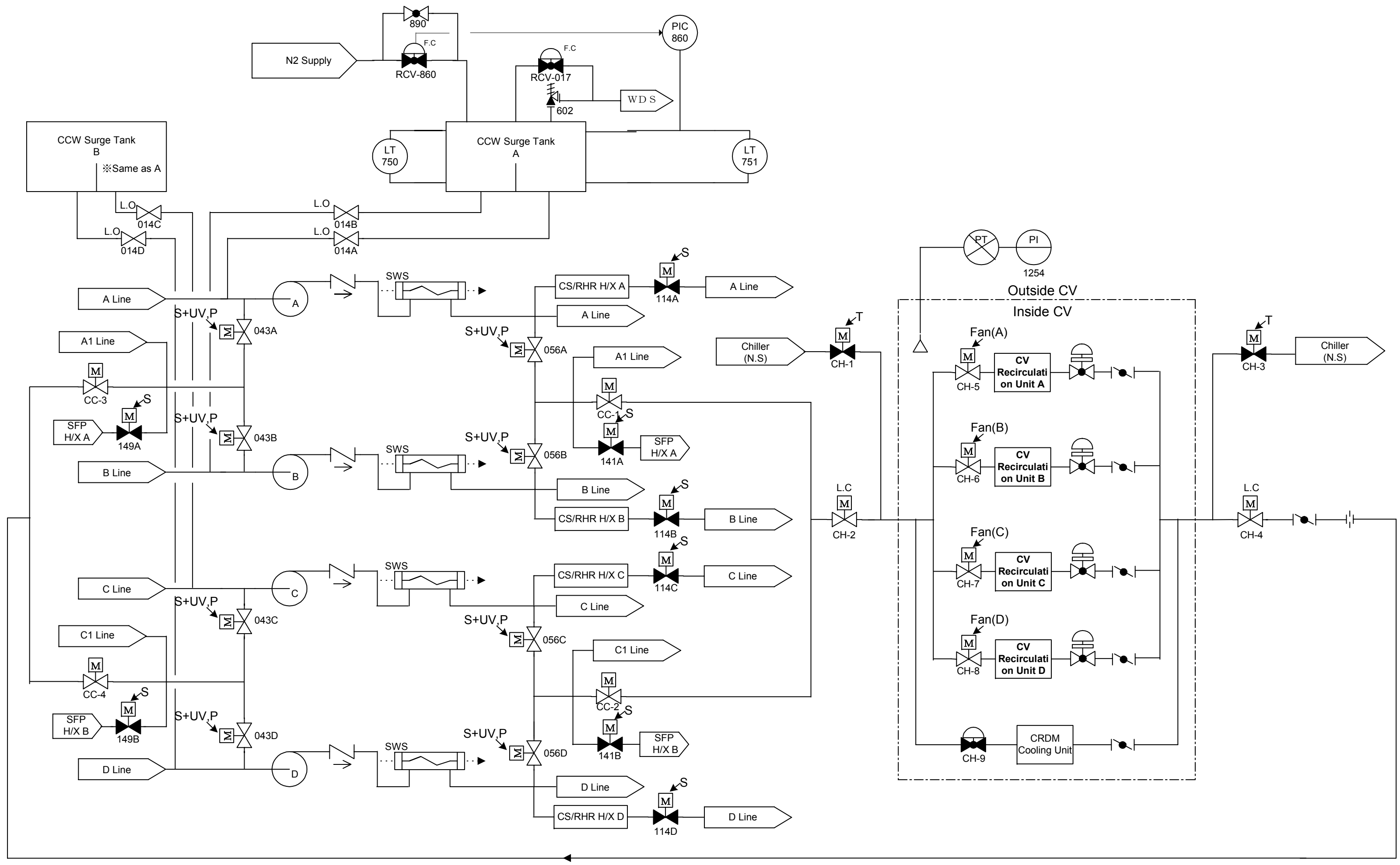


Figure 19.1-2 Simplified System Diagram (Sheet 26 of 36)

(Alternate Containment Cooling by Containment Fan Cooler System - Alternate Containment Cooling Mode)

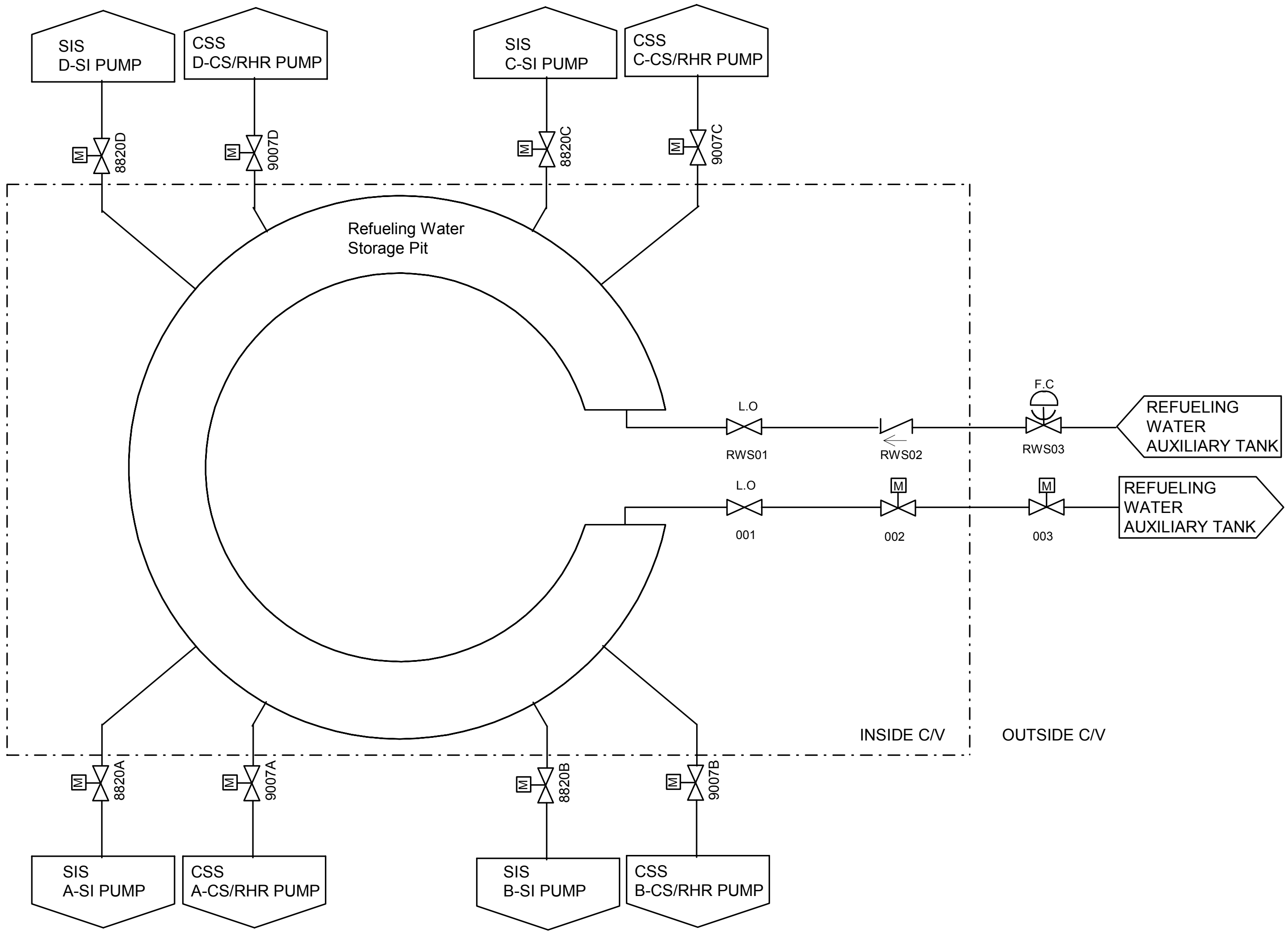


Figure 19.1-2 Simplified System Diagram (Sheet 27 of 36) (Refueling Water Storage Pit)

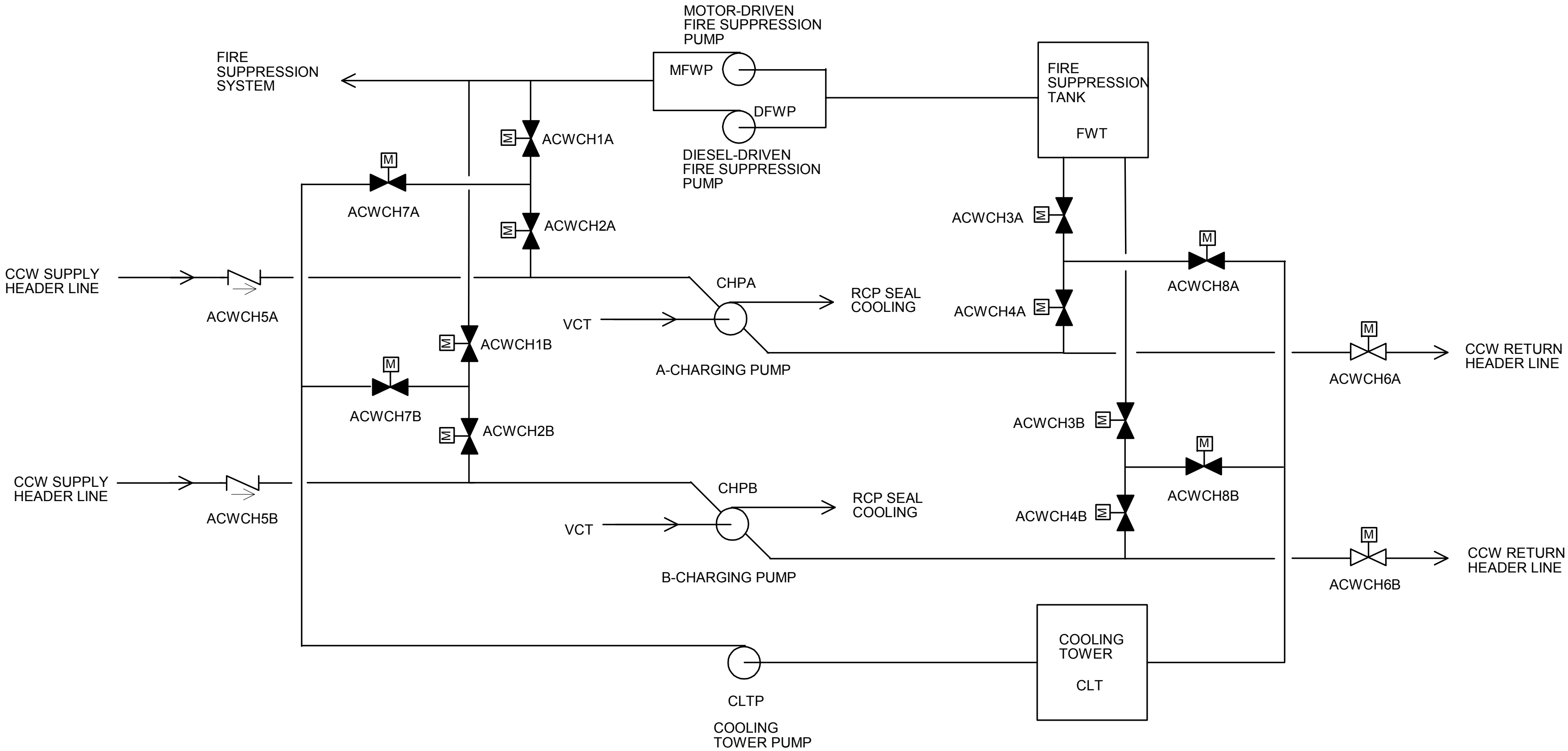


Figure 19.1-2 Simplified System Diagram (Sheet 28 of 36)

(Charging Pump Cooling by CCWS- Normal Operation)

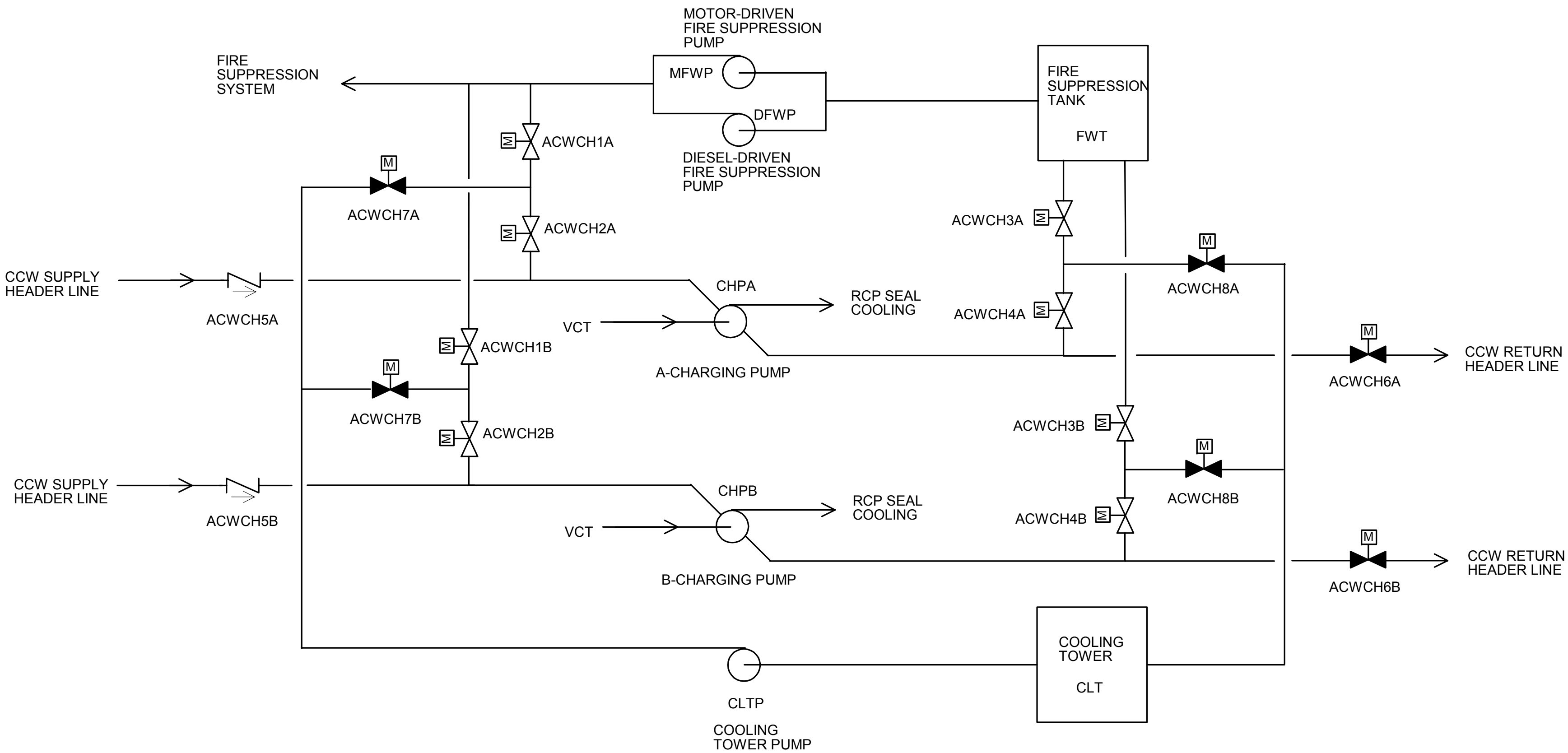


Figure 19.1-2 Simplified System Diagram (Sheet 29 of 36)

(Alternate Component Cooling by Fire Suppression System)

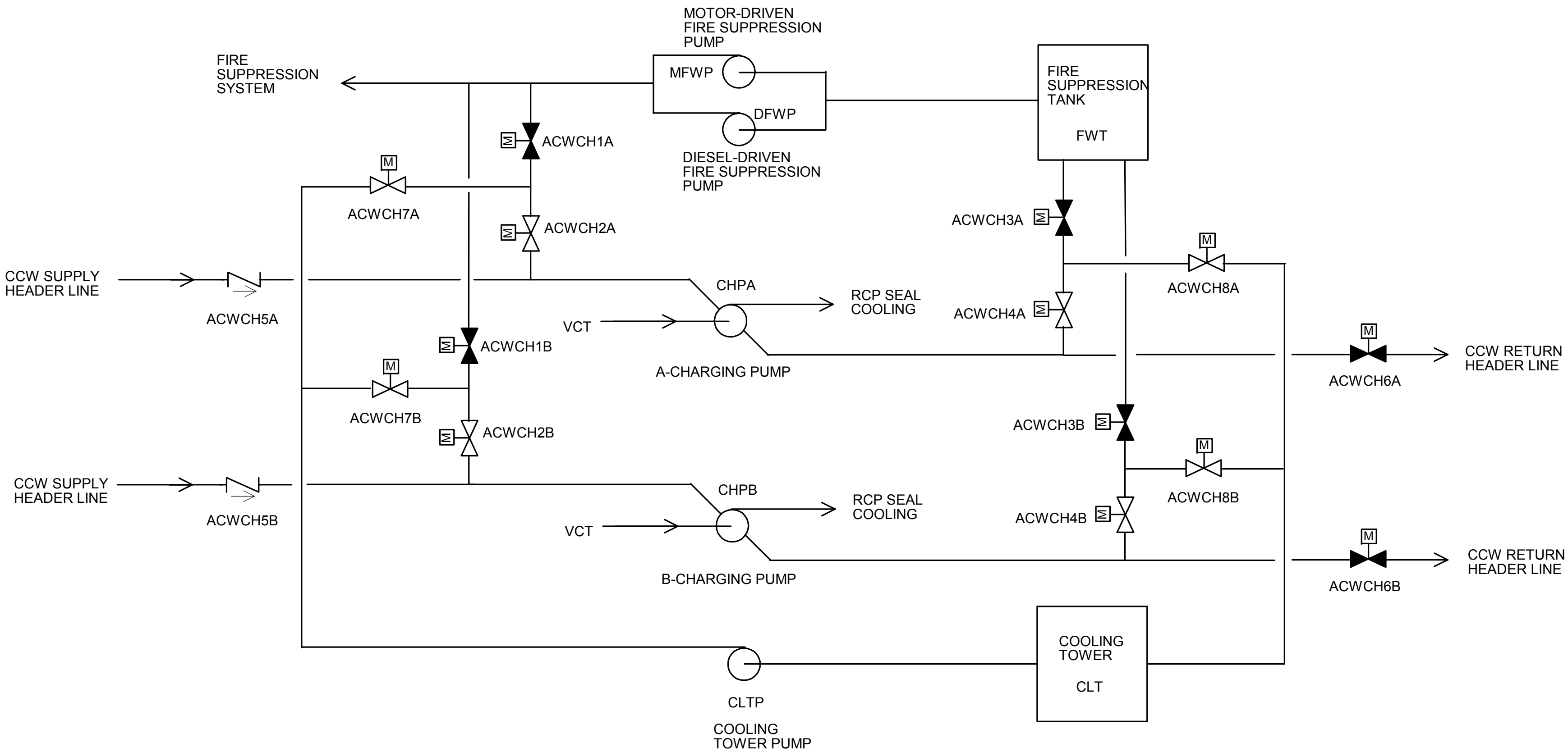


Figure 19.1-2 Simplified System Diagram (Sheet 30 of 36)

(Alternate Component Cooling by Non-essential Chilled Water System)

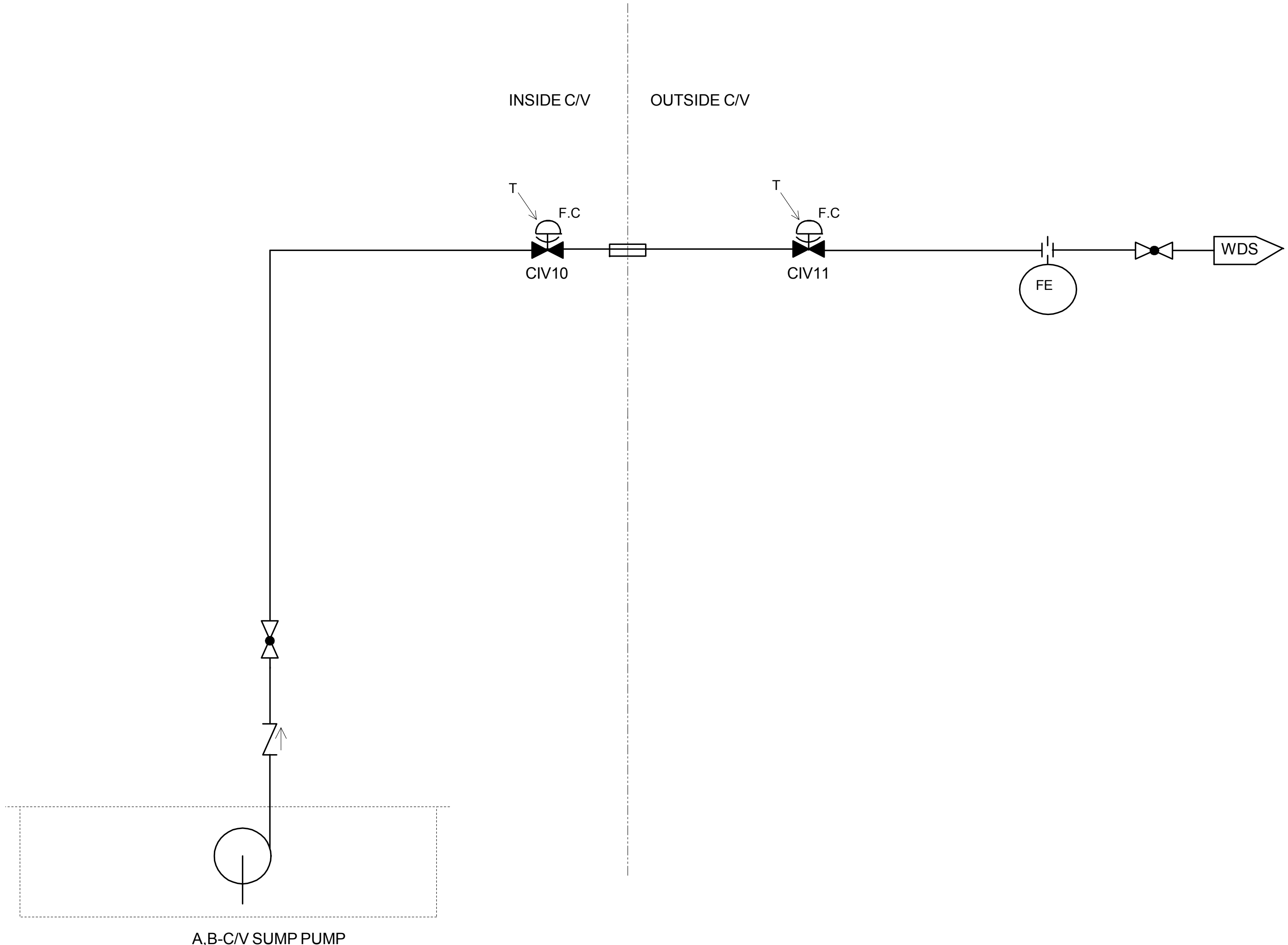


Figure 19.1-2 Simplified System Diagram (Sheet 31 of 36)

(Containment Isolation System - Liquid Waste Management System - C/V Sump Pump Discharge Line)

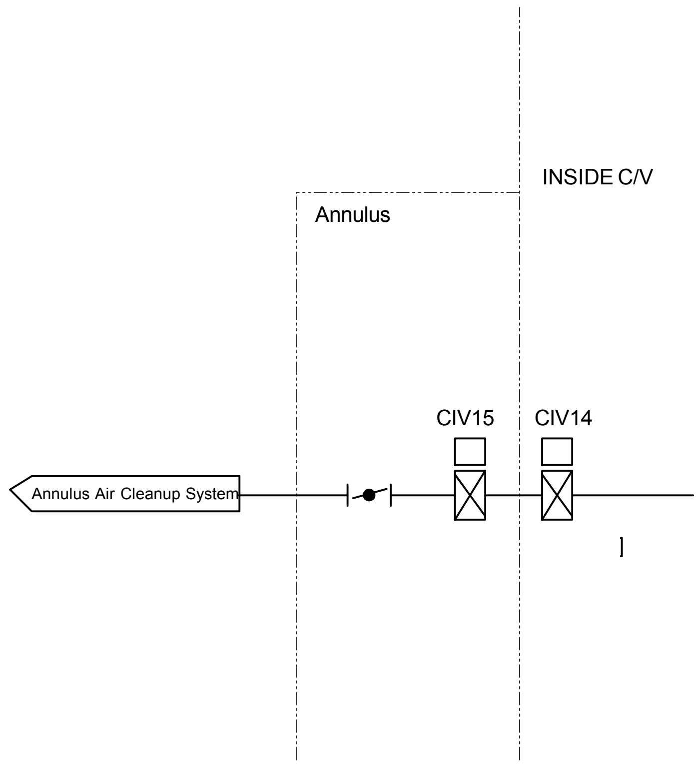


Figure 19.1-2 Simplified System Diagram (Sheet 32 of 36)

