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

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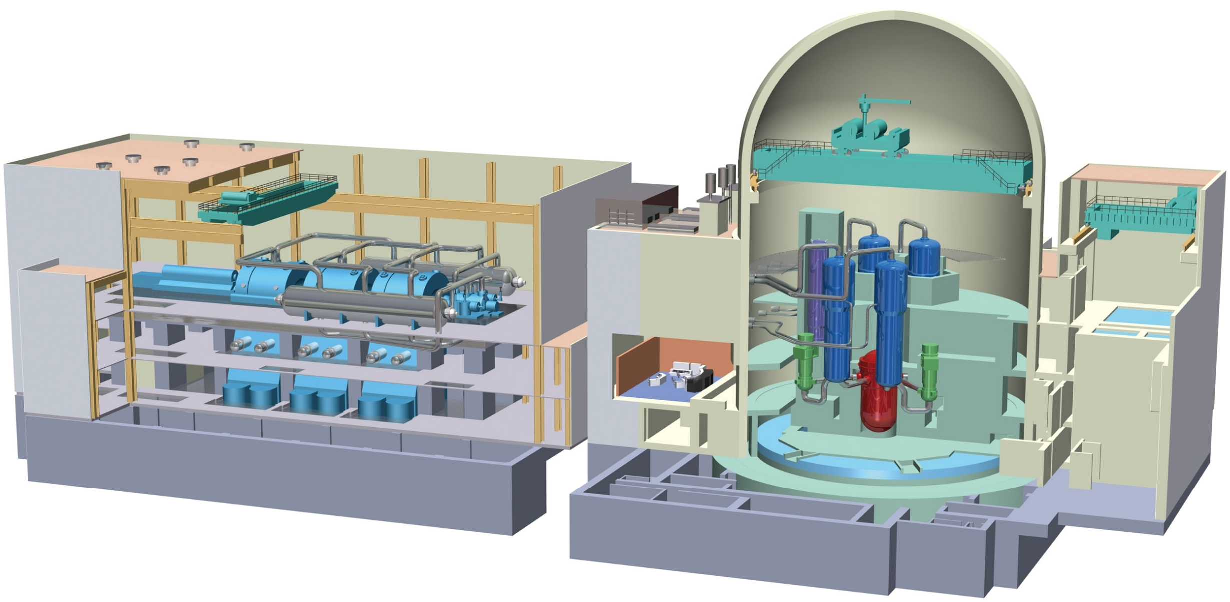

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ACRONYMS AND ABBREVIATIONS

A/B	auxiliary building
AAC	alternate 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

19.0- Contents of Applications; Technical Information, Title 10, Code of Federal Regulations, Part 52.47, U.S. Nuclear Regulatory Commission, Washington, DC, August 28, 2007.

19.0-2 Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs, SECY-93-087, U.S. Nuclear Regulatory Commission, Washington, DC, letter issued April 2, 1993 and Staff Requirements Memoranda issued July 21, 1993.

19.0-3 Contents of Applications; Technical Information, Title 10, Code of Federal Regulations, Part 50.34, U.S. Nuclear Regulatory Commission, Washington, DC, January 1, 2007.

19.0-4 Severe Reactor Accidents Regarding Future Designs and Existing Plants, NRC Policy Statement 50 FR 32138, U.S. Nuclear Regulatory Commission, Washington, DC, August 1985.

19.0-5 Safety Goals for the Operations of Nuclear Power Plants, NRC Policy Statement 51 FR 28044, U.S. Nuclear Regulatory Commission, Washington, DC, August 1986.

19.0-6 Nuclear Power Plant Standardization, NRC Policy Statement 52 FR 34884, U.S. Nuclear Regulatory Commission, Washington, DC, September 1987.

19.0-7 Regulation of Advanced Nuclear Power Plants, NRC Policy Statement 59 FR 35461, U.S. Nuclear Regulatory Commission, Washington, DC, July 1994.

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.

19.0-9 An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities, Regulatory Guide 1.200, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, January 2007.

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.

19.0-11 Evolutionary Light-Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements, SECY-90-016, U.S. Nuclear Regulatory Commission, Washington, DC, letter issued January 12, 1990 and Staff Requirements Memoranda issued June 26, 1990.