(Containment Isolation System - Containment Purge System - Containment Low Volume Purge Exhaust Line)

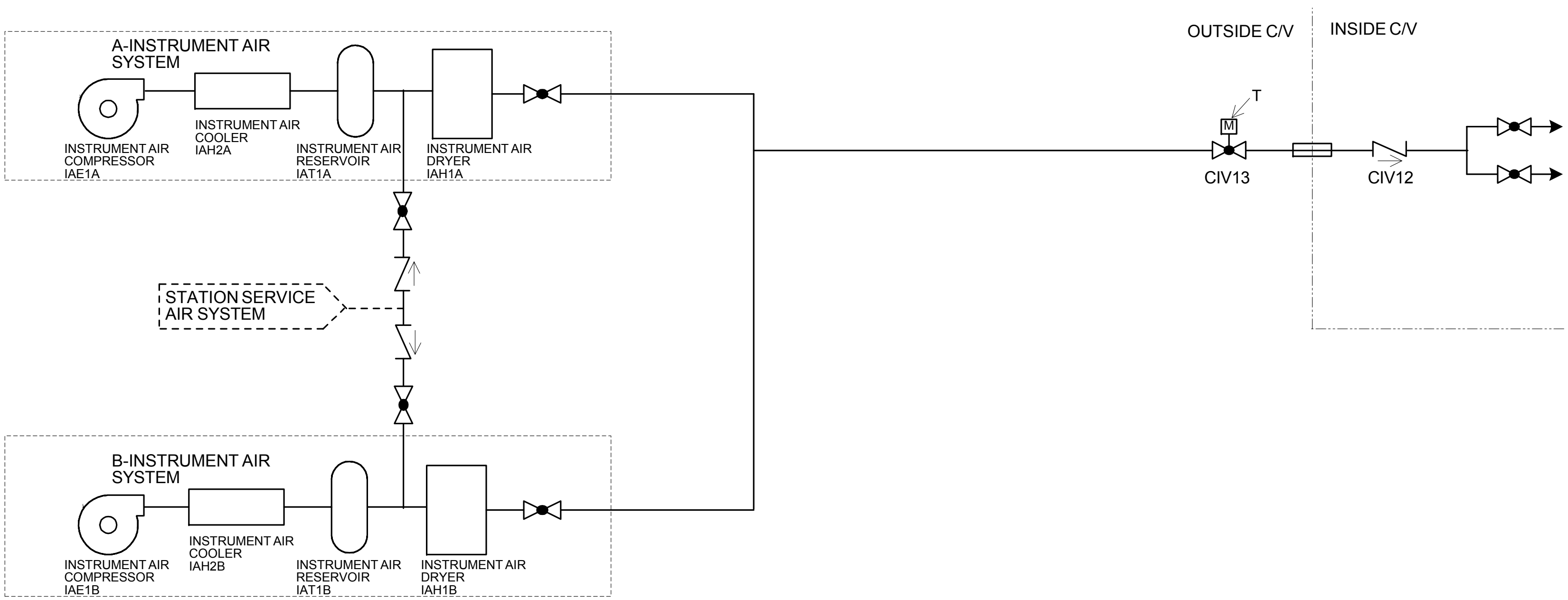


Figure 19.1-2 Simplified System Diagram (Sheet 33 of 36)
(Containment Isolation System - Instrument Air System - Instrument Air Line)

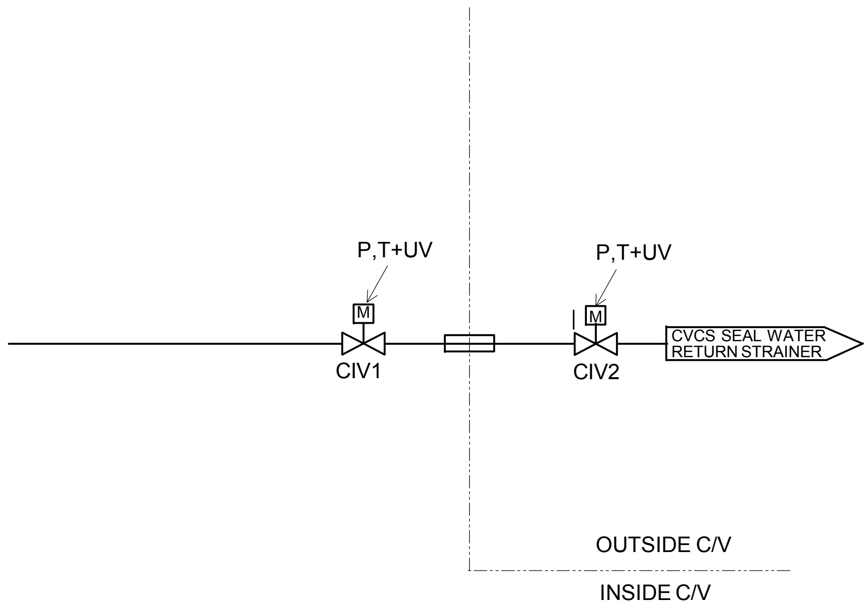


Figure 19.1-2 Simplified System Diagram (Sheet 34 of 36)

(Containment Isolation System - Chemical Volume Control System - Seal Water Return Line)

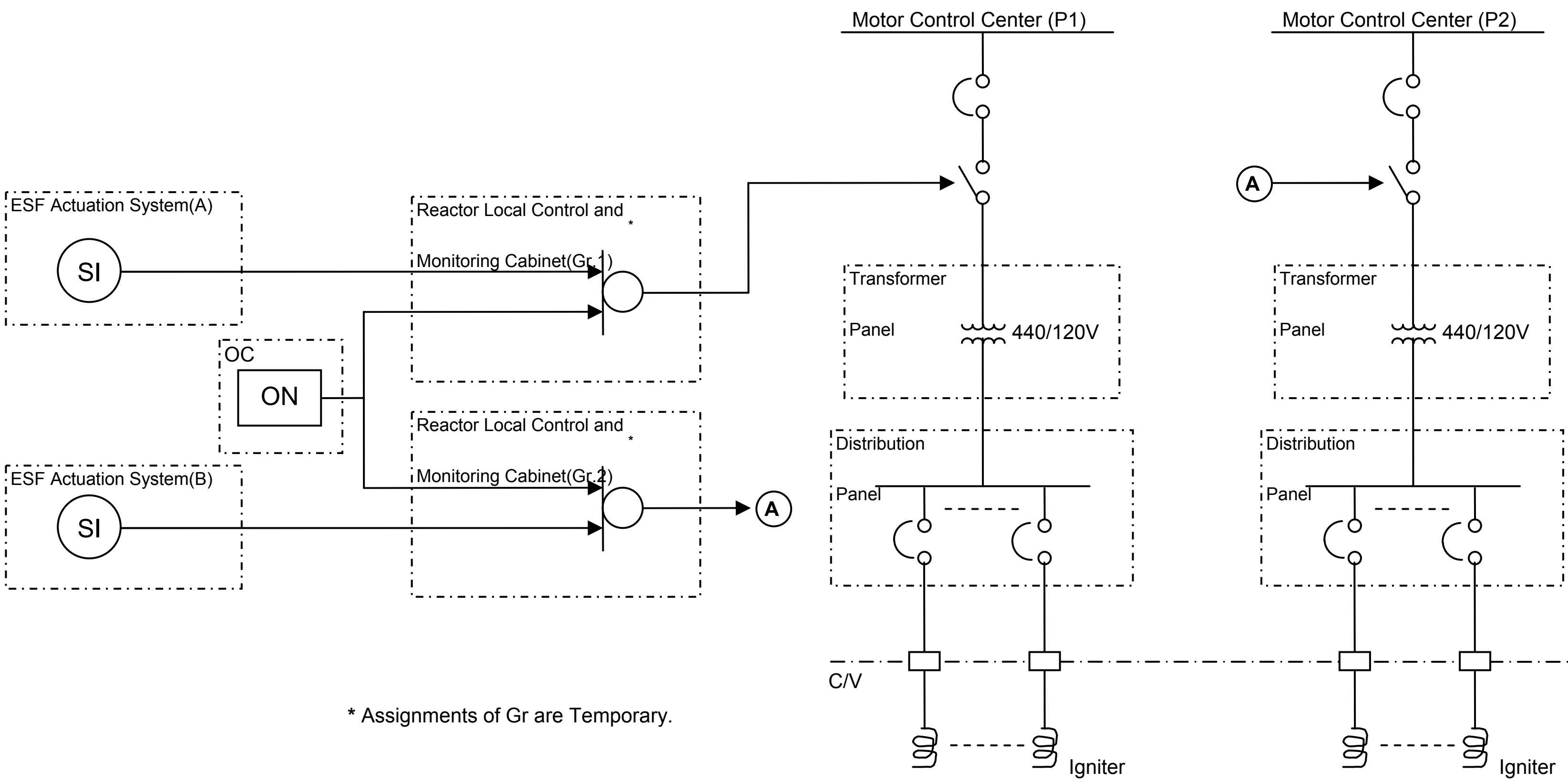


Figure 19.1-2 Simplified System Diagram (Sheet 35 of 36)
(Hydrogen Control System)

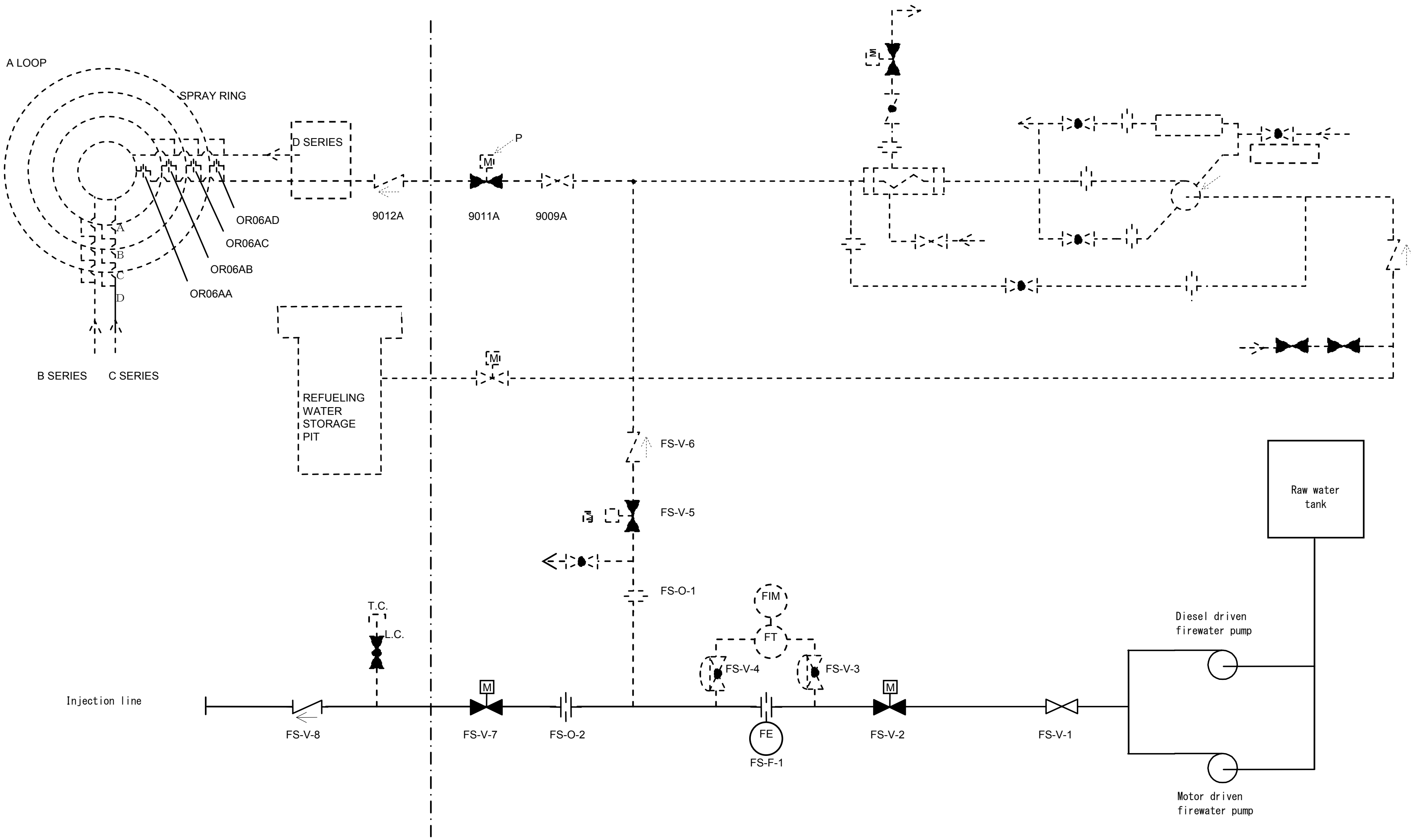
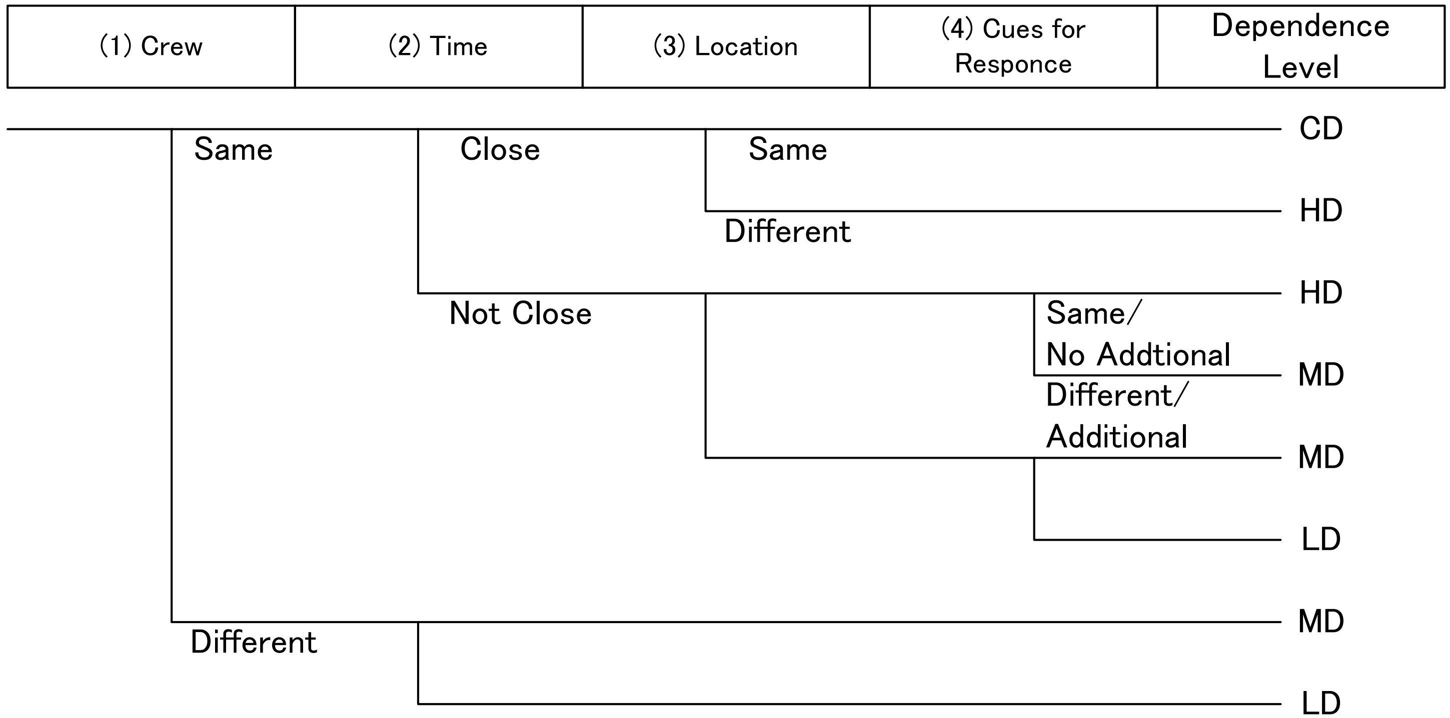


Figure 19.1-2 Simplified System Diagram (Sheet 36 of 36)
(Firewater Injection into the Reactor Cavity and into the Spray Header)



Notes; If this error is 3rd error in the sequence, then the dependency level is at least moderate,
if this error is 4th error in the sequence, then the dependency level is at least high, and
if this error is more in the sequence, then the dependency level is complete.

Figure 19.1-3 Decision Tree to Determine the Dependency Level between Multiple Human Failure Events

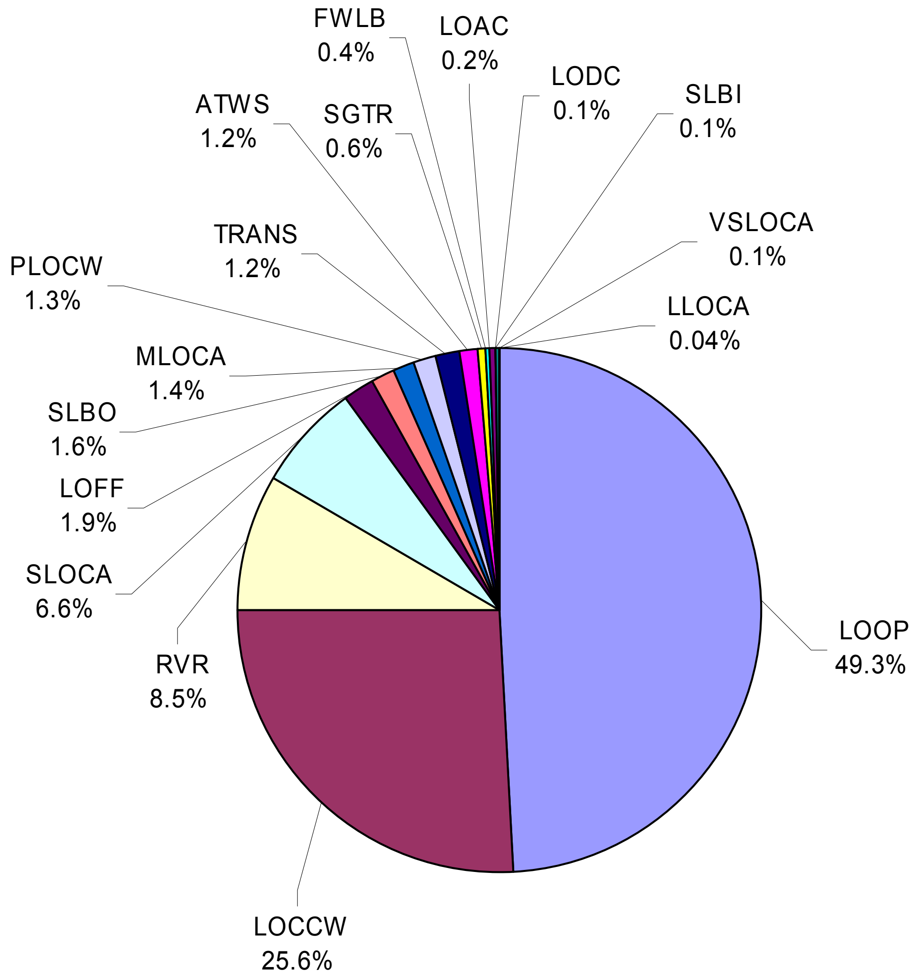


Figure 19.1-4 Internal Events Core Damage Frequency Contribution

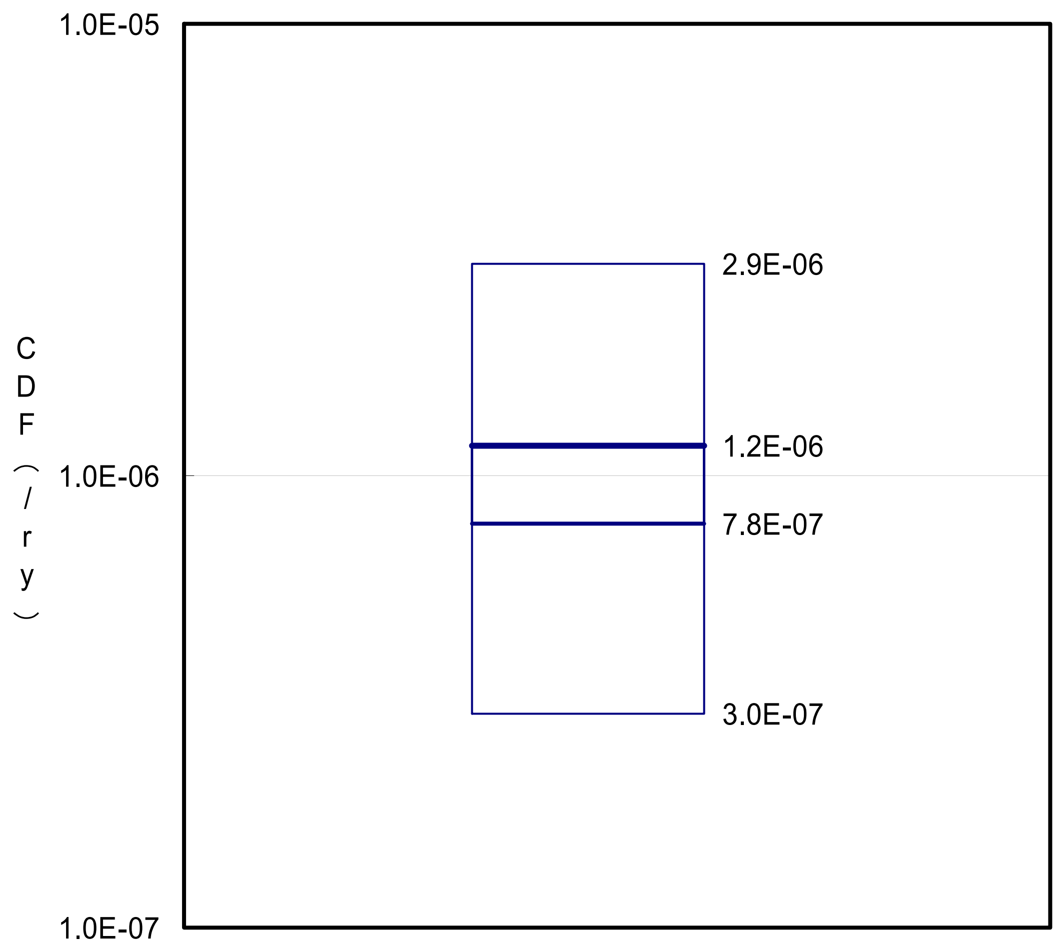


Figure 19.1-5 Result of Uncertainty Quantification for Internal Events at Power

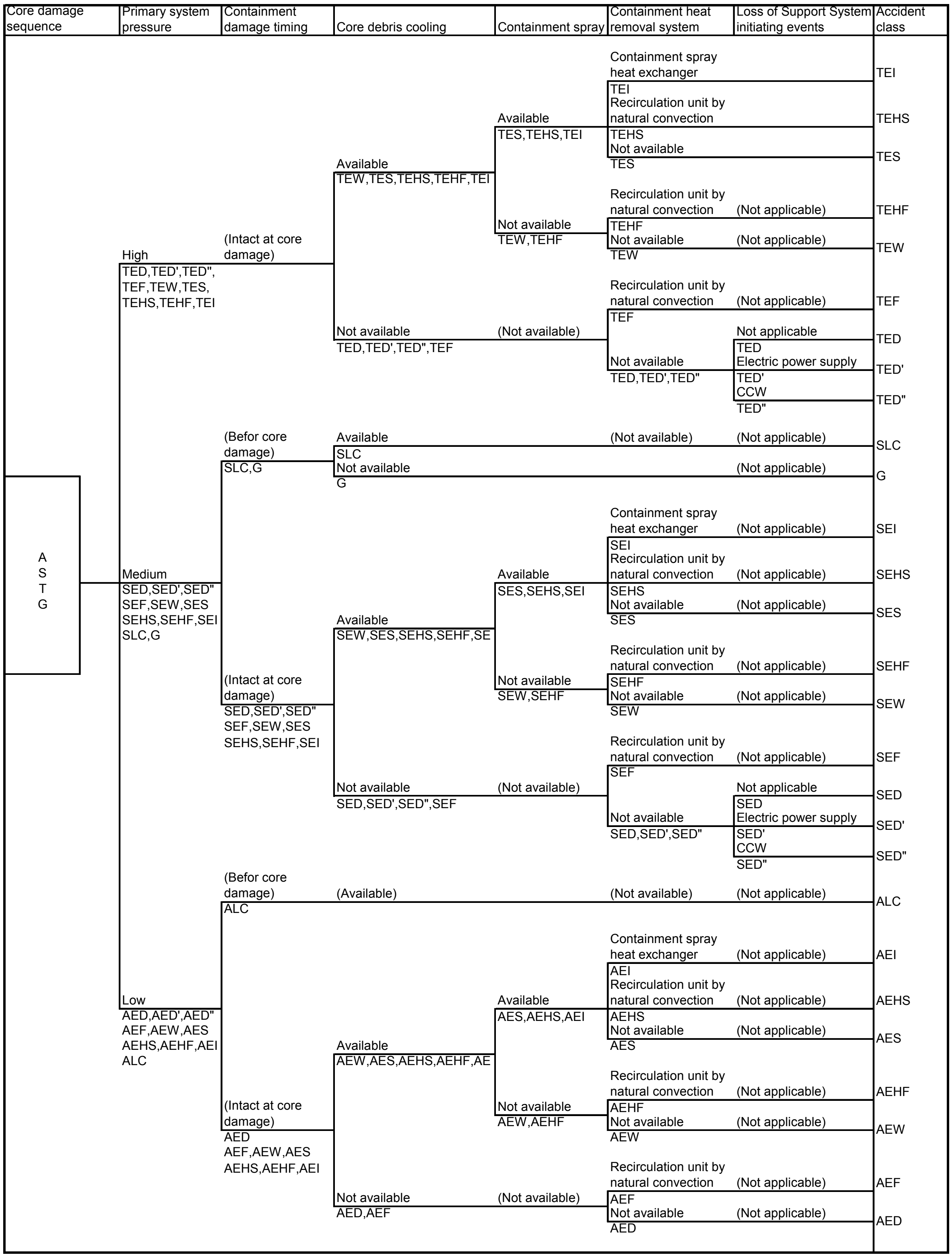


Figure 19.1- 6 Logic Tree for ACL Classification

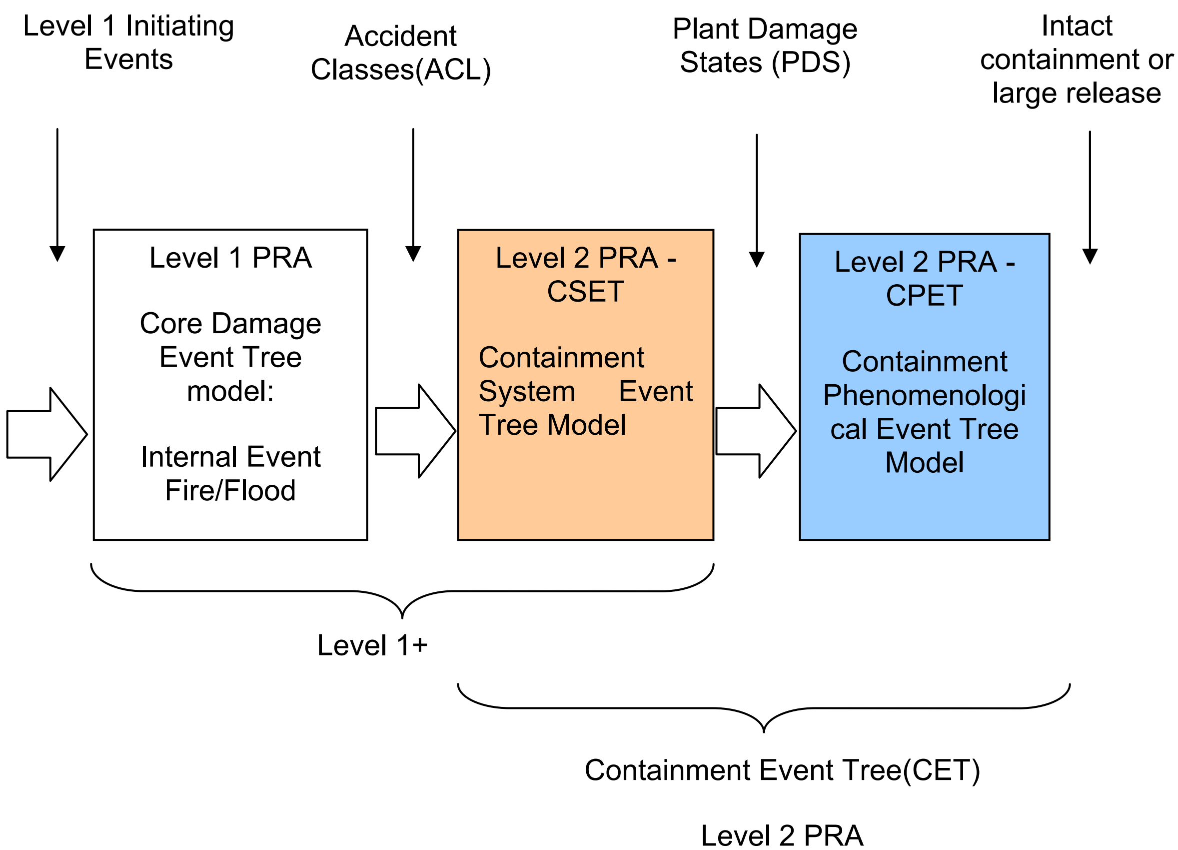


Figure 19.1- 7 CET Development Methodology

CSET	CSET	CSET	CSET	CSET		
Containment isolation	RCS depressurization	Igniters	Cavity flooding	Recovery of CSS&HX(SBO)	No.	PDS
CI	FD	IG	CF	RS		

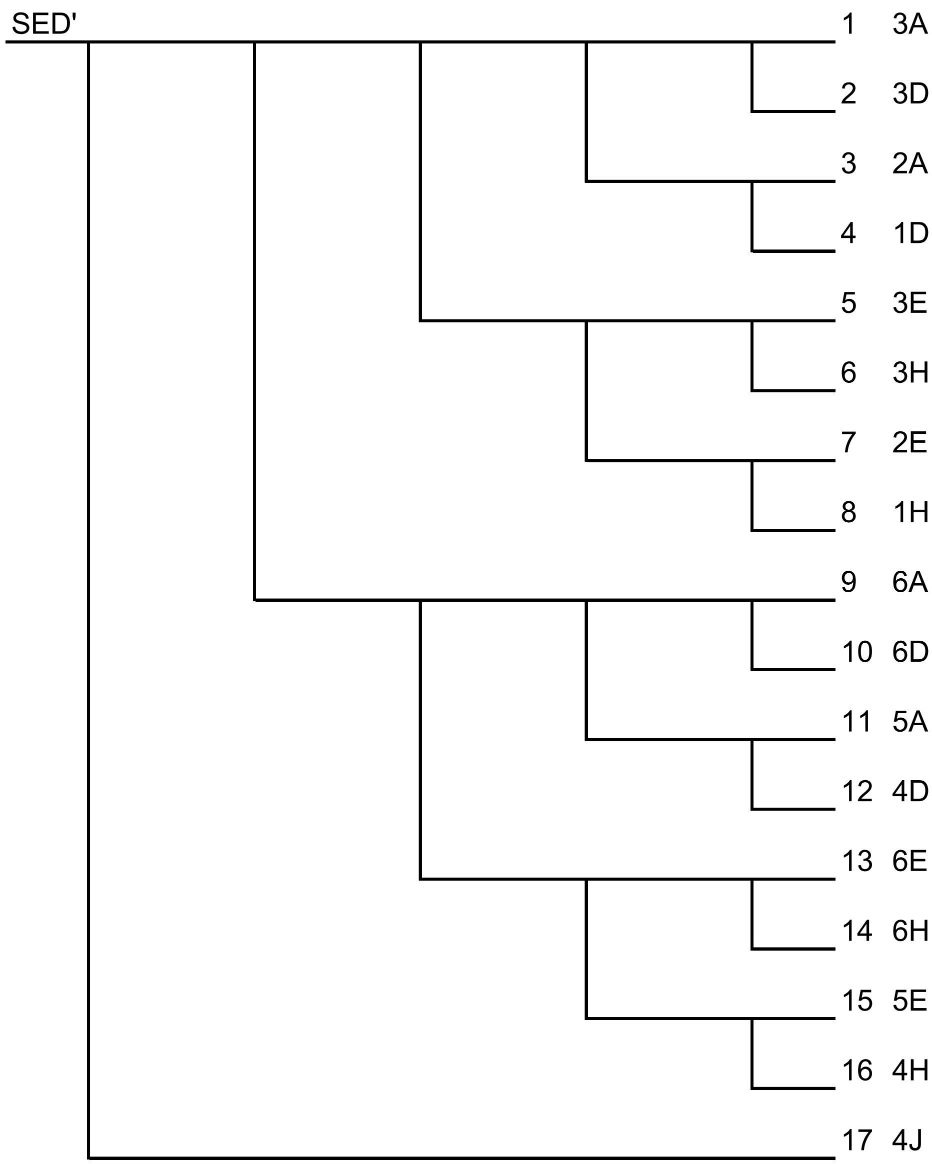
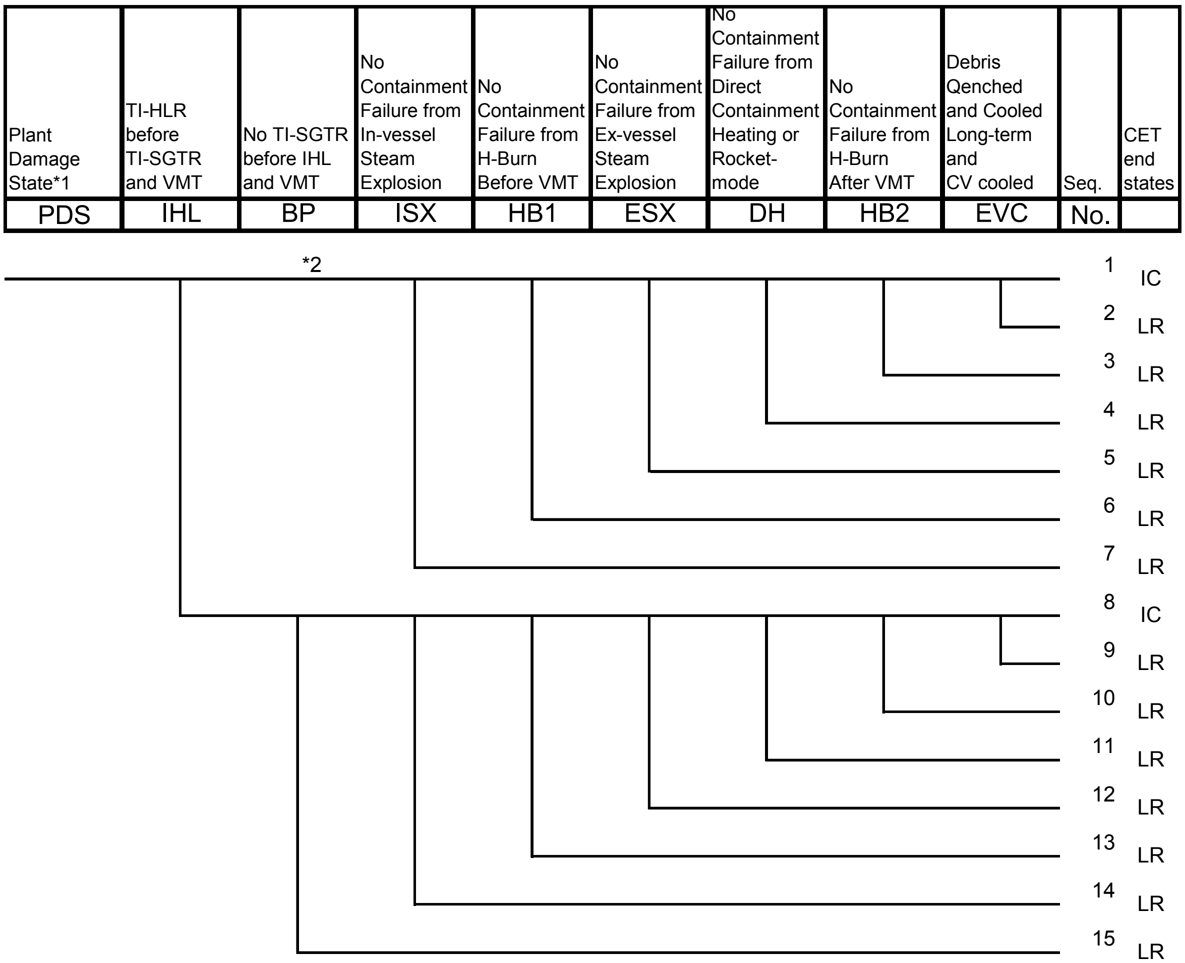


Figure 19.1- 8 Containment System Event Tree (Example)



Notes:

Branching	→ True ↓ False
LR	Large Release
IC	Intact Containment
HLR	hot leg rupture
VMT	vessel melt through
*1	CPET is developed only PDSs(<1-9>A,C,E,G).All other PDS result in a guaranteed containment failure. Because they do not have containment cooling or the containment is already failed
*2	There is no probability of TI-SGTR when hot leg creep failure precedes.

Figure 19.1- 9 Containment Phenomenological Event Tree

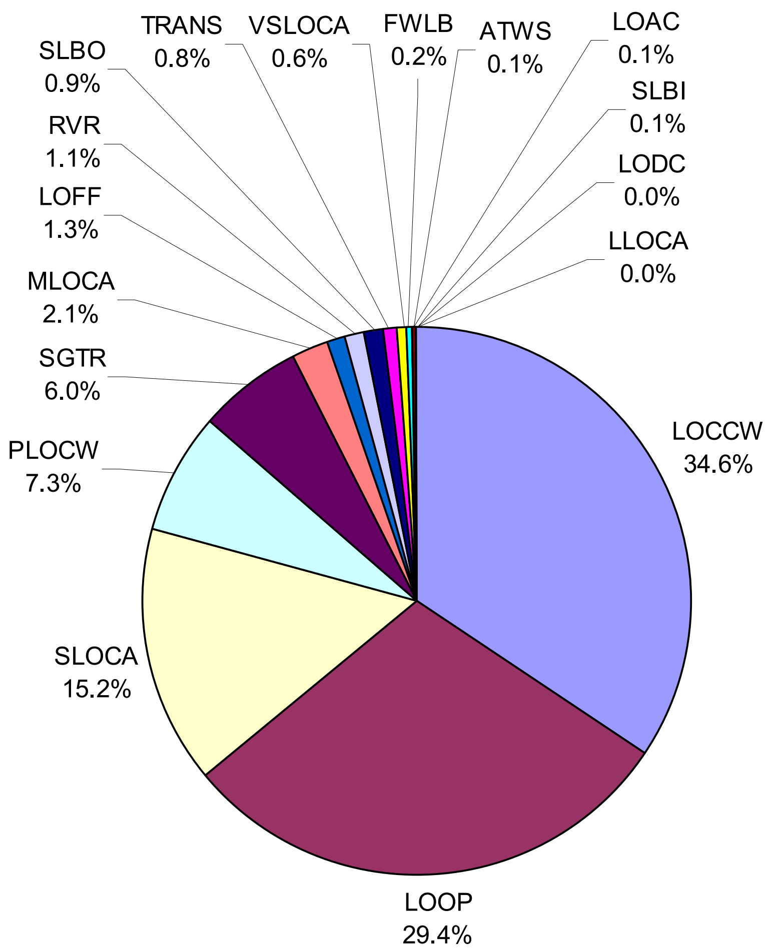


Figure 19.1-10 Contribution of Initiating Events to LRF

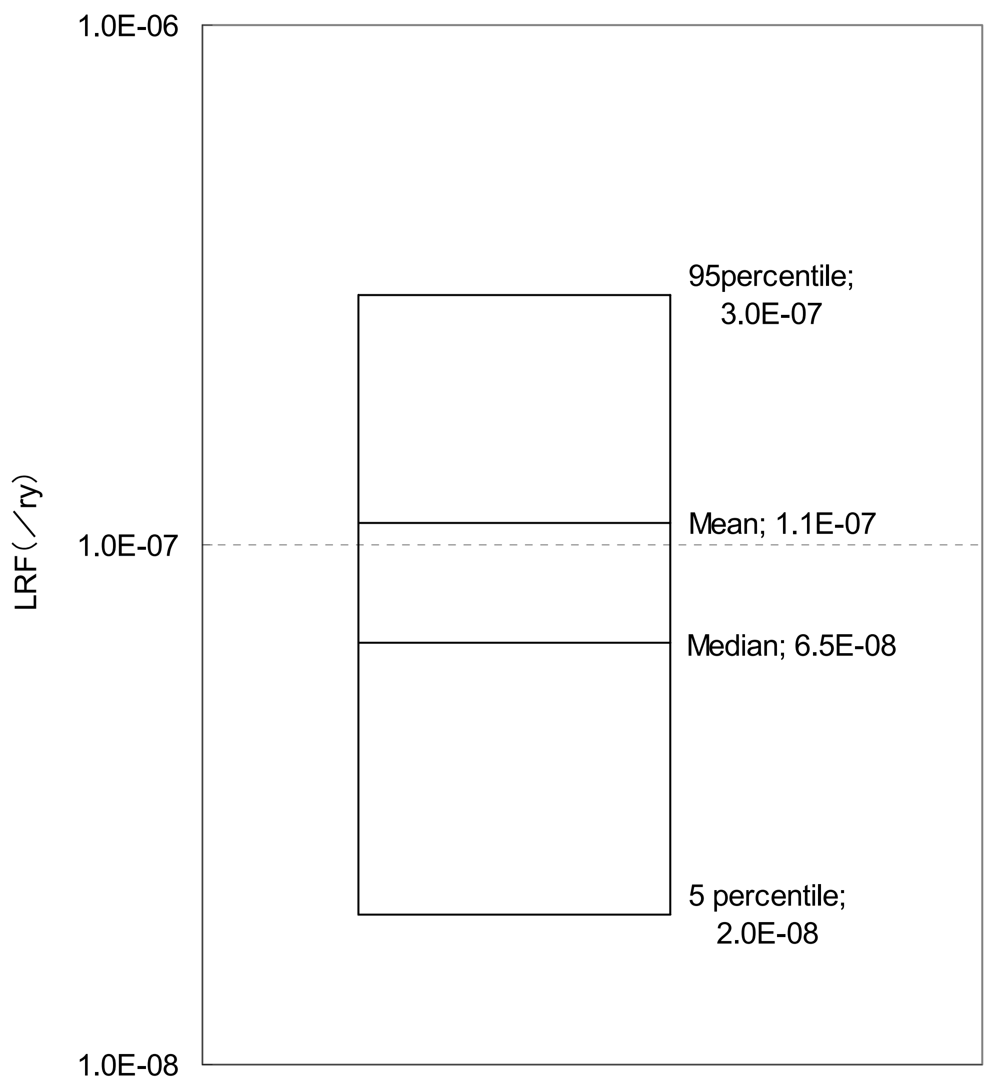


Figure 19.1- 11 Result of Parametric Uncertainty for LRF

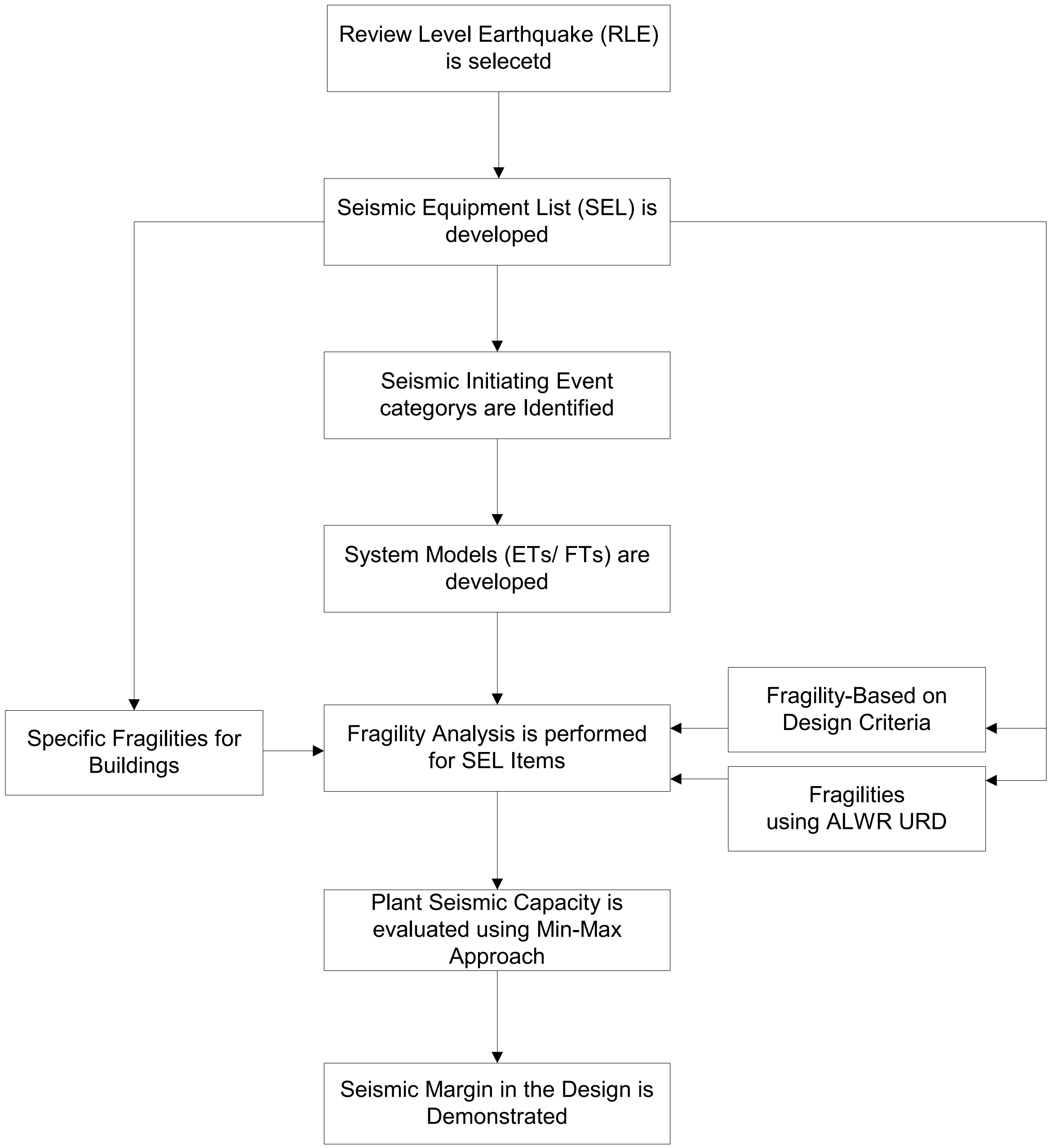


Figure 19.1-12 Outline for the PRA Based Seismic Margin Analysis

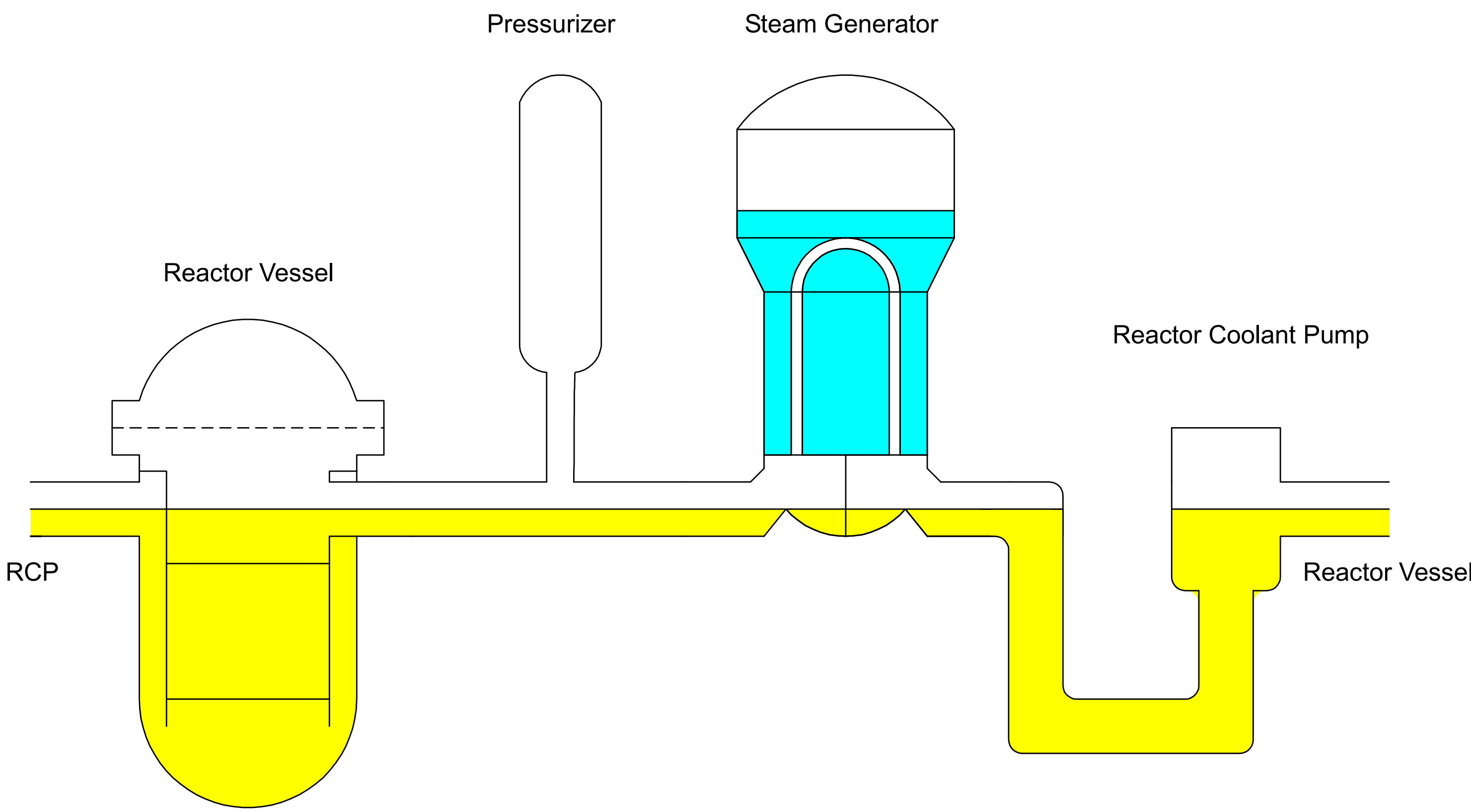


Figure 19.1-13 Feature of RCS Condition (POS 4-1 and POS 8-3)