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 US-APWR Probabilistic Risk Assessment, MUAP-07030-P Rev. 2 (Proprietary), Mitsubishi Heavy Industries, December 2009.

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 as well as 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 class 1E 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 alternate 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 class 1E 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, alternate 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 alternate 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.

- Alternate 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 alternate 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 as key mitigation 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 and the uncertainties of the events, are shown in Table 19.1-2. Uncertainties of initiating event frequencies are assumed to form the log-normal distribution. Large EF (=10) is assumed when there are no past records in NUREG/CR-6928 (Reference 19.1-16). Otherwise small EF (=3) is assumed with a few exceptions. 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 (Table 19.1-7).

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. Heading IDs used in event trees are listed in Table 19.1-8. Descriptions of event headings and branches for each initiating event are shown in Table 19.1-9.

The event tree end states result in a set of accident classes (ACLs). The ACLs are described in Table 19.1-10. 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; alternate containment cooling by containment fan cooler system is failed
- F – Potentially dry condition in reactor cavity; alternate 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); alternate containment cooling by containment fan cooler system is activated, heat removal success
- HS – Wet condition in reactor cavity by CS; alternate 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 19.1-11. 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.

The impact of initiating events on mitigation systems is summarized in Table 19.1-7.

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 peak cladding temperature of greater than 2200°F using a code with detailed core modeling and peak cladding temperature greater than 1400°F using a code with simplified core modeling. Examples for core damage described in ASME standard SC-A2 Category II/III include core-predicted peak node temperature > 2200°F using a code with detailed core modeling or core-predicted peak node temperature > 1800°F using a code with simplified core modeling. The specific plant parameters and associated criteria used for US-APWR can be accepted considering that the peak cladding temperature is almost equivalent to the core peak node temperature especially after core uncover and that temperature criterion using a code with simplified core modeling is much smaller than for the example described in ASME standard. In the success criteria analyses, MAAP4.0.6 and WCOBRA/TRAC(M1.0) are used as a code with simplified core modeling and with detailed core modeling, respectively.

- 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 19.1-12 shows the relation of these plant safety functions and the initiating events.

- The identification of mitigating systems

  Mitigating systems provided for the safety functions and alternate operator actions are summarized in Table 19.1-13 and Table 19.1-14, respectively.

- 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. 24 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 19.1-15 and Table 19.1-16. 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 19.1-15

- Determination of success criteria

  Final success criteria, shown in Table 19.1-16, 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 the maximum interval between plant shutdowns, 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 19.1-17 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 interactions 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 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 Table 19.1-18, and the recovery factors are summarized in Table 19.1-19 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

<u>Quantification</u>

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 of 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 four 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
- Basic 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. Basic software failures degrade all signals of the digital system. DAS is independent from basic 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 one 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 alternate 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 516 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 19.1-20 and 19.1-21, 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 19.1-20.

The total means CDF for the US-APWR is 1.0E-06/RY. The portion of each initiating event in the CDF is summarized in Table 19.1-22 and Figure 19.1-4. The conditional core damage probability given initiating event occurs is described in Table 19.1-23.

Table 19.1-24 shows the top 100 sequences. The list of identifiers for these sequences is shown in Table 19.1-25. As can be seen in Table 19.1-24, the top 100 sequences contribute more than 99% to the total CDF. The top 10 dominant core damage sequences account for 83% of the total CDF.

Table 19.1-23 shows that six 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)
- Anticipated transient without scram (ATWS)
- Steam Line Break/Leak (Downstream MSIV: Turbine side) (SLBO)

The first two events account for 45.2% and 20.5% of the total CDF, respectively. The contribution of the other initiating events is less than 10% of the total CDF. Table 19.1-25 shows the top 40 cutsets for the total CDF. The top 10 dominant cutsets for each initiating event are provided in Table 19.1-26.

LOCA events, excluding reactor vessel rupture, dominate 9.3% 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.

65% 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 one 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 two hours after initiation of RCP seal LOCA (three hours after LOOP), core is uncovered. The frequency of this sequence is 3.4E-07/RY and accounts for 32.9 % 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 1.7E-07/RY and accounts for 15.9 % of the total CDF.

(3) Reactor vessel rupture: 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 9.7 % 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 9.0E-08/RY and accounts for 8.7 % of the total CDF.

The top 20 cutsets for these sequences are shown in Table 19.1-27, Table 19.1-28, and Table 19.1-29. 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 Table 19.1-30 and Table 19.1-31, respectively.

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

OPS----PRBF (Failure of offsite power recovery within one 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 one hour, RCP seal LOCA is assumed to occur. The plant CDF is decreased by a factor of 34% if the probability of this failure is set to 0.0.

OPS---- PRCF (Failure of offsite power recovery within three hour) – This basic event applies only to condition where total loss of ac power occurs after LOOP. If offsite power does not recover within three hours, core damage is assumed to occur due to RCP seal LOCA. The plant CDF is decreased by a factor of 33% if the probability of this failure is set to 0.0.

EPSOO02RDG (Fail to connect alternate ac to class 1E 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 alternate ac power to class 1E buses, total loss of ac power occurs. The plant CDF is decreased by a factor of 29% if the probability of this failure is set to 0.0.

EPSCF4DLLRDG-ALL (CCF of class 1E emergency power generators to run for the first hour) – This basic event applies to LOOP conditions. When all class 1E emergency power generators fail to run, the operator will attempt to connect the alternate ac power source to the safety buses. If the operator fails to connect the alternate ac power source, total loss of ac power occurs. The plant CDF is decreased by a factor of 22% 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 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:

RTPCRDF (Rod injection failure of more than four rods mechanical failure of the control rod driving mechanism) - The plant CDF would increase approximately 1.7E+05 times if the probability of this failure were set to 1.0. If more than four control rods fail to drop into the core, control rods cannot provide sufficient negative reactivity to trip the plant.

RTPBTSWCCF (CCF of basic software) - The plant CDF would increase approximately 4.6E+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.

SGNBTHWCCF (CCF of safety related I&C hardware) - The plant CDF would increase approximately 1.4E+04 times if the probability of this failure were set to 1.0. The importance of this failure is due to loss of all trains of the plant safety and monitoring system which will result in failure of various safety related signals including plant trip signal and emergency core cooling system actuation signal.

EPSCF4CBSC52UAT-ALL (CCF of all incoming breakers from the unit auxiliary transformer) - The plant would increase approximately 8.5E+03 times if the probability of this failure were set to 1.0. If this the incoming breakers all spuriously open after LOOP, class 1E buses cannot be supplied power since the buses are not isolated from the faulted offsite power. Accordingly, loss of total ac power will occur.

EPSCF4CBSC52RAT-ALL (CCF of all incoming breakers from the reserve auxiliary transformer) - The plant would increase approximately 8.5E+03 times if the probability of this failure were set to 1.0. If this the incoming breakers all spuriously open after LOOP, class 1E buses cannot be supplied power since the buses are not isolated from the faulted offsite power. Accordingly, loss of total ac power will occur.

Common-cause importance

The ten most risk-important common cause basic events are given in Table 19.1-32 for FV importance and in Table 19.1-33 for a RAW.

The most significant CCF basic event based on FV importance is CCF of all emergency power generators to run. The second most significant CCF basic event is CCF of all emergency power generators to start.

The top eight 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 19.1-34 for FV importance and in Table 19.1-35 for RAW.

The most significant human error basic event based on FV importance is **EPSOO02RDG (Fail to connect alternate ac power source)**, with a FV importance of 2.9E-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 1.7E+01. The plant CDF would increase approximately 17 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 19.1-36 for FV importance and in Table 19.1-37 for RAW.

Two single failure basic events have a FV importance greater than 2.0E-02. The most significant single failure based on FV importance is EFWPTAD001A, which represents the failure of safety turbine-driven emergency feedwater pump to start, with a FV importance of 2.2E-02.

There are more than 500 basic events for hardware single failure 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 1.7E+05 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
- Digital I&C 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 4.5E-06/RY which is approximately four times the CDF of the base case. Increment of CDF from base line CDF is 3.5E-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 4.6E-06/RY. Increment of CDF from the base case CDF is 3.6E-06/RY. If this CDF increment continues 24 hours, incremental conditional core damage probability (ICDP) is 9.7E-09.