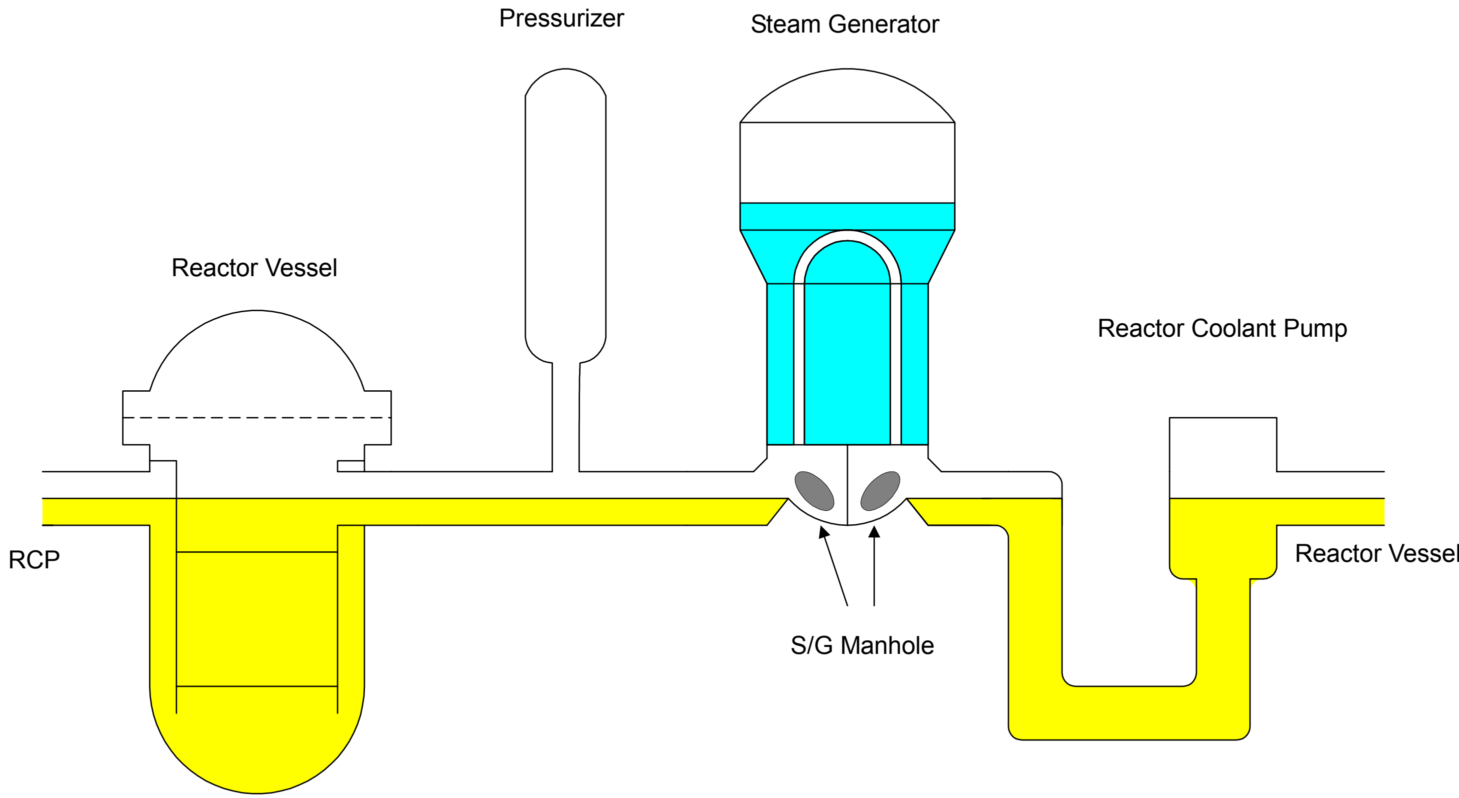


Figure 19.1-14 Feature of RCS Condition (POS 4-2 and POS 8-2)

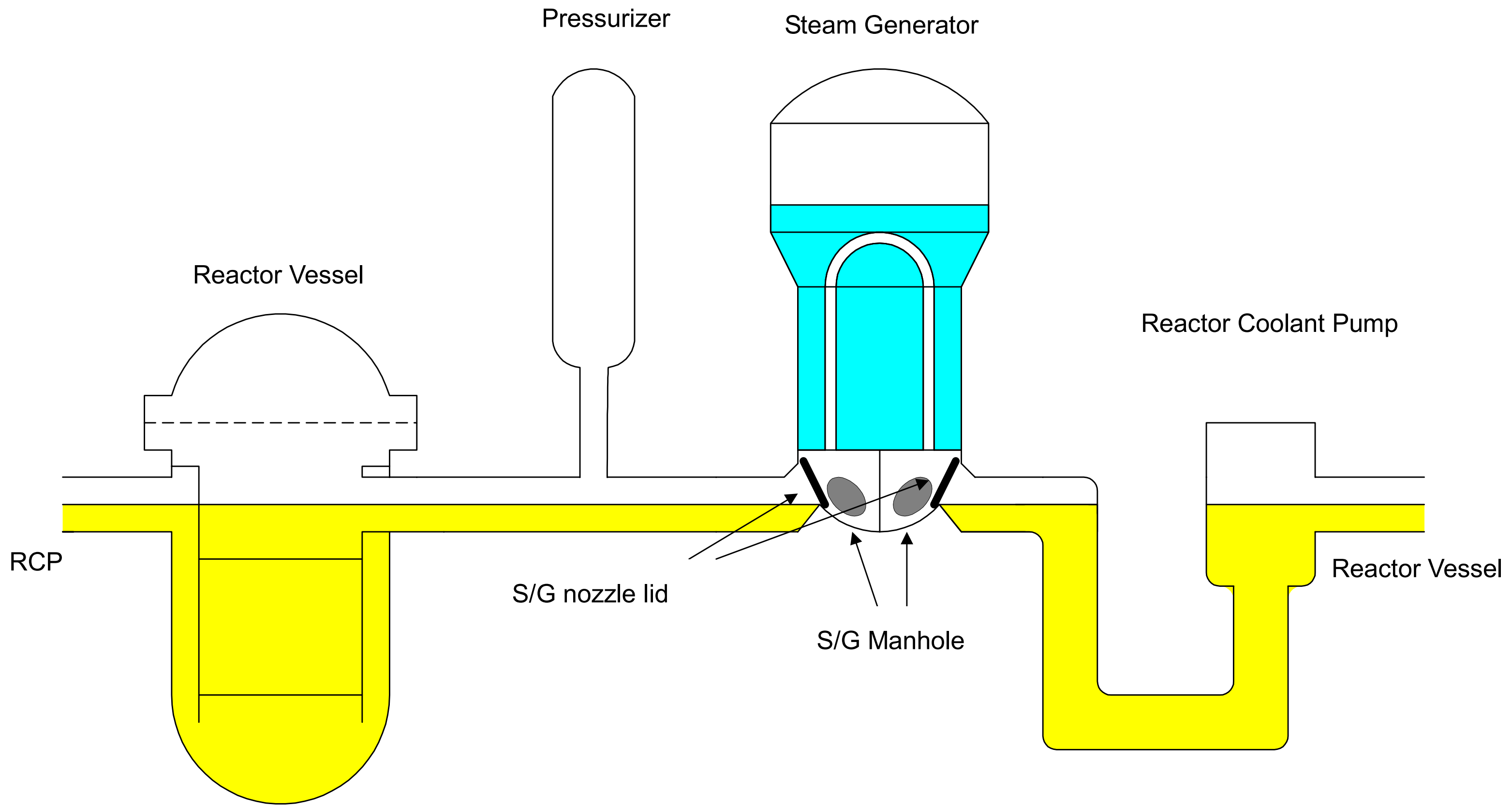
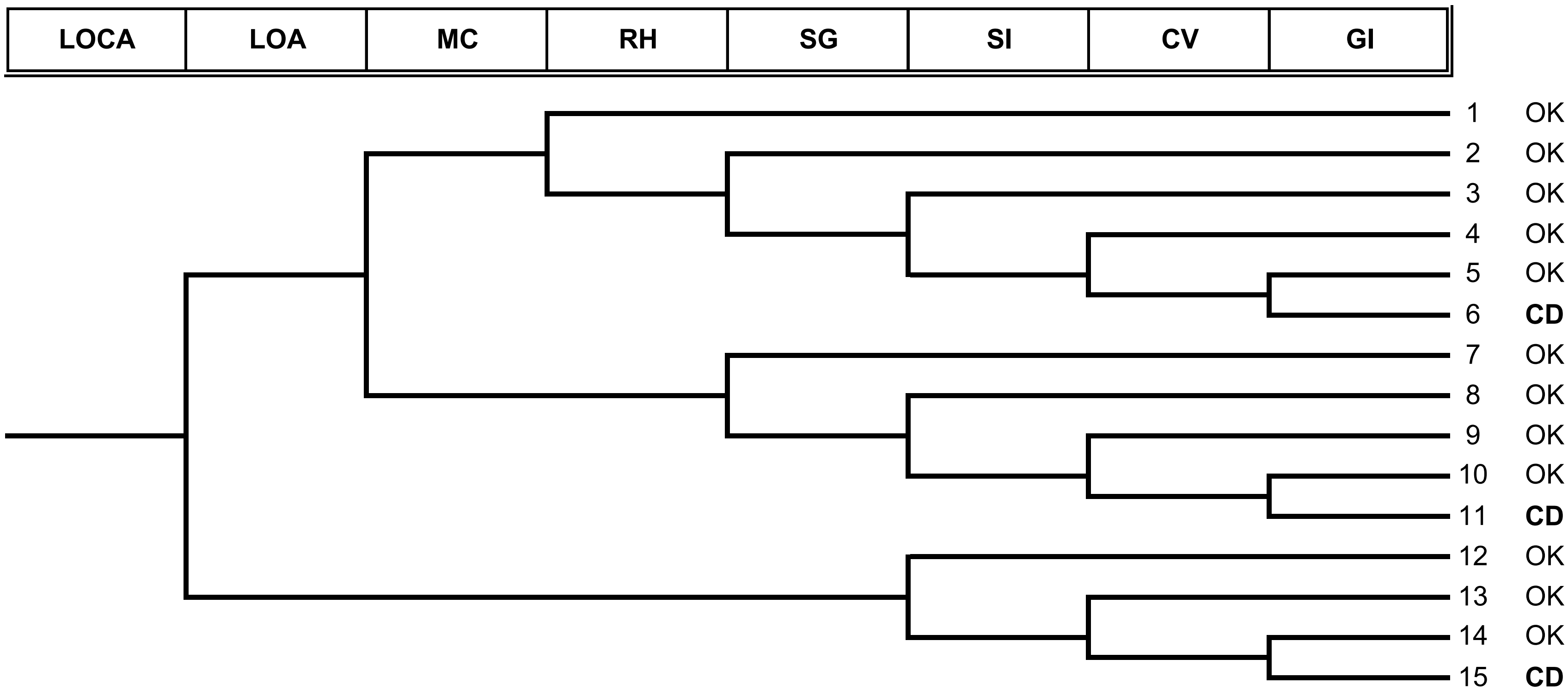
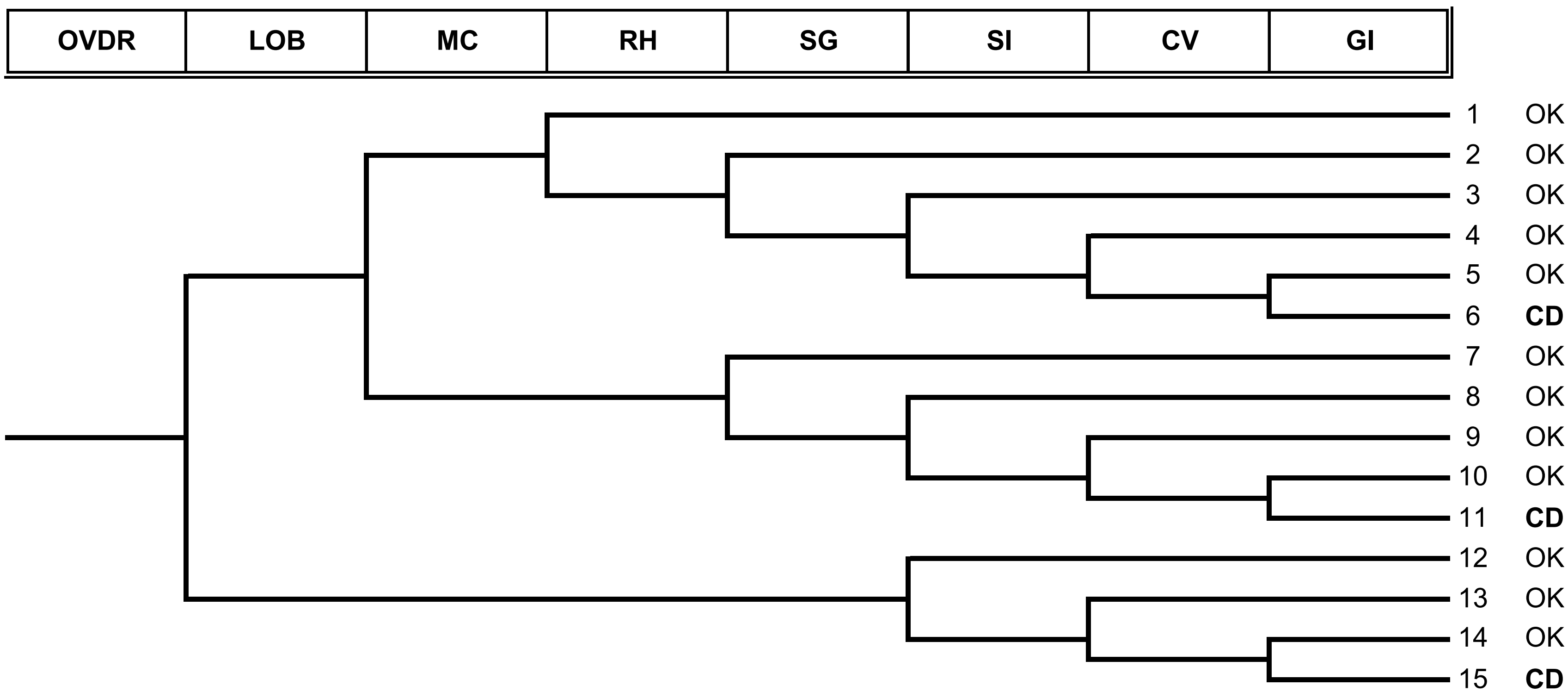


Figure 19.1-15   Feature of RCS Condition (POS 4-3 and POS 8-1)



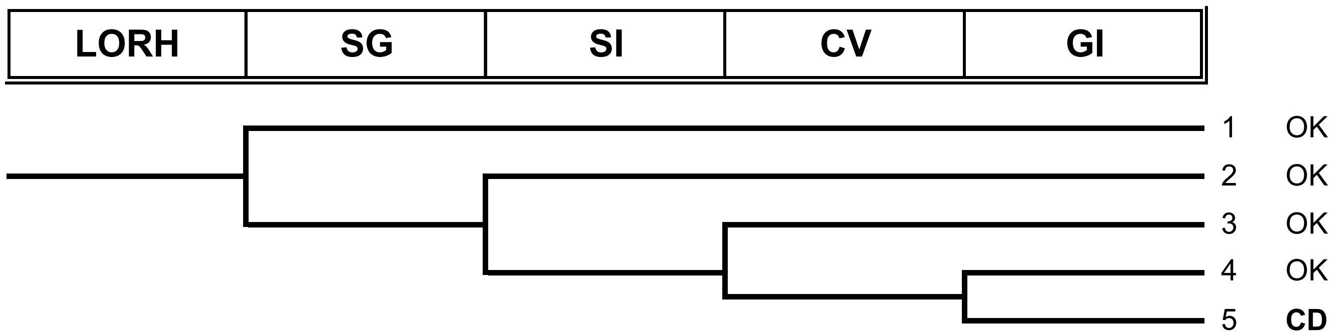
Event	Description
LOCA	: Loss of coolant accident
LOA	: Isolation of CS/RHR hot leg suction valves
MC	: RCS Makeup by charging pump
RH	: Decay heat removed from the RCS by the RHRS on standby
SG	: Decay heat removed from the RCS via SGs
SI	: High head injection
CV	: Injection by the CVCS
GI	: Gravitational injection

Figure 19.1- 16 Loss of Coolant Accident Event Tree



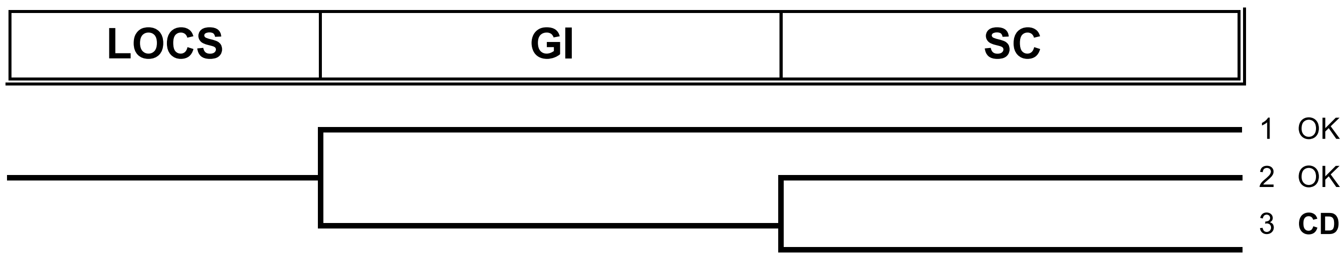
Event Description
OVDR : Loss of RHRS due to over-drain
LOB : Isolation of low-pressure letdown line
MC : RCS makeup by charging pump
RH : Decay heat removed from the RCS by the RHRS on standby
SG : Decay heat removed from the RCS via SGs
SI : High head injection
CV : Injection by the CVCS
GI : Gravitational injection

Figure 19.1- 17 Loss of RHRS due to Over-drain Event Tree



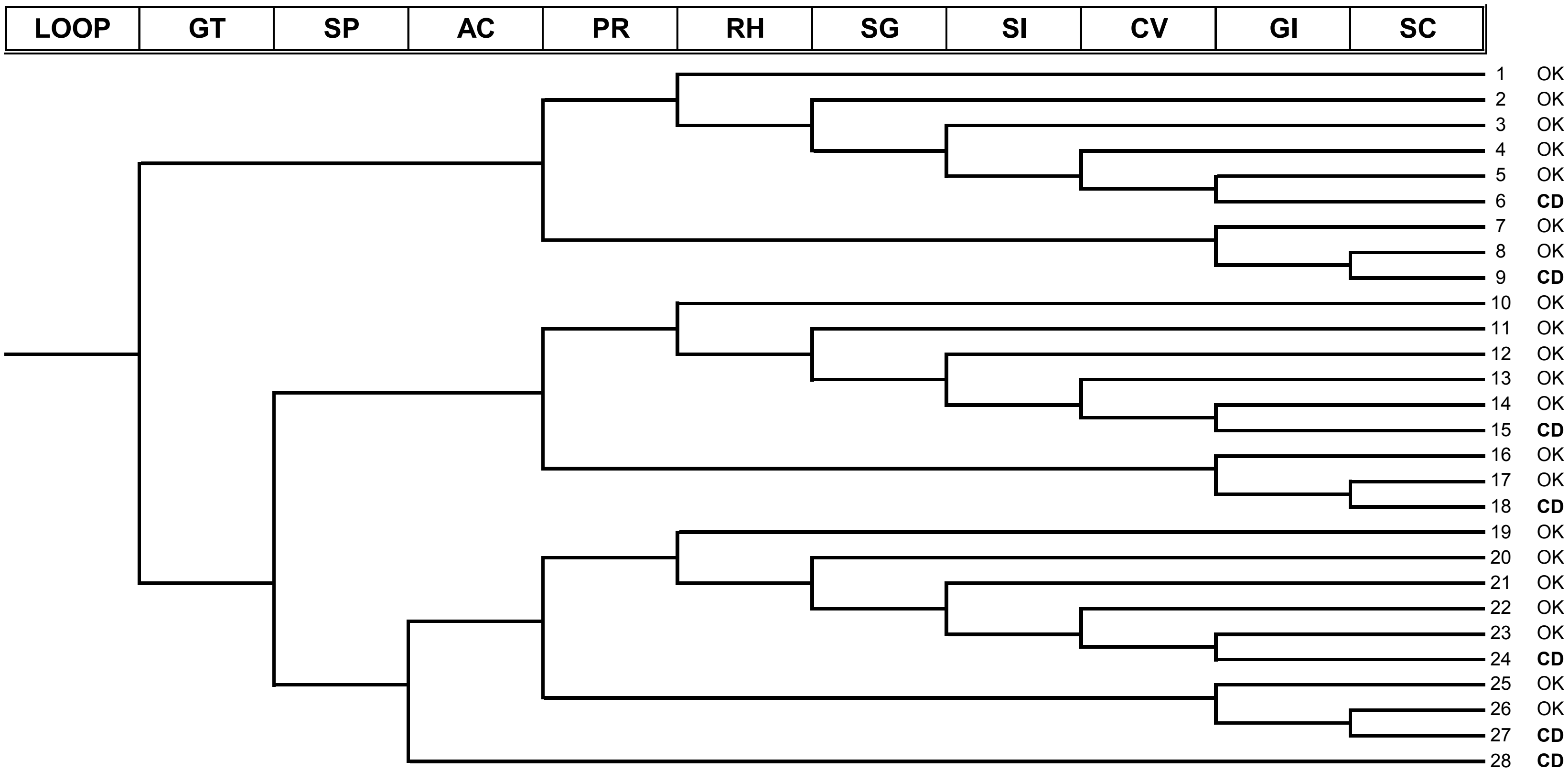
Event Description
LORH Loss of RHRS caused by other failures
SG : Decay heat removed from the RCS via SGs
SI : High head injection
CV : Injection by the CVCS
GI : Gravitational injection