- 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 4.3E-05/RY. Increment of CDF from the base case CDF is 4.2E-05/RY. If this CDF increment continues 72 hours, ICDP is 3.4E-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 5.6E-06/RY. Increment of CDF from the base case CDF is 4.6E-06/RY. If this CDF increment continues 72 hours, ICDP is 3.8E-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 3.9E-07/RY. The ratio of the sensitivity case frequency to the base frequency is approximately 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 1550.

- CASE 07: All HEPs set to mean value

  In this sensitivity study, mean HEPs, rather than lower bound value, are applied for human actions that will have frequent training. The resulting CDF is 4.6E-06/RY. The CDF is 4.4 times higher than that of base case.

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 08: 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 7.8E-07/RY. This CDF is 25% lower than the base case CDF.

- CASE 09: 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 1.3E-06/RY. This CDF is 29% higher than the base case CDF.

Digital I&C reliability

Sensitivity analysis of digital I&C software reliability is performed to study the impact of its uncertainty on plant CDF for internal initiating events at power.

- CASE10 Common cause failure of application software.

  The base case assumes that application software CCF is 1.0E-05/demand. Since this probability has high uncertainty, sensitivity analyses concerning software CCF have been performed.

In this sensitivity analysis, CCF probability of application software used for all signals, excluding that of the alternate ac power (AAC) system, is independent and has no diversity. Application software CCF will therefore result in failure of all signals modeled in the PRA besides that of the AAC. Three cases listed below were considered as part of the sensitivity analysis.

Case1: Application software CCF = 2.0E-05 /demand

If application software CCFs are assumed to occur 2.0E-05 /demand, which is twice the value considered in the base case, the resulting CDF is 1.1E-06/RY. This value is 3.9% higher than the base case CDF.

Case 2: Application software CCF = 5.0E-05 /demand

If application software CCFs are assumed to occur 5.0E-05 /demand, the CDF is 1.2E-06/RY, which is 15% higher than the base case CDF.

Case 3: Application software CCF = 1.0E-04 /demand

If application software CCFs are assumed to occur 1.0E-04 /demand, the CDF is 1.4E-06/RY, which is 34% higher than the base case CDF.

Results of sensitivity analyses show that if the probability of software CCF that results in failure of all safety related signals modeled in the PRA occur with a probability of 1.0E-04 /demand, which is ten times higher than the application software CCF probability assumed in the base case, the CDF is 1.4E-06/RY. This value is approximately 1.3 times 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 11 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 9.7E-07/RY. This CDF is 6% lower than the base case CDF.

- CASE 12: 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 two SGs, are kept closed regardless of emergency feedwater pump failures, the CDF will be 1.8E-06/RY. This CDF is 76% higher than the base case CDF.

- CASE 13: Common mode failure of all sump screens

In the base case, common cause failure of sump screens are evaluated from with generic failure data and generic common cause failure parameters. Although sump screens of US-APWR are design to minimize failure due to clogging, common cause failure CCF probability of sump screen may increase at for large LOCA. In this sensitivity analysis, the probability of all four sump screens to clog at large LOCA has been assumed to be 0.0625 (=0.5^4) per demand. The resulting CDF is 1.1E-06/RY. This CDF is 7% 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 4.5E-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 4.3E-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. If operator actions are assumed to succeed, the CDF is 3.8E-07/RY. 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 gas turbine generators is applied the CDF increases 29%. However, the reliability of gas turbine generators that will be installed in US-APWR are expected to be higher than gas turbine generators currently used in nuclear plants.
- 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 6%. 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 70%. Operation to open these valves when emergency feedwater pump is unavailable 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 – 3.2E-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 19.1-38 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 1.0E-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 5.0E-07/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 Table19.1-10. 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 alternate 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 19.1-39.

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

Followings are the physical phenomena that affect 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
- Alternate 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 Table 19.1-40 and the system dependency matrix is shown in Table 19.1-41. 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. 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 alternate 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 alternate 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 over-temperature 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 = 1.0E-06/RY

LRF = 9.9E-08/RY

CCFP = 0.095

The dominant cutsets of LRF are shown in Table19.1-42. 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) 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 alternate containment cooling by containment fan cooler system fails to operate and results in containment failure before core damage. The frequency of this cutset is 6.0E-09/RY and accounts for 6.2 % of LRF.