Figure 19.1- 18 Loss of RHRS caused by Other Failures Event Tree



Event	Description
LOCS	Loss of CCW/essential service water
GI	: Gravitational injection
SC	: Injection by the CVCS using alternate component cooling water

Figure 19.1- 19 Loss of CCW/Essential Service Water Event Tree



Event	Description
LOOP	: Loss of offsite power
GT	: Main G/T power
SP	: Spare G/T power
AC	: Offsite power recovery
PR	: CCW pumps/essential service water pumps restart
RH	: Decay heat removed from the RCS by the RHRS on standby
SG	: Decay heat removed from the RCS via SGs
SI	: High head injection
CV	: Injection by the CVCS
GI	: Gravitational injection
SC	: Injection by the CVCS using alternate component cooling water

Figure 19.1- 20 Loss of Offsite Power Event Tree

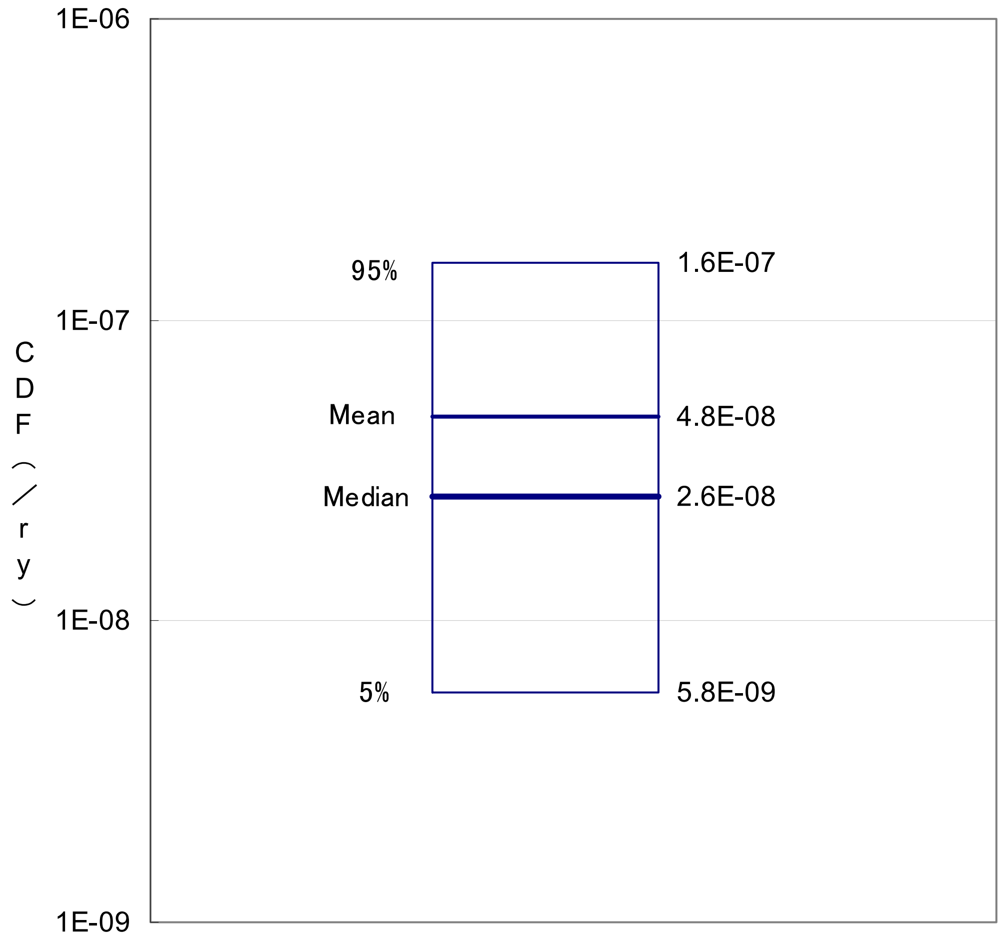


Figure 19.1- 21 Result of Uncertainty Quantification of POS 8-1 for LPSD PRA

19.2 Severe Accident Evaluation

This section describes the design features for the US-APWR to prevent and mitigate severe accidents in accordance with the requirements in 10 CFR 52.47(a)(23) (Reference 19.2-1). These features specifically address the issues identified in SECY-90-016 (Reference 19.2-2) and SECY-93-087 (Reference 19.2-3), which the NRC approved in related staff requirements memoranda dated June 26, 1990, and July 21, 1993, respectively, and SECY-94-302 (Reference 19.2-4) for prevention (e.g., anticipated transient without scram, mid-loop operation, SBO, fire protection, and interfacing system LOCA), for mitigation (e.g., hydrogen generation and control, core debris coolability, high-pressure core melt ejection, containment performance, dedicated containment vent penetration) and for equipment survivability.

In addition, the US-APWR design is demonstrated to satisfy the requirements of 10 CFR 52.47(a)(8) for a design certification application. In particular, this regulation invokes 10 CFR 50.34(f)(1)(i) (Reference 19.2-5) to specify that a design-specific or plant-specific PRA should be performed to seek improvements in core heat removal system reliability and containment heat removal system reliability that are significant and practical and do not excessively impact the plant.

19.2.1 Introduction

This section provides a description of the severe accident evaluation performed for the US-APWR. Specifically, Subsection 19.2.2 provides a deterministic evaluation to show how the plant severe accident preventive features would cope with specified accident conditions. Subsection 19.2.3 provides an overview of the containment design, describes severe accident progression (in-vessel and ex-vessel), and describes severe accident mitigation features. Subsection 19.2.4 addresses containment performance goals identified in SECY-93-087 and SECY-90-016, as approved by the associated U.S. NRC staff requirements memoranda. Subsection 19.2.5 describes the actions taken during the course of a postulated severe accident by the plant operating and technical staff. Finally, Subsection 19.2.6 describes how the requirement of 10 CFR 50.34(f)(1)(I) has been met.

19.2.2 Severe Accident Prevention

The purpose of this subsection is to provide a deterministic evaluation to show how the US-APWR design’s severe accident preventive features act to prevent the following events:

- Anticipated transient without scram
- Mid-loop operation
- SBO
- Fire protection
- Intersystem LOCA

Other severe accident preventive features of the US-APWR design are identified to conclude this subsection.

19.2.2.1 Anticipated Transient Without Scram

The safety grade reactor protection system is highly reliable due to the independent four-train design. The DAS, which has functions to prevent anticipated transient without scram, is installed as a countermeasure to CCF of the digital I&C systems and thus will preclude anticipated transient without scram events.

19.2.2.2 Mid-Loop Operation

The RHRS is highly reliable due to the independent four-train design. To prevent over-drain during mid-loop operation, an interlock, actuated by the detection of water level decrease, acts to isolate water extraction. Charging injection, high head injection, heat removal via SGs, and water injection from the spent fuel pit by gravity are also available as alternative core cooling mechanisms if the RHRS is not operative.

19.2.2.3 Station Black-Out

An independent, four-train, emergency ac power source design is applied. Two alternative ac power sources, which can supply power to the emergency buses, are introduced in order to prevent a total loss of ac power when all emergency ac power sources are lost. Even if SBO occurs, core damage is prevented at an early stage by the adoption of two turbine-driven emergency feed water pumps, four emergency batteries, and advanced RCP seal design.

19.2.2.4 Fire Protection

In the US-APWR design, safety systems are physically separated in order to assure safe shutdown following fire-induced initiating events. Loss of multiple trains by fire is prevented by physical separation of the four-train safety systems.

19.2.2.5 Intersystem Loss-of-Coolant Accident

Lines connected to the RCS have redundant isolation valves in order to prevent the RHRS from being exposed to RCS pressure during full power operation. Relief valves are installed to prevent over-pressurizing the RHRS if the isolation valves should leak. Any flow through the relief valves is directed to the in-containment RWSP. In addition, the RHRS is designed not to fail by over-pressure even if a large internal leak occurs in the redundant isolation valves. The RHRS piping is rated at 900 psia.

19.2.2.6 Other Severe Accident Preventive Features

The US-APWR design uses other features to prevent severe accidents including:

- In the case of an event that requires SG cooling, but where the EFWS is not available, feedwater can be continuously supplied to the SG by opening the crosstie valve at the EFWS pump exit.

- In the case of loss of all feedwater, feed and bleed operation is possible by SIS and pressurizer SDVs, which have redundancy.
- In the case of a LOCA, if the function of the SIS is lost, core cooling is achieved by using CS/RHRS. If the function of the containment spray is lost, long term heat removal is achieved by using CS/RHRS.
- In the case of a LOCA without the function of the containment heat exchanger, containment failure before core damage is prevented by alternative containment cooling by containment fan cooler system.
- The CCWS/ESWS is composed of four-train systems. These systems are designed to be separated automatically in an accident and to achieve a high level of reliability. If the CCWS/ESWS is lost at power operation, RCP seal injection function is prevented by the supply of alternative component cooling water to charging pumps. In the case of LPSD, if the CCWS/ESWS is lost, the core remains covered by supplying cooling water from one of the charging pumps with alternative component cooling water.

19.2.3 Severe Accident Mitigation

This subsection provides an overview of the containment design for the US-APWR with respect to mitigating severe accidents. Severe accident progression is described both in-vessel and ex-vessel, followed by a description of severe accident mitigation features. In particular, mitigation features are described for external RV cooling, hydrogen generation and control, core debris coolability, high-pressure melt ejection, fuel-coolant interactions, containment bypass (including SGTR and intersystem LOCA), equipment survivability, and other severe accident mitigation features.

19.2.3.1 Overview of the Containment Design

The containment is designed as an essentially leak-tight barrier that will safely accommodate calculated temperature and pressure conditions resulting from the complete size spectrum of piping breaks, up to and including a double-ended, guillotine-type break of a reactor coolant or main steam line.

The containment provided for the US-APWR is large volume type pre-stressed concrete containment (PCCV). The containment systems to mitigate severe accident are fundamentally the same with the current 4 loop PWR plant design. Thus the US-APWR containment systems do not introduce any new phenomena or configurations. The severe accident treatments and the related containment systems are discussed in the following subsections.

19.2.3.2 Severe Accident Progression

The accident progression analysis, including in-vessel and ex-vessel melt progressions, determines the physical and thermal-hydraulic behavior of accident sequences. Severe accident progression analysis as part of the US-APWR design is performed employing MAAP 4.0.6 code in accordance with the process of Level 2 PRA. Severe accident progression analysis is also performed in order to evaluate the effectiveness of specific design features provided to mitigate the consequences of a severe accident. In case any specific effects cannot be properly modeled by MAAP code, appropriate separate effect codes are employed to evaluate the specific accident progression.

19.2.3.2.1 In-Vessel Melt Progression

Key events evaluated in terms of the in-vessel melt progression are core uncovery, core damage and molten core relocation to lower plenum. Potential consequences from core uncovery and core damage that may result in a challenge to the containment integrity include hydrogen generation and release, and temperature-induced SGTR. Potential consequences from core relocation include in-vessel steam explosion. These accidental events are addressed more detail in Subsection 19.2.3.3. In-vessel retention of core debris by external RV cooling is evaluated as an effective potential mechanism for severe accident mitigation. Various physical phenomena related to severe accidents such as steam explosions and MCCI, which are the consequences of a result of core debris relocation to the reactor cavity, are prevented and resolved by attaining in-vessel retention. Since the US-APWR is designed to fill the reactor cavity with coolant water when a severe accident occurs, external RV cooling may be possible. In-vessel retention is however not credited for the US-APWR severe accident treatment or in the Level 2 PRA study due to its inherent uncertainty.

19.2.3.2.2 Ex-Vessel Melt Progression

Key events evaluated for the ex-vessel melt progression are melt relocation from vessel breach to the reactor cavity, fuel-coolant interaction, MCCI and debris cooling. Potential consequences from the ex-vessel melt progression events that may result in challenges to the containment integrity include hydrogen generation and combustion, ex-vessel steam explosion, basemat melt through, non-condensable gas generation, DCH, rocket-mode RV failure and long-term containment overpressure due to postulated failure of the decay heat removal function. These accidental events are addressed more detail in Subsection 19.2.3.3.

19.2.3.3 Severe Accident Mitigation Features

This subsection describes severe accident mitigation features for external reactor vessel cooling, hydrogen generation and control, core debris coolability, high-pressure melt ejection, fuel-coolant interactions, containment bypass (including steam generator tube rupture and intersystem LOCA), equipment survivability, and other severe accident mitigation features.

The fundamental design concept of the US-APWR for severe accident termination is to flood the reactor cavity with coolant water when a severe accident occurs, keep the molten fuel within the reactor cavity and providing sufficient cooling to maintain the core debris in a safe, cooled state for the long-term. This design concept is readily achievable by applying the existing design features implemented in current PWR plants, and it is expected that challenges posed by severe accidents are appropriately terminated.

The US-APWR design addresses the following eight severe accident issues with respect to mitigation features:

(1) Hydrogen generation and control (Subsection 19.2.3.3.2)

(2) Core debris coolability (Subsection 19.2.3.3.3)

(3) Steam explosion (in-vessel and ex-vessel) (Subsection 19.2.3.3.5)

(4) High pressure melt ejection (Subsection 19.2.3.3.4)

(5) Temperature-induced SGTR (Subsection 19.2.3.3.6)

(6) MCCI (Subsection 19.2.3.3.3)

(7) Long-term containment overpressure (Subsection 19.2.3.3.8)

(8) Equipment survivability (Subsection 19.2.3.3.7)

Severe accident mitigation design features provided for the US-APWR are basically the same as provided for current PWR plants with some improvements. Thus, the US-APWR design does not introduce any new phenomena or configurations. This is an advantage in terms of the reliability of system functionality since there are numerous studies and experiments available on the functions, capabilities, and limitations for these design features. This experimental and analytical database of information significantly improves the reliability of features addressed in the US-APWR designs.

Table 19.2-1 provides a listing of the US-APWR design features for mitigating severe accidents and the phenomenon mitigated. Figure 19.2-1 shows the design features for severe accident mitigation in the US-APWR. The numbers shown in boxes following the name of mitigation features correspond to the specific severe accident phenomenon addressed in the US-APWR design, discussed in this subsection.

19.2.3.3.1 External Reactor Vessel Cooling

In-vessel retention of core debris by external RV cooling is considered as effective potential mechanism for severe accident mitigation. Various physical phenomena related to severe accidents such as steam explosions and MCCI, which are the consequences of a result of core debris relocation to the reactor cavity, are prevented and resolved by attaining in-vessel retention. Since the US-APWR is designed to fill the reactor cavity with coolant water when a severe accident occurs, external RV cooling may be possible. However, in-vessel retention is not credited for the US-APWR severe accident treatment or in the Level 2 PRA study due to its inherent uncertainty.

19.2.3.3.2 Hydrogen Generation and Control

The US-APWR design includes a PCCV, which is a large volume type containment. Large volume containments are widely acknowledged as having a good ability for containment atmosphere mixing since any compartments are widely open to the neighboring area and do not form airtight space. This feature contributes to prevent combustible gas accumulation. The containment vessel also provides sufficient strength to withstand pressure loads generated by most hydrogen burns.

For controlling hydrogen generated during a severe accident, hydrogen ignition system, which consists of twenty hydrogen igniters, are provided. Hydrogen igniter is a proven technique to control combustible gases to prevent violent detonation, and has advantages such as no poisoning effect, good capability to control combustible gas in terms of gas amount and controlling speed, compact in size, easy to maintain, etc. The location to arrange hydrogen igniters is carefully determined through accident progression analyses using GOTHIC7.2a-p5(QA) code in order to enhance the effectiveness to control hydrogen.

If combustible gas control method other than inerting is adopted, the potential for diffusion flame induced containment failure is considered. The potential challenge to containment integrity by diffusion flames can be significantly reduced through consideration of location arrangement. Therefore, the pathways for in-vessel hydrogen flow and the potential location of diffusion flame is examined. And accordingly the challenges created by potential diffusion flame impacting directly the wall and the effect on containment integrity can be resolved.

Hydrogen monitors are also provided to continuously monitor hydrogen concentration during a severe accident.

Mitigation features

Mitigation features provided for US-APWR to address hydrogen generation and control are:

- Large volume containment
  - Provides hydrogen mixing and protection against hydrogen burns
- Hydrogen ignition system
  - Controls hydrogen rapidly with high reliability

Summary of relevant studies and experiments

A summary of relevant studies and experiments about hydrogen generation and control is shown in Table 19.2-2.

Goals of analysis

The goals of analysis for hydrogen generation and control are to meet the following requirements:

- Demonstrate that containment has capability for ensuring a mixed atmosphere (10 CFR 50.44(c)(1)) (Reference 19.2-6)
- Demonstrate that uniformly distributed hydrogen concentration is less than 10% by volume when hydrogen ignition system is functional (10 CFR 50.34(f)(2)(ix) (Reference 19.2-5) and 10 CFR 50.44(c)(2))

- Demonstrate that containment integrity is maintained when hydrogen ignition system is functional, assuming hydrogen generated from 100% fuel cladding-coolant reaction (10 CFR 50.34(f)(3)(v)(A)(1) and 10 CFR 50.44(c)(5))
- Demonstrate that containment integrity is maintained to address an accident that releases hydrogen generated from 100% fuel clad-coolant reaction accompanied by hydrogen burning (10 CFR 50.44 (c)(5))

Analysis approach

In order to satisfy the goals of analysis, the analytical approaches below are utilized:

- Evaluate effectiveness of hydrogen ignition system and local concentration of hydrogen
  - Employ MAAP to evaluate the hydrogen generation rate
  - Calculate independently the amount of hydrogen generated from 100% zirconium of active fuel length cladding-coolant reaction
  - Modify the MAAP results with independently calculated amount of hydrogen generation, and apply as boundary conditions for GOTHIC calculations
  - Employ GOTHIC with igniter model to evaluate effectiveness of hydrogen ignition system and atmospheric mixing through multi-nodes and sub-divided volumes
  - Show that local hydrogen concentration during severe accident is less than 10%
- Evaluate containment structural capability against local hydrogen burn
  - Investigate structural capability to withstand pressure rise due to hydrogen control by hydrogen ignition system
  - Evaluate in accordance with the approach specified by ASME Boiler Pressure Vessel Code, Section III, Division 2 Subsubarticle CC-3720, Factored Load Category
  - Criterion of containment structural capability is based on ultimate capability, not on design capability
- Evaluate containment structural capability against global hydrogen burn
  - Evaluate the containment pressure rise assuming adiabatic isochoric complete combustion of hydrogen
  - Examine containment structural integrity against pressure rise

Analysis result

Accident progression analyses for hydrogen generation and control utilizing the hydrogen ignition system have been performed using GOTHIC code. In the developed GOTHIC model, hydrogen igniters are located at 20 locations in the containment and are modeled to initiate hydrogen burning when hydrogen concentration becomes greater than 8% by volume except under steam inert condition.

Hydrogen concentration in each compartment is either lower than 10% or the compartment is inerted by steam. The pressure in containment vessel is kept below 68 psia, and this pressure is much lower than the containment ultimate pressure 216 psia described in Subsection 19.2.4. Therefore, the containment integrity is maintained against hydrogen combustion events, and the requirements of 10 CFR 50.44(c)(1), 10 CFR 50.34(f)(2)(ix), 10 CFR 50.44(c)(2), 10 CFR 50.34(f)(3)(v) (A)(1), and 10 CFR 50.44(c)(5) are therefore met.

The maximum pressure in the containment vessel under the adiabatic isochoric complete combustion condition is 136 psia. This pressure is lower than the containment ultimate pressure 216 psia and the requirement of 10 CFR 50.44(c)(5) is met.

19.2.3.3.3 Core Debris Coolability

The fundamental design concept of the US-APWR for severe accident termination is reactor cavity flooding and cool down of the molten core by the flooded coolant water. Therefore, dependable systems are provided to properly flood the reactor cavity during a severe accident. The US-APWR provides a diverse reactor cavity flooding system, which consists of the CSS with a drain line from the SG compartment to the reactor cavity and firewater injection to the reactor cavity. The CSS is automatically activated when the high-high containment pressure is detected and P-signal is transmitted. This containment spray water flows into the reactor cavity from the SG compartment through the drain line by gravity. The fire protection water supply system is provided outside of containment and in stand-by status during normal operation. The system line-up is modified for emergency operation during a severe accident and provides firewater from outside to the reactor cavity. These two systems are independent and thus provide high reliability reactor cavity flooding.

MCCI is a phenomenon that occurs when the temperature of core debris exceeds the melting temperature of concrete, and concrete is gradually eroded by high-temperature core debris resulting in potential basemat melt-through. Therefore, the primary mitigation of MCCI is cool down of core debris that has been relocated from RV to the reactor cavity. The US-APWR provides a highly reliable reactor cavity flooding system as discussed above, and coolant water is continuously supplied during a severe accident. The reactor cavity floor concrete, which has a thickness of 40 in., provides a protection against direct attack to the steel liner plate by the relocated core debris. This steel liner plate underneath the reactor cavity floor concrete is the pressure boundary between containment and the environment.

The geometry of the reactor cavity was designed to ensure adequate core debris coolability. Sufficient reactor cavity floor area is provided to enhance spreading of the core debris. This ensures that an adequate interface is maintained between the core debris and coolant water and that the thickness of the deposited core debris is reduced to diminish the heat flux transmitted from the core debris to the reactor cavity floor concrete.

In Generic Letter No. 88-20 issued by NRC in 1988; it states "…assessments (should) be based on available cavity (spread) area and an assumed maximum coolable depth of 25 cm. For depths in excess of 25 cm, both the coolable and noncoolable outcomes should be considered." In order to address this discussion, the debris spreading behavior is carefully reviewed in handling the US-APWR core debris coolability issue at the design stage. Reactor cavity depth is also designed to provide a sufficient degree of debris break-up due to interaction of molten core and coolant water for better coolability.

A concern on re-criticality may arise due to the reactor cavity flooding by unborated firewater injection. Re-criticality may occur if molten debris drops into water with low boron concentration and the low borated water may ingress into the gap of broken-up debris bed. However, if the gap within the debris bed is smaller than the moderator's volume ratio required for criticality, re-criticality does not occur. Also, residual gadolinium in molten fuel works as a preventive measure to preclude criticality. Thus, the possibility of re-criticality is considered very limited. Even in case that re-criticality would have occurred and molten fuel become in a heat-generating status, the power generation decreases due to generated void. And hence, it is very unlikely that this power generation due to re-criticality would become a severe challenge to containment integrity.

<u>Mitigation features</u>

Mitigation features provided for the US-APWR to address core debris coolability are:

- Diverse reactor cavity flooding system
  - Consists of drain line injection and firewater injection to ensure flooding of reactor cavity within required duration
- Reactor cavity geometry
  - Provides sufficient reactor cavity floor area and appropriate reactor cavity depth to enhance spreading debris bed for better coolability
- Reactor cavity floor concrete
  - Provides protection against challenge to liner plate melt through
- Basemat concrete
  - Provides protection against fission products release to the environment

<u>Summary of relevant studies and experiments</u>

A summary of relevant studies and experiments about core debris coolability is found in Table 19.2-3.

<u>Goals of analysis</u>

For core debris coolability, no specific requirements are stated in the CFRs. The goals of analysis for core debris coolability below are therefore established to ensure termination of severe accident progression in accordance with 10 CFR 52.47 (a) (23) (Reference 19.2-1).

- Demonstrate that core debris is adequately cooled when the reactor cavity is adequately flooded
- Demonstrate that containment integrity is maintained against pressure rise due to MCCI more than 24 hours following the onset of core damage
- Demonstrate that basemat melt through does not occur within 24 hours following the onset of core damage
- Demonstrate that the core debris deposition thickness on the reactor cavity floor is below approximately 25 cm (=10 in.)
- Address the inherent phenomenological uncertainties related to core debris coolability and MCCI, and confirm the above goals are still satisfied under reasonably conservative assumptions.

<u>Analysis approach</u>

In order to satisfy the goals of the analysis, the following analytical approaches are utilized:

- Perform severe accident progression analysis
    - Employ MAAP to investigate core debris coolability and MCCI
    - Consider characteristic scenarios for debris cooling and MCCI
        - Debris drops into water pool
        - Water is injected onto molten core on reactor cavity floor
        - No water is available in the reactor cavity
- Examine containment structural capability
    - Investigate whether containment integrity is maintained more than 24 hours following the onset of core damage against
        - Pressure rise by steam and non-condensable gas generation due to MCCI
        - Basemat melt through
- Evaluate the core debris spreading behavior
    - Employ FLOW-3D code to evaluate the debris spreading

- Assume no debris break-up by fuel-coolant interaction
- Confirm the debris deposition thickness is less than approximately 25 cm, suggested by the NRC staff as the debris coolable criterion

- Consider inherent phenomenological uncertainties
  - Examine the effectiveness of debris coolability by heat transfer between core debris and overlying water pool
  - Perform sensitivity analysis using MAAP for parameters related to the core debris coolability, such as
    - Heat transfer coefficient by film boiling
    - Amount of core debris involved in a postulated accident event
- Examine material properties
  - Investigate the characteristic differences between limestone/common sand and basalt in terms of MCCI, such as
    - Erosion rate
    - Amount of steam and non-condensable gas generation

Analysis result

Accident progression analyses have been performed using MAAP 4.0.6 code for 9 characteristic accident sequences in which both features of the diverse reactor cavity flooding system are available. It is identified from the analysis results that molten debris is appropriately cooled down in a reactor cavity water pool and no concrete erosion occurs for accident sequences in which molten debris drops into water pool. Very slight concrete erosion (i.e. less than 0.1 in.) occurs for an accident sequence in which coolant water is poured after molten debris spread on the dry reactor cavity floor. The coolability of debris for the cases that coolant water is available is confirmed through these calculations, and therefore, the first goal set earlier in this subsection on core debris coolability is considered satisfied. Accident progression analyses for 5 characteristic accidental sequences in which no continuous reactor cavity flooding means is available have also been performed using MAAP. It is concluded from the analysis results that the earliest possibility of complete erosion of the reactor cavity floor concrete (i.e. more than 40 in. erosion of concrete) is approximately 28 hours after onset of core damage. Furthermore, no containment failures due to overpressure are identified within 24 hours after onset of core damage from the 15 sequences addressed in this study. It is therefore concluded that containment integrity is maintained more than 24 hours after onset of core damage and accordingly the second and third goals set earlier in this subsection on containment integrity related to MCCI are satisfied.

Molten core spreading behavior is evaluated by FLOW-3D code. It is observed that molten core spreads very well on whole reactor cavity floor. The depth at most area is below the acceptance criterion of 25 cm (=10 in.) although the depth in very limited area mostly at adjacent of the reactor cavity wall exceeds 25 cm (=10 in.). However, the percentage of the area with over 25 cm (=10 in.) deposition is much less than 1% of the reactor cavity floor. And thus it is considered that the fourth goal set earlier in this subsection on debris deposition thickness is sufficiently satisfied. Non-coolable possibility due to exceeding of the 25 cm (=10 in.) deposition is probabilistically treated in the Level 2 PRA study.

Sensitivity analyses in terms of the heat transfer between molten core and coolant water are performed and core debris coolability and MCCI progression are evaluated. It is concluded through the sensitivity analyses that the containment integrity is likely to be maintained more than 24 hours after onset of core damage for the current US-APWR design under conservatively estimated conditions. This conservatively estimated sensitivity analysis result supports the conclusion that the goals set in this subsection are satisfactorily met.

Finally, studies for concrete composition comparing basalt and limestone/common sand are performed. Regarding the containment failure due to concrete erosion, limestone/ common sand concrete has clearly better characteristics to basalt concrete. Meanwhile, in terms of the containment failure due to overpressure, basalt concrete has moderately better characteristics to limestone/common sand concrete. However it is very difficult to judge the better design from the current understanding on core debris coolability and MCCI issues. It may be therefore concluded from this study that the selection of concrete type can be determined from the availability of the material at the location of plant construction.

19.2.3.3.4 High Pressure Melt Ejection

High pressure melt ejection (HPME) accident occurs when reactor vessel fails at high reactor coolant system (RCS) pressure. This physical phenomenon may lead to containment failure through two accidental events, direct containment heating (DCH) and rocket-mode reactor vessel failure. DCH is a phenomenon in which molten core is ejected into the reactor cavity driven by high reactor vessel pressure, followed by a rapid blowdown of primary system inventory. In the reactor cavity, the high speed steam stream entrains part of the discharged molten core into containment atmosphere in a form of fine aerosol particles, which may greatly enhance chemical reactions. Consequently the containment atmosphere is heated and pressurized. If not recovered or abated eventually this will cause containment failure. Rocket-mode reactor vessel failure is a phenomenon that may occur for reactor vessel without bottom penetrations when the vessel fails in a circumferential manner at the vessel periphery. An upward force is exerted on the upper portion of the vessel that is equal to the vessel pressure multiplied by the vessel cross-section. This force is postulated to fail the vessel holddown and accelerate the upper portion of the vessel up and through the containment dome, similar to an alpha-mode containment failure. Or this force may lift the whole reactor vessel body together with primary system loops, and this displacement of primary system loops could cause fall down of steam generators, and the consequent secondary system loop displacement could damage containment penetrations.

As HPME is a specific phenomenon for high RCS pressure scenario, the probability of HPME is significantly reduced by incorporation in the design of reliable RCS depressurization features. The US-APWR provides safety depressurization valves (SDV) as well as severe accident dedicated depressurization valves, which are independent of SDVs, and hence the high pressure scenario is very unlikely to happen for the US-APWR.

Even if the depressurization of RCS fails, the consequences of postulated DCH are mitigated by the reactor cavity geometry and containment layout. The debris trap in the reactor cavity as well as no direct pathway to the upper compartment is provided for prevention of the impingement of debris on the containment shell. Complete prevention of debris dispersion from reactor cavity to upper compartment cannot be expected to be achieved as long as there is a drain line pathway as the reactor cavity flooding system. However, since this pathway passes through SG loop compartment (between upper compartment and reactor cavity) which is not a straight path, and thus it is expected that a very limited amount of debris in a form of aerosol would reach the upper compartment. Accordingly the containment atmosphere temperature rise by the limited amount of core debris is not very significant.

As long as the debris dispersion to upper compartment due to HPME is very limited, the potential for deposition and accumulation of fine debris particulates in the recirculation suction line is also very limited. The potential plugging of the suction line caused by CSS recirculation can be considered negligibly small.

For rocket-mode reactor vessel failure, it is considered that this event is highly remote to happen. The percentage of high-pressure accident scenario contribution to the total CDF is evaluated very small. In addition, the potential failure mode for high-pressure scenario is a competence with RV breach, hot leg rupture or SGTR. Thus, no additional mitigation features are provided for this failure mode, instead probabilistic consideration is thoroughly performed through the Level 2 PRA.

Mitigation features

Mitigation features provided for the US-APWR to address HPME are:

- Depressurization valve
  - Reduces RCS pressure after core damage
- Core debris trap
  - Enhances capturing of ejected molten core in the reactor cavity
- Diverse reactor cavity flooding system
  - Provides reliable flooding of the reactor cavity

Summary of relevant studies and experiments

A summary of relevant studies and experiments about HPME is shown in Table 19.2-4.

Goals of analysis

For high pressure melt ejection and direct containment heating, no specific requirements are stated in the CFRs. The goals of analysis for high pressure melt ejection and direct containment heating are therefore established below to adequately address severe accidents for the US-APWR design features in accordance with 10 CFR 52.47(a)(23) (Reference 19.2-1).

- Demonstrate that the capacity of depressurization valve is adequate and accordingly the potential of high pressure melt ejection is sufficiently low
- Investigate the ability of the debris trap so that a very limited amount of core debris is dispersed to the containment atmosphere. Accordingly show that the challenge by direct containment heating is acceptably low
- Demonstrate that the containment structure has sufficient capability to withstand the pressure rise due to direct containment heating

Analysis approach

In order to satisfy the goals of the analysis, the following analytical approaches are utilized:

- Perform severe accident progression analyses for scenarios related to RCS depressurization
  - Employ MAAP to evaluate the capacity of the depressurization valve to prevent high pressure melt ejection
- Evaluate the amount of core debris dispersion in relation to DCH
  - Investigate the amount of core debris dispersion in general through existing studies
  - Examine the applicability of existing studies to the US-APWR
- Investigate the containment structural capability
  - Conservatively assume the amount of core debris dispersion
  - Employ the two-cell equilibrium model to evaluate pressure rise due to DCH
  - Examine whether the containment structure has sufficient capability to withstand the pressure rise due to DCH
- Assume rocket-mode reactor vessel failure always cause containment failure and detailed analysis is not performed; instead this failure mode is probabilistically addressed in the Level 2 PRA

Analysis result

Accident progression analysis has been performed using MAAP 4.0.6 for the high pressure core melt scenario. It is assumed that the depressurization valve is opened 10 minutes after onset of core damage, and that primary system pressure decreases to 169 psia at RV failure. In the US-APWR Level 2 PRA, the cut-off pressure for occurrence of HPME is defined as approximately 250 psia. This cut-off pressure is conservatively defined from an engineering judgment in accordance with the discussions such that an existing experiment cut-off pressure of debris dispersal is around 345 psi (Reference 19.2-49) and also 285 psi is typically used in Japanese manner. Therefore, the capacity of the depressurization valve is sufficient to reduce the RCS pressure lower than the conservatively defined cut-off pressure for preventing high pressure melt ejection as well as subsequent direct containment heating.

The containment peak pressure has been calculated by the two-cell equilibrium model described in NUREG/CR-6075 (Reference 19.2-51) for a postulated direct containment heating phenomenon although it is confirmed that the capacity of depressurization valve is sufficient. A debris dispersal fraction of 5% is assumed based on previous studies and experiments. The containment peak pressure for a postulated direct containment heating condition is 74 psia, and this is sufficiently lower than the containment ultimate pressure 216 psia, described in Subsection 19.2.4.

Rocket-mode RV failure is considered to be a very remote possibility although it is assumed in the US-APWR design that the containment integrity cannot be maintained by this failure mode. Therefore, no specific analysis for this failure mode has been performed; instead, this failure mode is thoroughly reviewed probabilistically in the Level 2 PRA.

19.2.3.3.5 Fuel-Coolant Interaction

There are two aspects to consider in relation to fuel-coolant interaction, one is in-vessel steam explosion and the other is ex-vessel steam explosion.

19.2.3.3.5.1 In-Vessel Steam Explosion

In-vessel steam explosion is known as an initiation event causing alpha-mode containment failure and has been studied for many decades. Numerous studies are available on this issue including the conclusion of NUREG-1524 (Reference 19.2-36) by the NRC sponsored Steam Explosion Review Group. In that report, it is concluded that the potential for alpha-mode containment failure is negligible and the issue of this failure mode has been resolved from a risk point of view. The conclusion of NUREG-1524 is supported by the specialist meeting held in the following year of the report has been issued (Reference 19.2-38). The US-APWR design is very similar to existing PWR plants and therefore no new phenomena or configurations are considered to be introduced. Accordingly the conclusion of the NUREG-1524 study is applicable to the US-APWR. Thus, no mitigation features for in-vessel steam explosion are provided.

<u>Mitigation features</u>

No mitigation features are provided to address in-vessel steam explosion.

<u>Summary of relevant studies and experiments</u>

A summary of relevant studies and experiments about in-vessel steam explosion is shown in Table 19.2-5.

Goals of analysis

For in-vessel steam explosion, no specific requirements are stated in the CFRs. The goals of the analysis for in-vessel steam explosion below are therefore established to adequately address severe accidents for the US-APWR design features in accordance with 10 CFR 52.47(a)(23) (Reference 19.2-1).

- Confirm that in-vessel steam explosion is very unlikely
- Confirm that existing study results are applicable to the US-APWR

Analysis approach

In order to satisfy the goals of the analysis, the following analytical approaches are utilized:

- Examine existing studies
  - Investigate the likelihood of in-vessel steam explosion in general through existing studies
  - Examine the applicability of existing studies to the US-APWR
    - Occurrence potential of steam explosion depends on system pressure, temperature, and interaction between molten core and water in lower plenum
    - Challenge to containment in an in-vessel steam explosion is from the mechanical impact of the vessel head and any other portions of the vessel and internal are torn loose by the explosion
    - No significant differences are identified between the US-APWR and existing plants

Analysis result

NUREG-1524 by the NRC sponsored Steam Explosion Review Group concluded that the potential for alpha-mode containment failure is negligible and the issue of this failure mode has been resolved from risk point of view. In the Organization for Economic Cooperation and Development (OECD)/Committee on the Safety of Nuclear Installations (CSNI) specialists meeting (Reference 19.2-38) held on the following year that NUREG-1524 was issued, it was concluded that no new information had been identified to question the conclusion of NUREG-1524. It was also concluded that alpha-mode containment failure has no importance with regard to risk.

The in-vessel steam explosion issue can broken down into a set of contributing physical processes, such as

- Melt relocation into the lower plenum
- Initial melt-water interactions leading to coarse breakup of melt and forming a pre-mixture
- Triggering of pre-mixture and energetic melt-water interactions
- Consequential loading of the lower head and its response
- Structural loads and response calculations.

Considering the above listed processes, no significant design differences are identified between the US-APWR and current four-loop PWR plants. The US-APWR has better characteristics such as lower power density. The US-APWR RV internal structure and primary system design is very similar to existing PWR plants and no new phenomena or configurations are considered to be introduced. Accordingly, the conclusions reached in the NUREG-1524 study are applicable to the US-APWR, and the challenge of alpha mode containment failure is considered negligible.

19.2.3.3.5.2 Ex-Vessel Steam Explosion

Ex-vessel steam explosion is one of the key issues to be resolved for the US-APWR design since the fundamental design concept for severe accident termination is to cool down molten core by reactor cavity coolant water. Therefore it is carefully reviewed and analytically demonstrated that the containment structure has sufficient capability to withstand the pressure load of an ex-vessel steam explosion. No mitigation features for ex-vessel steam explosion are provided for the US-APWR.

Mitigation features

No mitigation features are provided to address ex-vessel steam explosion.

Summary of relevant studies and experiments

A summary of relevant studies and experiments about ex-vessel steam explosion is shown in Table 19.2-5.

Goals of analysis

For ex-vessel steam explosion, no specific requirements are stated in the CFRs. The goals of analysis for ex-vessel steam explosion below are therefore established to adequately address severe accidents for the US-APWR design features in accordance with 10 CFR 52.47(a)(23) (Reference 19.2-1).

- Evaluate the shockwave impulse pressure if ex-vessel steam explosion occurs
- Demonstrate the containment structure has sufficient capability to withstand the shockwave pressure of postulated ex-vessel steam explosion and induced events by the load

Analysis approach

In order to satisfy the goals of the analysis, the following analytical approaches are utilized:

- Evaluate pressure load
  - Employ TEXAS-V for shockwave pressure prediction
  - Utilize MAAP calculation results to set the initial conditions for TEXAS-V
  - Perform sensitivity analyses to address inherent uncertainties
- Evaluate containment structural capability
  - Employ LS-DYNA to evaluate the structural capability of reactor cavity to withstand shockwave pressure from postulated steam explosion
  - Scope of this structural analysis includes
    - Reactor cavity wall
    - Reactor coolant pipes and nozzles
    - Reactor cavity sleeve structure
    - Extent of SG displacement
    - Containment penetration integrity

Analysis result

The accident scenario considered for ex-vessel steam explosion is a large break LOCA scenario. The accident sequence is that obtained with the following logic: large break LOCA + high pressure injection failure + accumulator injection success + CSS failure + firewater injection to reactor cavity success. This accident sequence is considered the most conservative in terms of occurrence possibility of steam explosion since the degree of subcooling of the reactor cavity water is expected to be very large and the thermal energy of molten debris is relatively high.

The MAAP code analysis result for this accident sequence has been employed as the initial condition for the TEXAS-V code to predict the shockwave pressure. The peak pressure by TEXAS-V is calculated as 1.23×10^4 psia. This time-dependent pressure is employed as the initial condition of a finite element model analysis employing LS-DYNA code for the reactor cavity structural capability. The analysis result by LS-DYNA shows that the maximum strain of the reactor cavity wall due to the shockwave pressure by steam explosion is within the range of elastic strain. The RV and RCS pipes displacement is evaluated as approximately 4 in., which is within the clearance of the sleeve 8 in. (nominal value). The maximum plastic strain of RCS pipes is approximately 1% observed at general pipe section. As the elongation criterion of general pipe material is less than 26%, it is concluded that structural capability of RCS pipes is maintained with sufficient margin. The extent of SG displacement due to RCS pipes displacement is therefore evaluated sufficiently small due to very tight anchor bolt holding. The containment penetration integrity is accordingly expected to be maintained for this level of SG displacement.

It is confirmed that containment structural capability is maintained under these conservative assumptions for ex-vessel steam explosions. It is therefore concluded the containment structural capability will withstand the challenge posed by an ex-vessel steam explosion. Therefore, the goals set in the beginning of this subsection are fully met.

19.2.3.3.6 Containment Bypass

There are two aspects to consider in relation to containment bypass during a severe accident, one is temperature induced steam generator tube rupture and the other is intersystem loss of coolant accident.

19.2.3.3.6.1 Temperature Induced Steam Generator Tube Rupture

Temperature-induced SGTR is a postulated high primary system pressure accident. In high primary system pressure accident scenarios, temperature-induced SGTR competes with creep rupture induced failures of RCS piping at hot leg nozzles, surge line, or RV failure that leads to high pressure melt ejection. The severe accident dedicated depressurization valve contributes to prevention of temperature-induced SGTR as well as high pressure melt ejection.

<u>Mitigation features</u>

Mitigation features provided for US-APWR to address temperature-induced SGTR are:

- Depressurization valve
  - Reduces RCS pressure after core damage

<u>Summary of relevant studies and experiments</u>

A summary of relevant studies and experiments about temperature-induced SGTR is shown in Table 19.2-6.

<u>Goals of analysis</u>

For temperature-induced SGTR, no specific requirements are stated in the CFRs. The goals of analysis for temperature-induced SGTR are therefore established below to adequately address severe accidents for the US-APWR design features in accordance with 10 CFR 52.47(a)(23) (Reference 19.2-1).

- Demonstrate that the capacity of the depressurization valve is sufficient and that the potential of temperature-induced SGTR is acceptably low

Analysis approach

In order to satisfy the goal of the analysis, the following analytical approaches are utilized:

- Perform severe accident progression analyses for scenarios related to RCS depressurization
  - Employ MAAP to analyze RCS high pressure scenarios
  - Evaluate the capacity of depressurization valve to prevent temperature-induced SGTR
- Examine existing studies
  - Examine the applicability of existing studies to the US-APWR

Analysis result

Accident progression analysis has been performed using MAAP 4.0.6 for the high pressure core melt scenario by assuming that the depressurization valve is manually opened 10 minutes after the onset of core damage. For an accident assuming main steam line break, it is calculated that primary system pressure decreases to 169 psia, when the SG secondary system is at atmospheric pressure. Therefore the anticipated pressure difference between primary system and secondary system for the most severe case is approximately 155 psi. This pressure difference can be considered insignificant in terms of the material properties, and hence it is confirmed through this analysis that the capability of depressurization valve is sufficient.

The US-APWR provides the safety depressurization valve as well as the depressurization valve. The safety depressurization valves (SDV) are provided in order to prevent a severe accident. The depressurization valve is provided as a backup system of SDV, and these systems are independent each other. Therefore the RCS depressurization feature, which consists of SDV and depressurization valve, is highly reliable. The existing literature shows that the probability of temperature-induced SGTR occurrence is high when the RCS is not depressurized and the SG secondary side is depressurized. The capacity of the depressurization valve is considered sufficient to reduce RCS pressure for preventing temperature-induced SGTR. However temperature-induced SGTR includes inherently high uncertainty and it is still controversial on the occurrence of this phenomenon. Therefore, temperature-induced SGTR is carefully addressed in the Level 2 PRA and probabilistically considered about the challenge to the large release of radioactive materials.

19.2.3.3.6.2 Intersystem Loss of Coolant Accident

Intersystem loss of coolant accident is considered resolved for the US-APWR design as discussed in Subsection 19.2.2.5. No further discussion is therefore provided here.

19.2.3.3.7 Equipment Survivability

10 CFR 50.34(f)(2)(ix)(C) (Reference 19.2-5) requires that "Equipment necessary for achieving and maintaining safe shutdown of the plant and maintaining containment integrity will perform its safety function during and after being exposed to the environmental conditions attendant with the release of hydrogen generated by the equivalent of a 100% fuel-clad metal water reaction including the environmental conditions created by activation of the hydrogen control system." 10 CFR 50.34 (f)(2)(xvii) (Reference 19.2-5) requires instrumentation to measure, record and readout in the control room: containment pressure, containment water level, containment hydrogen concentration, containment radiation intensity (high level), and noble gas effluents at all potential, accident release points. 10 CFR 50.34(f)(2)(xix) (Reference 19.2-5) also requires instrumentation adequate for monitoring plant conditions following an accident that includes core damage. 10 CFR 50.34(f)(3)(v) (Reference 19.2-5) requires that "Containment integrity will be maintained during an accident that releases hydrogen generated from 100% fuel clad metal-water reaction accompanied by either hydrogen burning." 10 CFR 50.44(c)(3) (Reference 19.2-6) similarly requires that "Containments that do not rely upon an inerted atmosphere to control combustible gases must be able to establish and maintain safe shutdown and containment structural integrity with systems and components capable of performing their functions during and after exposure to the environmental conditions created by the burning of hydrogen. Environmental conditions caused by local detonations of hydrogen must also be included, unless such detonations can be shown unlikely to occur. The amount of hydrogen to be considered must be equivalent to that generated from a fuel clad-coolant reaction involving 100 percent of the fuel cladding surrounding the active fuel region."

The functions of equipment in containment for which credit is taken in the US-APWR PRA are reviewed to determine if the equipment is required to operate under severe accident environment and beyond design basis limits, including the effect of pressure, temperature, humidity, etc. especially under the conditions created by hydrogen burning. The US-APWR design considers the following attributes:

- Containment systems credited for severe accident mitigation in the US-APWR Level 2 PRA
- Accident conditions considered in the Level 2 PRA
- Functional performance success criteria in the Level 2 PRA, including the timeframe necessary to be functional
- Design requirements relative to environmental conditions, such as pressure, temperature, humidity, etc.

<u>Goals of analysis</u>

The goal of the analysis for equipment survivability is to meet the following requirement:

- Demonstrate the equipment survivability of systems and components to maintain safe shutdown and containment structural integrity under the environmental conditions created by hydrogen burning (10 CFR 50.44(c)(3) (Reference 19.2-6))

Summary of relevant studies and experiments

A summary of relevant studies and experiments about equipment survivability is shown in Table 19.2-7.

Analysis approach

In order to satisfy the goals of analysis, the following analytical approaches are utilized:

- Determine the scope of analysis
  - Identify time frames necessary to consider in accordance with accident progression
  - Identify key systems and components to be examined during design certification stage
- Perform severe accident progression analysis
  - Employ MAAP to analyze representative accident scenarios to generate input conditions for GOTHIC analysis
  - Employ GOTHIC to analyze environmental conditions especially for hydrogen combustion
- Examine equipment survivability for design certification stage
  - Investigate availability of systems and components under calculated environmental conditions
  - Evaluate the effectiveness of systems and components

Analysis result

During accident conditions, key systems and components are maintained with the most appropriate set of mitigation measures.

The key systems and components are selected by considering:

- The time frame of the severe accident progression, i.e. when the system or components are expected to be functional,
- The location that equipment and instrumentation are arranged, i.e. at inside or outside of containment,
- The significance of evaluations, i.e. if the system is backed up by alternative measure, etc.

The selected systems and components include containment penetrations, hydrogen igniters, depressurization valves used for severe accident mitigation, and containment pressure monitors.

An environmental condition under hydrogen burning by hydrogen ignition system operation has been evaluated using GOTHIC code. The peak temperature is approximately 1000°F in some compartments and in a specific timing such as core melt, RCS depressurization, and reactor vessel failure. The analysis results show that the duration with very high temperature such as 1000°F is considered sufficiently short and does not significantly damage the devices. The temperatures in most of the compartments are around 200°F.

Referring to existing experiments and the literatures (References 19.2-58, 19.2-59, and 19.2-60), it is confirmed through these studies that the systems and components in the US-APWR design are able to maintain safe shutdown and containment structural integrity with high confidence and to keep their functions under the postulated severe accident environmental conditions created by hydrogen burning.