(2) 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. Recovery of power systems within 1 hour succeeds. However CCW pumps fail to restart due to software CCF. Consequently, it results in core damage.

    The containment isolation and RCS depressurization succeed. However reactor cavity flooding, and firewater injection to the spray header fails to operate due to software CCF. Recovery of CCWS fails and therefore results in containment failure. The frequency of this cutset is 4.0E-09/RY and accounts for 4.1 % of LRF.

(3) 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. Recovery of power systems within 3 hours succeeds. However CCW pumps fail to restart due to software CCF. Consequently, it results in core damage.

    The containment isolation and RCS depressurization succeed. However reactor cavity flooding, and firewater injection to the spray header fails to operate due to software CCF. Recovery of CCWS fails and therefore results in containment failure. The frequency of this cutset is 2.6E-09/RY and accounts for 2.7 % of LRF.

(4) LOCCW with reactor trip: EFWS succeeds. Both alternate CCW supply by the cooling tower and by the firewater system fails to operate and results 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 software CCF. Recovery of CCWS fails and therefore results in containment failure. The frequency of this cutset is 2.4E-09/RY and accounts for 2.5% of LRF

(5) LOCCW with reactor trip: This is the same as (4) 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 2.2E-09/RY and accounts for 2.2 % of LRF.

(6) 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 three hours fails and results in core damage.

The containment isolation before core damage succeeds. However, RCS depressurization fails due to loss of emergency ac power supply. Also reactor cavity flooding fails due to loss of electrical power after core damage. The recovery of power system succeeds. However CSS fails due to software CCF and results in containment failure. The frequency of this cutset is 1.8E-09/RY and accounts for 1.9 % of LRF.

(7) LOCCW with reactor trip: This is the same as (4) 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 succeed. However the containment fails due to some severe accident phenomenon. The frequency of this cutset is 1.7E-09/RY and accounts for 1.8 % of LRF.

(8) SLOCA with reactor trip: EFWS and SIS succeed. Therefore, core cooling succeeds. However, CSS fails. Also, the alternate containment cooling by containment fan cooler system fails to operate and results in containment failure before core damage. The frequency of this cutset is 1.3E-09/RY and accounts for 1.4 % of LRF.

(9) SGTR with reactor trip: EFWS and SIS succeed. However the isolation of the faulted SG fails. Also, high head injection flow fails to control and results in core damage..

This is the containment bypass. The frequency of this cutset is 1.3E-09/RY and accounts for 1.3 % of LRF.

(10) Reactor vessel 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 1.3 % of LRF.

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

The containment isolation, RCS depressurization, and reactor cavity flooding succeed. 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 1.2E-09/RY and accounts for 1.2% of LRF

(12) LOOP with reactor trip: This is the same as (6) until core damage.

The containment isolation before core damage succeeds. However, RCS depressurization fails due to loss of emergency ac 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 1.0E-09/RY and accounts for 1.1% of LRF

(13) LOOP with reactor trip: This is the same as (6) until core damage.

The containment isolation before core damage succeeds. However, RCS depressurization fails due to loss of emergency ac 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 1.0E-09/RY and accounts for 1.1% of LRF

(14) SLBO with reactor trip: FAB succeeds. Therefore, core cooling succeeds. However, containment heat removal, and the alternate containment cooling by containment fan cooler system fails to operate and results in containment failure before core damage. The frequency of this cutset is 1.0E-09/RY and accounts for 1.0 % of LRF.

The portion of each initiating event in the LRF is summarized in Table 19.1-43. This information is presented in the chart shown in Figure 19.1-10 with the percentage of total LRF.

Table 19.1-43 shows that six initiating events account for over 90 percent of the total LRF. These events are as follows:

- Loss of offsite power (LOOP)
- Small pipe break LOCA (SLOCA)
- Loss of component cooling water (LOCCW)
- Steam generator tube rupture (SGTR)
- Partial loss of component cooling water (PLOCW)
- Steam Line Break/Leak (Downstream MSIV: Turbine side) (SLBO)

The first four events account for 32.0%, 21.8%, 11.7% and 11.1% 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 19.1-44 and Table 19.1-45 respectively.