19.2.3.3.8 Long-term Containment Overpressure

The US-APWR containment is cooled and depressurized primarily by the CSS during a postulated severe accident. The CSS which supplies coolant water from the RWSP is automatically activated upon detecting high-high containment pressure. Accordingly, the containment pressure is limited to less than the design pressure during a severe accident. In case the CSS is not functional, the US-APWR provides diverse mitigation features against challenges by containment overpressure. One is the alternative containment cooling by containment fan cooler system. This is a system to depressurize containment by promoting natural circulation in containment. The containment fan cooler system is a system provided to stabilize the containment environmental condition during normal operation through forced air circulation by fan. However, the electrical power of fan may not be available during a severe accident. Natural circulation is instead credited to adequately mix the containment atmosphere. The containment fan cooler system employs non-essential chilled water as the coolant under normal operation. Since this non-essential chilled water cannot be available under severe accident conditions, the system line-up is switched from the chilled water system to the CCW system which supplies CCW to the containment fan cooler units as coolant. Although CCW is not as cold as chilled water, it is sufficiently colder than the containment atmosphere under severe accident conditions. This temperature difference between the containment fan cooler units and containment atmosphere causes condensation of surrounding steam. This condensation mechanism promotes more natural circulation flow because of the pressure difference due to condensation of steam. This enhances continuous containment depressurization.

The firewater system is also utilized to promote condensation of steam. The firewater system is lined up to the containment spray header when the CSS is not functional, and provides water droplet from top of containment. This temporarily depressurizes containment. However, the firewater system does not contain a heat exchanger, and thus has no ability to remove heat from containment to terminate the containment pressurization. Instead, this design feature can be expected to temporarily increase the heat sink in containment and extend the critical time of containment failure.

Goals of analysis

For long-term containment overpressure, no specific requirements are stated in the CFRs. The goals of the analysis for long-term containment overpressure are therefore established below to adequately address severe accidents for the US-APWR design features in accordance with 10 CFR 52.47(a)(23) (Reference 19.2-1).

- Demonstrate the effectiveness of diverse mitigation features against containment overpressure
- Demonstrate that containment withstands pressurization for more than 24 hours following the onset of core damage

Mitigation features

Mitigation features provided for the US-APWR to address long-term containment overpressure are:

- Large volume containment
  - Provides sufficient capability to withstand overpressure
- Containment spray
  - Provides primary function to mitigate containment overpressure
- Alternative containment cooling by containment fan cooler system
  - Enhances condensation of surrounding steam by natural convection
- Firewater injection to spray header
  - Delays containment failure (no heat removal)

Summary of relevant studies and experiments

A summary of relevant studies and experiments about long-term containment overpressure is shown in Table 19.2-8.

Analysis approach

In order to satisfy the goals of the analysis, the following analytical approaches are utilized:

- Perform severe accident progression analyses
  - Employ MAAP to evaluate the effectiveness of mitigation features

- Containment cooling by containment spray
- Alternative containment cooling by containment fan cooler system
- Firewater injection to spray header

- Examine containment structural capability
  - Investigate whether containment integrity is maintained for more than 24 hours following the onset of core damage

Analysis result

Accident progression analyses have been performed using MAAP 4.0.6 as part of the Level 2 PRA analysis for the PDSs. It is found that even if the containment heat removal system is not available, the containment vessel can withstand pressurization for more than 24 hours following the onset of core damage.

The performance of alternative containment cooling by containment fan cooler system has been analyzed by MAAP 4.0.6. The heat removal characteristics of the system are modeled as a function of containment atmosphere temperature based on the experimental results performed using a real containment fan cooler unit on heat removal efficiency under natural circulation conditions. The environmental conditions applied to this system performance analysis are separately calculated utilizing MAAP code. For the system performance analysis, it is assumed that the alternative containment cooling system is activated when multiple failures of CS system occur and the containment pressure rises over the design pressure of 83 psia (68 psig). It has been confirmed through the MAAP analysis results that the containment peak pressure is approximately 117 psia (102 psig), which is much lower than the ultimate pressure 216 psia (201 psig), and hence, containment integrity is maintained. In addition, it is concluded that CS and firewater spray are effective to depressurize containment vessel.

19.2.3.3.9 Other Severe Accident Mitigation Features

Mitigation features for specific severe accident phenomena addressed for the US-APWR design have been discussed. In addition, there are several requirements to mitigate accidental conditions in general, stated in 10 CFR 50.34(f) (Reference 19.2-5).

10 CFR 50.34(f)(2)(vi) requires the design to “Provide the capability of high point venting of noncondensible gases from the RCS, and other systems that may be required to maintain adequate core cooling. Systems to achieve this capability shall be capable of being operated from the control room and their operation shall not lead to an unacceptable increase in the probability of LOCA or an unacceptable challenge to containment integrity.” In order to satisfy this requirement, the US-APWR provides RV head vent valves. Detailed design description of this valve is presented in Chapter 5.

10 CFR 50.34(f)(3)(iv) requires to “Provide one or more dedicated containment penetrations, equivalent in size to a single 3-foot diameter opening, in order not to preclude future installation of systems to prevent containment failure, such as a filtered vented containment system.” In order to satisfy this requirement, a dedicated

containment penetration with the size as specified above requirement is provided. This penetration can be shared with the containment high volume purge system and does not preclude the future usage of systems such as a filtered vent.

19.2.4 Containment Performance Capability

19.2.4.1 Evaluation of the Containment Ultimate Capacity

Goals of analysis

Requirements for the analysis and evaluation used to estimate the containment internal pressure capability (i.e., ultimate pressure capability) are below listed documents:

- 10 CFR 50.34(f)(3)(v)(A)(1), which states that "Containment integrity will be maintained (i.e., for concrete containments by meeting the requirements of the ASME Boiler Pressure Vessel Code, Section III, Division 2 Subsubarticle CC-3720, Factored Load Category, considering pressure and dead load alone) during an accident that releases hydrogen generated from 100% fuel clad metal-water reaction accompanied by either hydrogen burning or the added pressure from post-accident inerting assuming carbon dioxide is the inerting agent."
- RG 1.7 Rev. 3 states that "Concrete containments meet the requirements of the ASME Boiler Pressure Vessel Code, Section III, Division 2, Subsubarticle CC-3720, Factored Load Category, considering pressure and dead load alone.

Analysis approach

This analysis is performed through the characteristic consideration of containment elements, such as found in the containment body and penetrations. Included are:

- Containment cylindrical shell
- Upper dome
- Equipment hatch
- Personnel airlock
- Penetrations
- Discontinuity

The aim of this study is to determine the containment failure pressure as reality as possible. The analysis is therefore expected to perform on a best-estimate basis without any safety factors and conservative biases or assumptions. However, the specific design information of each element given at DC stage to perform detailed FEM model evaluation is very limited for identification of failure mode, location and point-estimate pressure capacity. Hence, this analysis at DC stage is through assuming the weakest elements of containment. PCCV basically consists of a cylindrical shell with a hemispherical upper dome and a flat floor. Discontinuities are identified at the interface of cylindrical shell and upper dome, the ring guarder section, etc. However the degree of these discontinuities is not significant compared to other interfaces such as between the wall and floor. This analysis conservatively assumes containment failure at containment shell yield, where the strains and deflections are small. Therefore the failures at local penetrations which are induced by larger plastic strains do not occur at the small yield strains. In addition, major penetrations are considered stronger than general containment wall since the thickness of penetration wall area is thicker than general wall thickness, besides they are strengthened by additionally embedded reinforcing steels. It is therefore assumed in this study that cylindrical shell limits the capacity of whole containment, and nominal containment capacity under severe accident conditions (assuming 400~600°F) is predicted.

Analysis result

This analysis is limited on the static pressure load by slow pressurization and the dynamic pressure load due, for example to violent hydrogen detonation, is not considered.

The ultimate pressure is predicted by summation of each multiplication of the cross sectional area and yielding stress of rebar, tendon, and liner plate. It is considered a very conservative assumption to apply the yielding stress of each material to predict ultimate pressure. In terms of the material property of carbon steel, there is no significant deterioration on strength for temperatures around 400°F~600°F. It is therefore a conservative assumption even though the temperature dependency is neglected. In addition, tendon and rebar are embedded in concrete and thus not influenced greatly by the surrounding temperature due to lower thermal conductivity of concrete. These considerations indicate that the ultimate pressure is 216 psia (201 psig).

19.2.4.2 Review of the Containment Performance Goal

Discussions on the containment performance goals are identified in SECY-90-016 (Reference 19.2-2) and SECY-93-087 (Reference 19.2-3). The staff's recommendations on the containment performance goals in these documents have been approved by the commission in the associated SRMs. The staff's recommendations are interpreted in the latest standard review plan as "a deterministic goal that containment integrity be maintained for approximately 24 hours following the onset of core damage for the more likely severe accident challenges, and a probabilistic goal that the conditional containment failure probability be less than approximately 0.1 for the composite of all core damage sequences associated in the PRA."

Regarding the deterministic goal, it is carefully examined in Subsection 19.2.3, severe accident mitigation, in accordance with the conservatively estimated ultimate capability, 216 psia (201 psig), obtained in the above section. Specifically in Subsection 19.2.3.3, severe accident issues on hydrogen combustion, core debris coolability, MCCI, steam explosion, DCH, and long-tem decay heat removal are discussed focusing on challenges to the containment integrity. It is confirmed through the analyses that the containment integrity is maintained for more than 24 hours following the onset of core damage for all the severe accident conditions listed above. These severe accident issues fully cover the discussions identified in SECY-90-016 and SECY-93-087. Accordingly the deterministic goal suggested by the staff is sufficiently met for the current US-APWR severe accident mitigation design.

Regarding the probabilistic goal, it is carefully examined in Section 19.1, probabilistic risk assessment. Specifically in Subsections from 19.1.4 to 19.1.6, internal event at power, external event at power and LPSD are discussed, respectively. In these analyses, the CCFP of the internal event at power is calculated as 0.09, achieved below the probabilistic goal that the CCFP be less than approximately 0.1, suggested in the R.G. 1.206. However the CCFP for the composite of all core damage sequences assessed in the US-APWR PRA, which additionally include external events and LPSD, is calculated as 0.18. This CCFP value exceeds the suggested goal 0.1. However this is because the total CDF of the US-APWR achieves comparatively low by implementing such substantial countermeasures as described in Subsection 19.1.3.1, and accordingly the total CCFP becomes relatively high. In addition, the conservative assumption in the Level 2 PRA for LPSD condition, as the CCFP is one, contributes to enlarge the CCFP. If the LPSD condition is excluded from the consideration, the subtotal CCFP is calculated as 0.14. The excess of the total CCFP to the goal is not very significant and satisfactorily acceptable.

Noticeably, the CCFP of the internal events for operations at power satisfies the suggested probabilistic goal. This explicitly shows that the severe accident mitigation features provided for the US-APWR is sufficiently effective to achieve the level of safety expected for the evolutionary plant.

19.2.5 Accident Management

Accident management includes those actions taken during the course of an accident by the plant operating and technical staff to: (1) prevent core damage; (2) terminate the progress of core damage if it begins and retain the core within the RV; (3) maintain containment integrity as long as possible; and (4) minimize offsite releases (Reference 19.2-7). Accident management extends the defense-in-depth principle to plant operating staff by extending the operating procedures well beyond the plant design-basis into severe fuel damage regimes, and by making use of existing plant equipment and operator skills and creativity to terminate severe accidents and limit offsite releases. The US-APWR design incorporates accident management approaches in the severe accident regime and is articulated in the present subsection.

As discussed in Subsections 19.2.2 and 19.2.3 of the DCD, while the US-APWR has enhanced features for the prevention and mitigation of severe accidents, accident management remains an important element of defense-in-depth. Essential features of accident prevention and mitigation in the US-APWR design are basically the same as in operating reactors and have greater diversity of countermeasures. Accident management is used to relieve the operators of the need for rapid decisions based on operator skills and creativity, and permit greater reliance on support from outside sources, within a proceduralized framework.

<u>Severe Accident Management Framework</u>

The US-APWR applicant develops a severe accident management framework to guide the COL applicant in the development of plant-specific accident management procedure for the US-APWR design. This accident management procedure discusses the anticipated structure for the decision-making process, the goals to be accomplished in accident management, a summary of possible strategies for the US-APWR accident management, and potential adverse impacts of accident management strategies. A severe accident management framework includes:

- An approach for evaluating plant conditions and challenges to plant safety functions;
- Operational and phenomenological conditions that may influence the decision to implement a strategy, and which will need to be assessed in the context of the actual event; and
- A basis for prioritizing and selecting appropriate strategies, and approaches for evaluating the effectiveness of the selected actions.

The following countermeasures and operating actions are essentially addressed in the US-APWR severe accident management framework in accordance with the NRC guidance specified in the Reference 19.2-7.

(1) To prevent core damage

Key function of accident management to prevent core damage is to keep the core in a condition covered by coolant water. This includes core cooling, secondary cooling, containment cooling, isolation of containment bypass path, power supply, and component cooling. Countermeasures and operator actions for each function are described below.

- Accident management of core cooling function is to prevent core damage in case of LOCA and loss of safety injection. The CS/RHR pump has the function to inject the water from RWSP into the cold leg piping by switching over the CS/RHR pump lines to the cold leg piping (i.e. alternative core cooling operation). If all of safety injection systems are not available, operators are required to switch over the RHRS lines to the cold leg injection.
- Accident management of secondary cooling function is to prevent core damage in case of non-LOCA events. If emergency feedwater pumps cannot feed water to two intact SGs, operators are required to attempt to open the cross tie-line of emergency feedwater pump discharge line in order to feed water to two or more SGs by operable pumps. In case of loss of all feedwater and SG secondary side dried-out, operators are required to initiate the feed and bleed operation by starting the safety injection pump and opening the safety depressurization valve.
- Accident management of alternative containment cooling function is to prevent core damage in case of LOCA and loss of containment spray. This feature actually prevents containment failure before core damage, but not core damage itself. If containment fails before core damage, containment temperature and pressure immediately decrease and coolant water, which is very likely to be in steam state under this condition, is rapidly lost, and eventually core damages. The containment fan cooler system is utilized as alternative containment cooling

by promoting natural circulation in containment. If CSS is not activated when containment pressure monitor detects that the pressure reaches the design pressure, operators are required to switch the cooling water supply from the chilled water system to the CCW system.

- Accident management of the isolation of containment bypass path is to prevent core damage in case of SGTR and failure of ruptured SG isolation. In case of SGTR and if MSIV or turbine bypass valves (TBV) are failed to close, operators are required to close the valves, which are manual-handling valves installed upstream of TBV, in order to isolate the failed SG.
  If ruptured SG cannot be isolated, operators are required opening safety depressurization valves and intact SG secondary forced cooling with opening main steam depressurization valves to depressurize RCS. After that, it is required to connect RHR system to move into heat removal with RHR operation mode.
  If it is failed to move RHR operation mode, operators are required feed and bleed operation by starting the safety injection pump and opening the safety depressurization valve.

- Accident management of power supply is to prevent core damage in case of loss of offsite power and complete loss of emergency ac power. If both offsite power and emergency ac power are lost, operators are required to connect alternate ac power to the emergency bus.

- Accident management of component cooling function is to prevent core damage in case of loss of CCW. Either non-essential chilled water system cooling tower or fire water service system provides alternative component cooling water to charging pumps in order maintain RCP seal water injection. Operator action is required to connect non-essential chilled water system cooling tower or fire water service system to component cooling water line to charging pumps, and supply alternative component cooling water to charging pumps.

(2) To terminate the progress of core damage if it begins and to retain the core within the reactor vessel

Core damage is identified by that both core outlet temperature and containment radiation level exceed criteria.

Essential countermeasure for termination of core damage progression and retention of core within the reactor vessel is to recover borated water injection into the reactor vessel. This is achieved by operating the safety injection system or alternative injection system. Safety injection system is provided primarily to prevent core damage however in case it fails to operate, recovery of safety injection system may be possible. Countermeasures and operator actions for each function are described below.

- Operator recovers the safety injection into RV before vessel melt through if possible.

- The alternative injection systems, such as CS/RHR pump and CVCS, are employed in case the safety injection system is down. Recovery action of the failed safety injection system is continued taken while the alternative core injection system is in operation.

- If RCS pressure is higher than the injection pump shut off head despite RCS is depressurized in case of a severe accident, additional depressurization is utilized if available.

(3) To maintain containment integrity as long as possible

Key functions of accident management to maintain containment integrity are containment vessel isolation and decay heat removal from containment vessel. Decay heat removal is achieved in case both molten core cooling due to reactor cavity flooding and depressurization of containment vessel atmosphere are succeeded. Prevention of early containment failure due to temperature induced SGTR, hydrogen detonation and direct containment heating is also considered. Countermeasures and operator actions for each function are described below.

- Core damage is detected then operator confirms that containment vessel is properly isolated. Containment isolation may be done before core damage and hence it is required to reconfirm after core damage.

- Accident management of reactor cavity flooding is in order to cool down molten core relocated from RV breach to the reactor cavity. Decay heat is released to water and removed from containment vessel. The reactor cavity flooding is achieved utilizing the CSS and/or fire water service system. Molten core cooling prevents containment failure due to basemat melt through, hydrogen generation due to MCCI, etc. Operator action is initiated if the water level in the reactor cavity is lower than a criterion when core damage is detected. CSS is manually activated and water flows into the reactor cavity by gravity through the drain line. In order to utilize the fire water service system for the reactor cavity flooding, it is necessary to establish lineup before activating the fire water service pump.

- Accident management of containment heat removal is in order to prevent containment overpressure failure. The containment heat removal is achieved utilizing either CSS or alternative containment cooling by containment fan cooler system. CSS is one of engineered safety features and operator action is required if CSS is not automatically activated. Containment fan cooler system is a non-safety system and the fan operation is not credited during a severe accident. Cooling water is switched from chilled water system to CCW system. In order to apply the alternative containment cooling, operator pressurize CCW surge tank. This is in order to prevent boiling of CCW in the cooling unit of containment fan cooler system. Fire water service system is employed in case neither CSS nor alternative containment cooling is available in order to acquire longer recovery time. Fire water service system is lined up to the containment spray header and provides water as spray droplet. This operation temporarily depressurizes containment however the fire water service system does not contain a heat exchanger, and thus has no ability to remove heat from containment to terminate the containment pressurization.

- Accident management of prevention of early containment failure is through prevention of containment bypass, HPME and hydrogen detonation. RCS depressurization is in order for prevention of HPME and temperature-induced SGTR. When core damage is detected, severe accident dedicated depressurization valve is opened and if necessary safety depressurization valve is opened. In case water supply to SG is available, main steam depressurization valve is opened to enhance primary system cooling and depressurization if needed. Water supply to SG is recovered or controlled to avoid FP release due to temperature induced SGTR through secondary system, also to depressurize RCS. Main feedwater system or emergency feedwater system are employed for this function and operation is required when SG water level decreases below a criterion if available. Combustible gas control is in order to prevent containment failure especially due to hydrogen detonation. Although the combustible gas control is automatically achieved by hydrogen ignition system, in case CSS fails and containment vessel atmosphere is kept inerted for certain duration, CSS recovery may lead containment vessel atmosphere to combustible condition under high hydrogen concentration. In such case containment depressurization is suspended at a relatively high containment pressure. This operation is taken if combustible gas concentration is more than certain value before or when containment depressurization is in operation.

(4) To minimize offsite release

Key function of accident management to minimize offsite release is fission products removal from containment vessel atmosphere. CSS and fire water service system are utilized to reduce the amount of airborne FP in the containment atmosphere. Countermeasures and operator actions for each function are described below.

- Operator recovers CSS even after containment vessel failure if available.

- If CSS is not available, operator recovers fire water service system connected to the spray header if available.

19.2.6 Consideration of Potential Design Improvements Under 10 CFR 50.34(f)

19.2.6.1 Introduction

This section is prepared using design-specific PRA information to consider potential design improvements as required under 10 CFR 50.34(f) and follows content guidance provided in NRC Regulatory Guide 1.206. The PRA analysis and related information for the US-APWR, required inputs for the subject analysis, are discussed in Section 19.1 of this DCD.

The complete Severe Accident Mitigation Design Alternatives (SAMDA) analysis is reported in the Applicant's Environmental Report - Standard Design Certification (Reference 19.2-66), and its summary is described in this section. In addition, the supporting analysis is reported in the US-APWR Level 3 PRA report (Reference 19.2-73).

19.2.6.1.1 Background

In a 1985 policy statement, the U.S. Nuclear Regulatory Commission (NRC) defined the term "severe accident" as an event that is "beyond the substantial coverage of design-basis events," including events where there is substantial damage to the reactor core. While design-basis events are considered to be those analyzed in accordance with the NRC's Standard Review Plan (NUREG-0800), severe accidents are considered in a PRA analysis. Accordingly, the PRA for the US-APWR design has been prepared to achieve the following objectives:

1. Identify the dominant severe accident sequences.
2. Modify the design, on the bases of PRA insights, to prevent or mitigate severe accidents and reduce the risk of severe accidents.
3. Provide a basis for concluding that all reasonable steps have been taken to reduce the chances of occurrence, and to mitigate the consequences, of severe accidents.

Applicants for reactor design certification must also consider alternative design features for severe accidents consistent with the requirements of 10 CFR Part 52 and 10 CFR Part 50, as well as a court ruling related to NEPA. These requirements can be summarized as follows:

> The NRC's severe accident safety requirements for new reactor designs are provided 10 CFR Part 52, paragraph 52.47. Specifically, the NRC's Three Mile Island safety requirements are referenced in the 10 CFR 52.47(a)(8) and are found in 10 CFR 50.34(f). Paragraph 52.47(a)(21) concerns the treatment of unresolved safety issues and generic safety issues. Finally 10 CFR 52.47(a)(27) requires the performance of a design-specific PRA.
>
> 10 CFR 50.34(f)(1)(i) requires the applicant to perform a plant/site-specific probabilistic risk assessment, the aim of which is to seek such improvements in the reliability of core and containment heat removal systems as are significant and practical and do not impact excessively on the plant (Reference 19.2-5).

The U.S. Court of Appeals decision, in *Limerick Ecology Action vs. NRC*, 869 F.2d 719 (3rd Cir. 1989), effectively requires the NRC to include consideration of certain SAMDAs in the environmental impact review performed under Section 102(2)(c) of NEPA.

Although these two requirements are not directly related, they share a common purpose to consider alternatives to the proposed design, to evaluate potential alternative improvements in the plant design which increase safety performance during severe accidents, and to prevent reasonable alternatives from being foreclosed. While the NRC has noted that it is not required to consider alternatives to a specific design, as a matter of discretion, the Commission has determined that considering SAMDAs concomitant with the rulemaking is consistent with the intent of 10 CFR Part 52 for early resolution of issues, finality of design issues resolution, and achieving the benefits of standardization.

In its decision in *Limerick Ecology Action v. NRC*, the Court of Appeals for the Third Circuit expressed its opinion that it would likely be difficult to evaluate SAMDAs for NEPA purposes on a generic basis. However, the NRC has determined that generic evaluation of SAMDAs for standard designs is warranted for two significant reasons. First, the design and construction of all plants referencing the specific certified design will be governed by the rule certifying a single design. Second, the site parameters specified in the rule and the DCD establish the consequences for a reasonable enveloping set of SAMDAs for the specified design. Related discussions are recognized in SECY-91-229 and its SRM (Reference 19.2-72).

The information provided in this section complies with applicable parts of NUREG-1555. Included are: (i) a list of leading contributors to (1) core damage frequency, and (2) dose consequences; (ii) the methodology process, and rationale used by the applicant to identify, screen, and select design alternatives and procedural modifications; (iii) the estimated cost, risk reduction, and value impact ratios for the selected SAMAs and the assumptions used to make these estimates; and (iv) a description and list of any alternatives that have been or will be implemented to prevent or mitigate severe accidents or reduce the risk of a severe accident (Reference 19.2-67).

For the US-APWR, an evaluation of potential design improvements, or severe accident mitigation design alternatives (SAMDAs), has performed to meet these requirements.

19.2.6.1.2 Purpose

The purpose of this section is to provide an evaluation of SAMDAs for the US-APWR design. The approach taken is to consider the net value of a design alternative (SAMDA) as the difference between the benefit of the modification and the cost of the enhancement, with the outcome determining whether the safety benefits of the identified SAMDA outweigh the cost of incorporation in the plant design.

The cost-benefit methodology follows the current guidance for regulatory analysis contained in NUREG/BR-0184 and NUREG/BR-0058 (References 19.2-8 and 19.2-9). Industry implementation guidance (NEI 05-01, Rev. A) is applied to identify and screen SAMDAs (Reference 19.2-68). Review of potential design alternatives will consider those of current PWR plant designs, PRA information on US-APWR, and design alternatives identified by US-APWR design personnel. Both onsite and offsite costs will be included in a manner consistent with SECY-99-169 (Reference 19.2-10).