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

SGNBTSWCCF2 (CCF of group-2 application software) – This basic event applies to the operation of almost safety systems. If this software CCF occurs, almost safety systems such as SIS and CCS fail to start. 18% reduction from the current LRF is anticipated if the probability of this failure is set to 0.0.

EPSOO02RDG (Fail to connect the alternate ac power source to class 1E bus) – This basic event applies only to condition where loss of emergency ac power occurs after LOOP. If operators fail to connect the AAC power source to class 1E bus, SBO occurs. 17% 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 one hour) – This basic event applies only to condition where total loss of ac power occurs after LOOP. If offsite power does not recover within one hour under total loss of ac power condition, RCP seal LOCA is assumed to occur. 17% 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 three hours) – This basic event applies only to condition where total loss of ac power occurs after LOOP. If offsite power does not recover within three hours under total loss of ac power condition, core damage is assumed to occur due to RCP seal LOCA. 12% reduction from the current LRF is anticipated if the probability of this failure is set to 0.0.

RSSCF4MVOD145-ALL (CCF of CS/RHR HX discharge line motor operated valves to open) – This basic event applies to containment heat removal of the CS/RHR HX. If these valves fail to open, one of the systems for containment heat removal is lost. 12% 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:

RTPBTSWCCF (CCF of basic software)

The plant LRF would increase approximately 3.9E+05 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.

EPSCF4CBSO52STH-ALL (CCF of all circuit breaker between class 1E 6.9kV bus and class 1E station service transformer to spurious open)

The plant LRF would increase approximately 6.5E+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 class 1E 480V load centers.

EPSCF4CBSO52STL-ALL (CCF of all circuit breaker between class 1E station service transformer and class 1E 480V load center to spurious open)

The plant LRF would increase approximately 6.5E+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 class 1E 480V load centers.

SWSCF4PMYR-FF (CCF of all essential service water pump to run)

The plant LRF would increase approximately 6.3E+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 all CS/RHR HX to plug / foul)

The plant LRF would increase approximately 5.8E+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.

Common cause importance

The top 10 risk-important common cause basic events for a FV importance and for a RAW are given in Table 19.1-46 and Table 19.1-47, respectively.

The most significant CCF basic event based on FV importance is CCF of group-2 application software. 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 19.1-48 and Table 19.1-49, respectively.

The most significant human error basic event based on FV importance is **EPSOO02RDG (Fail to connect the alternate ac power source to class 1E bus)**, with a FV importance of 1.7E-01.

The most significant human error basic event based on RAW is **SGNOO04ICVR12 (Miscalibration of C/V pressure sensors A,B,C,D)**, with a RAW of 5.5E+01. The plant LRF would increase approximately 55 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 19.1-50 and Table 19.1-51, respectively.

Three 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 **EPSDLLRDGP2-L2**, which represent the failure of AAC GTG, with a FV importance of 3.1E-02.

There are top 10 basic events that have a RAW greater than 2.0E+03. The most significant single failure basic event is a rod injection failure. The plant LRF would increase approximately 2.8E+04 times if the probability of this failure were set to 1.0.

The top 15 dominant PDSs are given in Table 19.1-52. This table shows that 11 PDSs account for over 90 percent of the total LRF. These PDSs are as follows:

- 4K (Medium RCS pressure, and containment failure before core damage)
- 1D (Low RCS pressure, cavity not flooded, igniter functional, CSS not injected, and no containment heat removal)
- 3D (Low RCS pressure, cavity flooded before RV failure, igniter functional, CSS not injected, and no containment heat removal)
- 4L (SGTR)
- 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)
- 4H (Medium RCS pressure, cavity not flooded, igniter not functional, CSS not injected, and no containment heat removal)
- 3H (Low RCS pressure, cavity flooded before RV failure, igniter not functional, CSS not injected, and no containment heat removal)
- 6H (Medium RCS pressure, cavity flooded before RV failure, igniter not functional, CSS not injected, and no containment heat removal)

- 8A (High RCS pressure, cavity flooded after RV failure, igniter functional, CSS injected, and containment heat removal)
- 2I (Low RCS pressure, cavity flooded after RV failure, CSS injected, and containment not isolated)

The 4K accounts for 22.7% of the total LRF. This PDS is containment failure before core damage.