This evaluation will include a design description, estimated cost, and estimated benefit for each alternative.

19.2.6.2 Estimate of Risk for Design

The SAMDA analysis uses two distinct analyses to form the basis for the baseline design risk. The first analysis is the Level 1 and 2 PRA of the US-APWR design, as summarized in Section 19.1 of the DCD. The second analysis is a Level 3 PRA analysis that integrates the Level 2 source terms to quantify the consequences based on a reference site.

The CDF from at power internal events, fire and flood events is 4.4E-06 per reactor-year and from LPSD events is 2.0E-07 per reactor-year. The LRF from at power internal events, fire and flood events is 6.1E-07 per reactor-year and from LPSD events is 2.0E-07 per reactor-year. The total CDF and LRF are therefore 4.6E-06 per reactor-year and 8.1E-07 per reactor-year, respectively. The major contributors to CDF and LRF are described in subsections 19.1.4 through 19.1.6 of the DCD. Additional detail on the Level 1 and 2 PRA are found in the US-APWR PRA report (Reference 19.2-69).

The MAAP code is used to develop the fission product source term corresponding to each release category. The MACCS2 code, Version 1.13.1 (Reference 19.2-70) is used in the Level 3 PRA analysis to estimate the population dose for each release category source term. In the offsite dose risk quantification, the meteorological data of the Surry site has been used as “typical”. The 50-mile population distribution data for the Surry site in the MACCS2 code sample input file has been adjusted to be in exceedance of about 80% of the U.S. nuclear plant sites, as described in NUREG/CR-2239, “Technical Guidance for Siting Criteria Development” (Reference 19.2-71). The population data and other assumptions applied are found in the Environmental Report for the US-APWR (Reference 19.2-66).

The total population dose risk is 2.7E-01 person-rem/reactor-year, and the largest contributor is from RC3 - Containment overpressure failure due to loss of heat removal (86%). The total offsite property risk is $8.9/reactor-year, with the largest contributors are: RC3 - Containment overpressure failure due to loss of heat removal (58%), RC4 – Early containment failure (20%), and RC1 – Containment Bypass (18%).

19.2.6.3 Identification of Potential Design Improvements

19.2.6.3.1 Screening method

The approach for identifying potential design improvements followed NEI 05-01, Rev. A (Reference 19.2-68). SAMDA candidates are selected primarily from two sources; one is screening from the NEI -05-01 for pressurized water reactors (PWRs, Table 14), the other is US-APWR specific candidates considering the design and insights from the CDF and population dose risk profile. The process used for SAMDA identification follows Section 5 of NEI 05-01, and resulted in the 156 SAMDA candidates.

Two phases of evaluation are performed with the first being a Phase I qualitative screening analysis following section 6 of NEI 05-01. This screening is done to eliminate SAMDAs from further consideration, and is done to reduce the number of SAMDAs for which quantitative cost analysis in a later phase (Phase II) is necessary.

19.2.6.3.2 Screening criteria

The screening criteria identified in NEI-05-01 are applied for the US-APWR design.

As the result of phase I screening, the following 10 SAMDAs are retained for Phase II analysis (Subsection 19.2.6.5). The candidate SAMDAS for Phase II analysis are:

1. Provide additional dc battery capacity (At least one train emergency dc power can be supplied more than 24 hours.)
2. Provide an additional diesel generator (At least one train emergency ac power can be supplied more than 24 hours.)
3. Install an additional, buried off-site power source
4. Provide an additional high pressure injection pump with independent diesel (With dedicated pump cooling)
5. Add a service water pump (Add independent train)
6. Install an independent reactor coolant pump seal injection system, with dedicated diesel (With dedicated pump cooling)
7. Install an additional component cooling water pump (Add independent train)
8. Add a motor-driven feedwater pump (With independent room cooling)
9. Install a filtered containment vent to remove decay heat
10. Install a redundant containment spray system (Add independent train)

19.2.6.4 Risk Reduction Potential of Design Improvements

Guidance contained in NUREG/BR-0184 (Reference 19.2-8) and NEI 05-01, Rev. A (Reference 19.2-68) provide the methodology for value-impact (benefit-cost) analysis, which is a central part of regulatory analysis. Values and impacts are characterized in monetary terms when feasible. The analysis balances benefits (values) with costs (impact) related to a proposed NRC action.

There are five principal component costs considered using the NRC handbook methodology when the proposed action changes either accident frequencies or consequences.

- Offsite exposure cost
- Onsite exposure cost
- Offsite property cost
- Cleanup and decontamination cost
- Replacement power cost

The risk reduction potential assessment covers four categories of events: (1) internal events; (2) internal fire; (3) internal flood; and (4) low-power and shut down (LPSD).

In the present analysis, the assumption is made that the population dose risk from internal events at power is applicable to internal fire events at power, internal flooding events at power, and shutdown events. A CDF scaling factor is applied to adjust from the population dose risk from internal events to the subject event dose risk. The same argument is also applied to the economic cost risk from internal events at power and scaling economic cost risk for internal fire events at power, internal flooding events at power, and shutdown events.

The total maximum averted cost benefit is the sum of the five component cost benefits for the four events discussed above. The maximum averted cost is $289k.

19.2.6.5 Cost Impacts of Candidate Design Improvements

This subsection discusses the cost impacts of candidate design improvements (Phase II evaluation of SAMDA candidate items). For those SAMDAs involving hardware modifications, the cost estimation process was to find “standard” costs from the following:

- NEI 05-01, Rev. A
- SAMA analyses for current U.S. power plants
- SAMDA analyses for other reactor designs.

Cost estimates that were derived independent of earlier precedents included procurement and installation, and where applicable, long-term maintenance, surveillance, calibration and training. These factors are allowable under NEI 05-01. A measure of conservatism was retained in the cost estimates to allow a reasonable examination of cost vs. benefit.

SAMDA cost evaluation results are described in Table 19.2-9. The lowest cost SAMDA is SAMDA #10, *Install a redundant containment spray system*, at $870k. The second lowest cost SAMDA is SAMDA #4, *Provide an additional high pressure injection pump with independent diesel*, at $1,000k.

19.2.6.6 Cost-Benefit Comparison

Based on that the every SAMDA cost is less than the Maximum Averted Benefit of $289k, none of the SAMDA candidates is cost-beneficial.

As an uncertainty analysis, table 19.2-9 shows the outcome of each SAMDA benefit sensitivity analysis. Each SAMDA benefit is derived by multiplying each ratio of contribution to decrease CDF or LRF and the maximum averted cost together. The baseline benefit involves a real discount rate, r, of 7%/year (0.07/year), as recommended in NUREG/BR-0184, the sensitivity cases of 5% and 3% discount rate are specified in NEI 05-01 and NUREG/BR-0058 respectively. The last column shows the SAMDA benefit using a monetary equivalent of population dose of $3,000 per person-rem (instead of the $2,000 per person-rem value used in the baseline analysis). The benefit of each SAMDA is observed to be significantly less than the cost impact.

19.2.6.7 Conclusions

There are no additional design alternatives that are shown to be cost-beneficial in severe accident mitigation design.

19.2.7 References

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Table 19.2-1 Design Features for the US-APWR and Severe Accident Phenomena (Sheet 1 of 2)

Design Feature in US APWR	Severe Accident Phenomena							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Hydrogen Generation and Control	**Core Debris Coolability**	**Steam Explosion (in- and ex-vessel)** (Note 1, Note 2)	**High Pressure Melt Ejection**	**Temperature Induced SGTR**	**MCCI**	**Long-term Containment Overpressure** (Note 3)	**Equipment survivability** (Note 4)
Depressurization valve	-	-	-	X	X	-	-	-
Hydrogen igniter	X	-	-	-	-	-	-	-
Large volume containment	X	-	-	-	-	-	X	-
Hydrogen monitor	X	-	-	-	-	-	-	-
Alternative containment cooling	-	-	-	-	-	-	X	-
Firewater injection to spray header	-	-	-	-	-	-	X	-
Drain line to reactor cavity	-	X	-	X	-	X	-	-
Core debris trap	-	-	-	X	-	-	-	-
Debris spreading area	-	X	-	-	-	X	-	-

Table 19.2-1 Design Features for the US-APWR and Severe Accident Phenomena (Sheet 2 of 2)

Design Feature in US APWR	Severe Accident Phenomena							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Hydrogen Generation and Control	Core Debris Coolability	Steam Explosion (in- and ex-vessel) (Note 1, Note 2)	High Pressure Melt Ejection	Temperature Induced SGTR	MCCI	Long-term Containment Overpressure (Note 3)	Equipment survivability (Note 4)
Reactor cavity floor concrete	-	-	-	-	-	X	-	-
Reactor cavity depth	-	X	-	-	-	-	-	-
Firewater injection to reactor cavity	-	X	-	X	-	X	-	-

Note 1. In-vessel explosion in US-APWR is determined to be very unlikely and thus does not warrant explicit mitigation features.
Note 2. Containment structure has sufficient capability to withstand the load of an ex-vessel steam explosion and induced events by the load.
Note 3. A fourth mitigation feature is the CSS. The CSS's primary function is to mitigate containment overpressure.
Note 4. Will identify systems and components, and time frames and environmental condition to be examined during design certification stage. Will examine equipment survivability during design certification stage based on existing studies.

Table 19.2-2 Summary of Relevant Studies and Experiments on Hydrogen Generation and Control

Paper / Experiment	Findings
NUPEC large scale test (Reference 19.2-11) (NUPEC: Nuclear Power Engineering Corporation)	Experiment modeled Japanese PWR dry containment showed that hydrogen released from steam generator compartment and annular compartment was well mixed and no local high concentration was observed.
NUPEC large scale hydrogen burn test (Reference 19.2-12)	NUPEC reported that no global burn was observed when hydrogen concentration was below 8% with less burning efficiency. 100% burning efficiency was observed for concentration 10%~15% however pressure rise was less than that assumed AICC. No DDT was observed for concentration less than 15%.
NUPEC detonation and containment integrity test (Reference 19.2-13)	Postulated hydrogen detonation under 13% hydrogen concentration caused approximately 0.6% of maximum plastic strain for PCCV liner plate, which is much lower than fracture strain of 19%. Potential of containment failure due to detonation was confirmed to be very small.
NUREG/CR-4905 (Reference 19.2-14)	SNL reported that hydrogen detonation was observed for hydrogen concentration 13.5%~70%.
NUREG/CR-6524 (Reference 19.2-15)	BNL reported that DDT occurred at lower hydrogen concentration for higher temperature. However, hydrogen concentration for DDT became higher when either steam or sideward opening existed.

Table 19.2-3 Summary of Relevant Studies and Experiments on Core Debris Coolability

Paper / Experiment	Findings
GL 88-020 (Reference 19.2-16)	NRC staff recommends that assessments be based on available cavity area and an assumed maximum coolable depth of 25 cm.
SWISS (Reference 19.2-17)	Debris cooling failed due to formation of stable crust and water pool above melt was kept below boiling point.
MACE (References 19.2-19, 19.2-21)	Debris cooling failed due to formation of stable crust and concrete erosion was not suppressed. Debris coolability cannot be concluded based on this series of experiment programs as observed phenomena are not prototypic to actual plant geometry.
WETCOR (Reference 19.2-18)	Influence of sidewall was eliminated by heating. Debris cooling failed due to formation of stable crust. Neither fragmentation of melt nor indication of instability of crust was observed.
COTELS (Reference 19.2-20)	Debris was cooled by coolant water and concrete erosion was suppressed. This was by water penetration to the porous of debris bed via eroded concrete sidewall clearance.
OECD MCCI (References 19.2-22, 19.2-23, 19.2-24)	Debris was cooled by coolant water and concrete erosion was suppressed. Water was able to penetrate the interface between the corium and concrete sidewalls. This cooling mechanism was not observed in MACE M1b, with inert refractory (MgO) sidewall.
BETA (References 19.2-25, 19.2-26)	Experiments performed at Kernforschungszentrum Karlsruhe (KZK). Downward erosion was greater than sideward for high-power experiments. This tendency was more significant for silicate concrete than limestone.
ACE (Reference 19.2-27)	Experiments performed at ANL. Melt was thoroughly mixed by gases released from the decomposing concrete and no stratification of oxidized and metallic melts was observed.
TURC (Reference 19.2-33)	Experiments performed at SNL. Transient heat conduction into concrete was observed in this experiment, resulting in decomposition of concrete. H_2O and CO_2 were reduced to CO and H_2 during decomposition, respectively.
SURC (References. 19.2-29, 19.2-30, 19.2-31, 19.2-32)	Experiments performed at SNL to provide information on heat transfer mechanism, gas release chemistry and vaporization release of aerosols. Interaction temperature remained well above the concrete melting point and zirconium chemistry drastically affects the ablation rate and gas composition.

Table 19.2-4 Summary of Relevant Studies and Experiments on High Pressure Melt Ejection

Paper / Experiment	Findings
B. W. Spencer, et al. (Reference 19.2-46)	Experiment performed by ANL showed that containment atmosphere temperature rise is very small when reactor cavity was filled with water.
NUREG/CR-6510 (References 19.2-47, 19.2-48)	Dispersed debris was captured at traps during flowing within tunnel area and opening of stairs, etc. Influence of DCH was reduced due to this debris capture.
Transaction of ANS; Vol/Issue: 57 (Reference 19.2-49)	It was suggested that a value of 2.38 MPa of primary system can be a low-pressure cutoff for direct containment heating.
NUREG/CR-6152 (Reference 19.2-50)	Scaling experiment by SNL showed that the pressure rise during DCH was as much as 0.5 MPa.
NUREG/CR-6075 (Reference 19.2-51) NUREG/CR-6109 (Reference 19.2-52) NUREG/CR-6338 (Reference 19.2-53)	It was concluded from this series of studies that the challenges by DCH have already been resolved for Westinghouse large dry containment. CCFP by DCH for all Westinghouse large dry containments were calculated less than 0.01. It was concluded that DCH issue has been resolved for these plants and no additional studies are required.

Table 19.2-5 Summary of Relevant Studies and Experiments on Fuel-Coolant Interaction

Paper / Experiment	Findings
NUREG-1116 (Reference 19.2-37) NUREG-1524 (Reference 19.2-36)	It was concluded that the potential for alpha-mode containment failure is negligible and the issue of this failure mode is resolved from risk point of view.
OECD/CSNI (Reference 19.2-38)	It was concluded that alpha-mode failure has no importance with regard to risk perspective.
ALPHA (References 19.2-39, 19.2-42) NUREG/CR-5372 (Reference 19.2-43)	It is commonly understood that steam explosion is unlikely to happen for saturated water. Potential of steam explosion includes large uncertainty since the occurrence of steam explosion triggering shows statistical behavior. It is considered very limited fraction of corium contributes to steam explosion when large amount of corium drops into water all at once. Fraction of energy conversion from corium to mechanical load is considered as much as a few %, or less.
COTELS (Reference 19.2-35) FARO (Reference 19.2-40) KROTOS (Reference 19.2-41)	No steam explosion was observed when mixture of molten UO_2 and Zr is dropped into water in the experiments of COTELS by NUPEC, and FARO and KROTOS by JRC-Ispra.

Table 19.2-6 Summary of Relevant Studies and Experiments on Containment Bypass

Paper / Experiment	Findings
NUREG-1150 (Reference 19.2-54)	It is considered that temperature-induced SGTR is very unlikely failure mode for high pressure core melt scenarios as long as tubes have no defect
NUREG-1570 (Reference 19.2-55)	Analysis result using SCDAP/RELAP5 have shown that surge line break is the most likely failure mode. It has been pointed that temperature-induced SGTR is likely in case of RCP seal LOCA sequences. Although RCP seal leak depressurize RCS, the associated RCS loop seal clearing greatly contributes to the tube failure potential. Secondary system pressure integrity is as important as RCS depressurization.
JAERI-Research (Reference 19.2-56)	JAERI performed a research focusing on secondary system depressurization during SBO and identified that SG tube integrity was narrowly maintained for the condition. It was however concluded that potential temperature-induced SGTR could not be ignored taking account of inherent uncertainty of computational calculation.
JNES research (Reference 19.2-57)	A research by JNES focusing on potential of temperature-induced SGTR under condition of secondary system depressurized at core damage. It has been reported that the mean of probability density for temperature-induced SGTR is 0.50, and that for surge line break is 0.37.

Table 19.2-7 Summary of Relevant Studies and Experiments on Equipment Survivability

Paper / Experiment	Findings
EPRI NP-4354 (Reference 19.2-58)	Experiments on response of typical safety equipment under hydrogen burn condition were performed. Most of equipment operated normally during and after all tests. It is concluded that the test data may be useful in assessing the survivability of safety equipment.
NUREG/CR-4763 (Reference 19.2-59)	Experiments performed by SNL for pressure transmitter and cables, under condition of single-burn and multiple-burn have been reported. Equipment survivability for single-burn was confirmed but not for multiple-burn.
NUREG/CR-5334 (Reference 19.2-60)	Experimental results on response of 3 types of wire penetrations have been reported. For Westinghouse containment, it was exposed to 400°F condition for 10 days. Electrical capability was maintained for 4 days, and mechanical capability was maintained for 10 days.

Table 19.2-8 Summary of Relevant Studies and Experiments on Long-Term Containment Overpressure

Paper / Experiment	Findings
NUREG/CR-6906 (Reference 19.2-61)	Containment may generally have pressure capability of a few times design pressure. Global, free-field strains on the order of a few % can be achieved before failure or rupture. However, actual containment may have more complexity than models, thus the capacities of models can be interpreted as an upper bound on actual containment capacity.
NUREG/CR-4119 (Reference 19.2-62)	Study on the integrity of containment penetrations under severe accident condition has been summarized. Database to predict leak rate of containment penetrations under severe accident conditions have been established.
NUREG/CR-4149 (Reference 19.2-63)	Modeling techniques and analysis procedures to determine ultimate pressure capacity of reinforced and pre-stressed concrete containments have been presented.
NUREG/CR-6809 NUREG/CR-6810 (References 19.2-64, 19.2-65)	Overpressurization test to failure for 1:4 scaled PCCV and the test analysis. Various data were collected, and containment response and failure modes were observed. Post-test analysis predicts liner's strain near weld seams and test itself shows the need for continuous backup bars on all liner seam welds.

Table 19.2-9 SAMDA Benefit Sensitivity Analyses

	Design Alternative	Cost Impact	Maximum Averted Cost	Sensitivity of each SAMDA benefit			
				Baseline	Discount rate		Monetary equivalent of unit dose ($3000/person-rem)
					5%	3%	
1	Provide additional dc battery capacity	$2,000k		$116k	$188k	$304k	$124k
2	Provide an additional gas turbine generator	$10,000k		$116k	$188k	$304k	$124k
3	Install an additional, buried off-site power source	$10,000k		$118k	$193k	$312k	$127k
4	Provide an additional high pressure injection pump with independent diesel	$1,000k		$150k	$244k	$395k	$161k
5	Add a service water pump	$5,900k		$72k	$118k	$190k	$78k
6	Install an independent reactor coolant pump seal injection system, with dedicated diesel	$3,800k	$289k	$136k	$221k	$357k	$146k
7	Install an additional component cooling water pump	$1,500k		$72k	$118k	$190k	$78k
8	Add a motor-driven feed-water pump	$2,000k		$101k	$165k	$266k	$109k
9	Install a filtered containment vent to remove decay heat	$3,000k		$173k	$282k	$455k	$186k
10	Install a redundant containment spray system	$870k		$14k	$22k	$36k	$15k

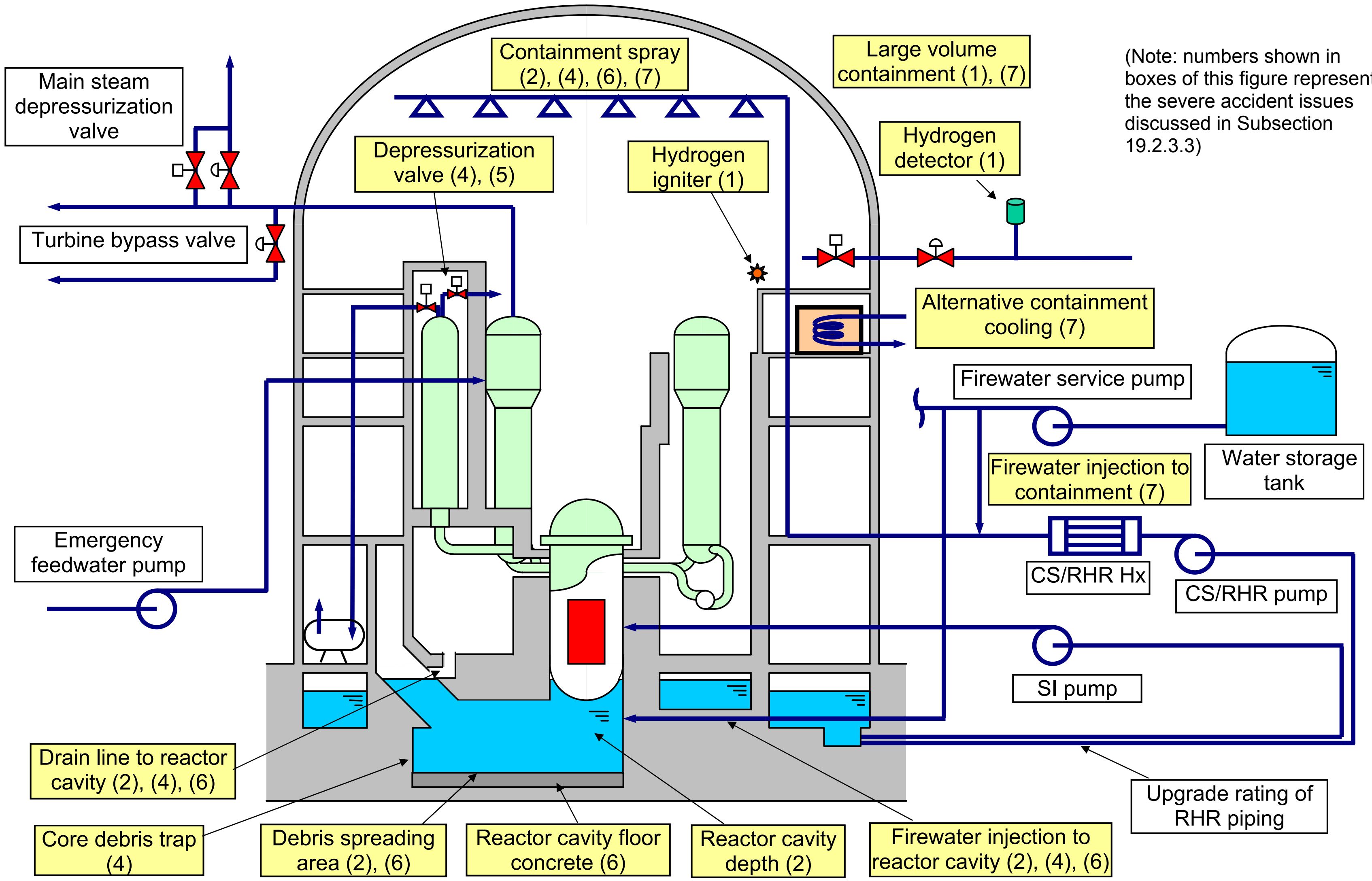

Figure 19.2-1 Schematic Diagram of the US-APWR Severe Accident Mitigation Features

19.3 Open, Confirmatory, and COL Action Items Identified as Unresolved

The following subsections identify the open, confirmatory and COL action items associated with this Chapter.

19.3.1 Resolution of Open Items

There are no open items associated with this Chapter.

19.3.2 Resolution of Confirmatory Items

There are no confirmatory items associated with this Chapter.

19.3.3 Resolution of COL Action Items

The following are the COL action items associated with this Chapter:

COL 19.3(1) The COL Applicant who intends to implement risk-managed technical specifications continues to update Probabilistic Risk Assessment and Severe Accident Evaluation to provide PRA input for risk-managed technical specifications.

COL 19.3(2) Deleted

COL 19.3(3) To provide PRA input to the reactor oversight process is a responsibility of the COL Applicant.

COL 19.3(4) The Probabilistic Risk Assessment and Severe Accident Evaluation is updated as necessary to assess specific site information and associated site-specific external events (high winds and tornadoes, external floods, transportation, and nearby facility accidents).

COL 19.3(5) When the design activity progresses and specific design data becomes available, SSC fragilities are updated during the COLA phase to reflect specific design data.

COL 19.3(6) The COL applicant develops an accident management program based on the U.S. industry initiated and coordinated program in this area and related information from efforts on an international front.