The 1D, 3D, 4D, 4H, 3H, and 6H account for 11.7%, 11.2%, 9.6%, 5.9%, 3.3%, and 3.1% of the total LRF, respectively. These PDSs involve loss of containment heat removal. Therefore, containment cannot maintain its integrity.

The 4L accounts for 10.3% of the total LRF. This PDS is containment bypass.

The 3A accounts for 6.5% 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 8A accounts for 2.8% of the total LRF. This PDS is success of containment isolation, containment heat removal, reactor cavity flooding after 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.

The 2I accounts for 2.8% of the total LRF. This PDS is containment isolation 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 1.9E-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 9.7E-08/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 – 2.3E-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 3.6.

Modeling uncertainty consists of key assumptions and key decisions that are made in developing the model. Table 19.1-53 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 alternate 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.

The beyond design basic aircraft impact assessment for the US-APWR in accordance with 10 CFR 50.150 is discussed in Appendix 19A.

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 Figure 19.1-12. 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 Table19.1-54 for HCLPF values of structures and categories of components, and Table19.1-55 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 Table19.1-56.

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 Table19.1-56. 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, the SSC HCLPF values will be confirmed that they are greater or equal to the review level earthquake PGA.

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 focused 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.

Step 8 has not been applied in this fire PRA for the reasons described below.

- In Step 8, the methodology how to revise the compartment fire frequency and execute the screening of ignition sources by reviewing the location of ignition sources with respect to the targets is provided. This is undertaken to reduce the level of effort for the detailed analysis (Step 11). However, this task has conservatively been skipped because it is impossible to performed plant walk down for the design stage plant.
- A portion of Step 11, in which the method of giving the credit for the function of mitigating fire adverse effects to the fire detection and suppression system is provided, has been skipped, and the credit of those has not been taken.

Regarding Step 12, HRA has been performed for screening stage (Step 7).

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 19.1-57 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 has 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 has 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 source 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 criterion is given in Table 7-2 of NUREG/CR-6850 as:

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

The second criterion 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 result, 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 result, 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 Table19.1-58. 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 Switchyard 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 means 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 Table19.1-59. 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/RY.

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 be 6.0E-05.

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 random failure.
- Operator may fail to connect the emergency power bus to AAC by the human error.
- Reactor has the potential to cause the loss of all power supplies of safety systems

The CDF of this fire scenario is 1.2E-06/RY and account for 67.0% of total CDF. The LRF of this scenario 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 be 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/RY.

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

The CDF of this scenario is 1.0E-07/RY and account for 5.6% of total CDF. The LRF of this scenario 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/RY.

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 be 6.0E-05.

Fire scenario is as follows:

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

The CDF of this scenario is 8.4E-08/RY and account for 4.7% of total CDF. The LRF of this scenario 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 class 1E 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 be approximately 1.4E-03.

FA4-101(Auxiliary building) fire

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/RY.

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) such as EFWS and ECCS. Therefore, CCDP of this fire scenario is low; and has been estimated to be 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 CDF of this scenario is 4.6E-08/RY and account for 2.6% of total CDF. The LRF of this scenario is 1.8E-09/RY and accounts for 0.8% of total LRF.

<u>FA2-205 (D class 1E electrical room) fire</u>

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/RY.

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 has 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 two steam generators. CCDP of this fire scenario is low; and has been estimated to be 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 random failure, and it may result in loss of Secondary system cooling.
- 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 CDF of this scenario is 4.6E-08/RY and account for 2.6% of total CDF. The LRF of this scenario is 1.3E-08/RY and accounts for 5.7% of total LRF.

The reason why the CDF of FA2-205 fire scenario is higher than those of FA2-203 and FA2-204 fire scenarios is the difference in CCDPs quantified based on the availability of mitigation function for fire-induced initiating events. The fire compartment of FA2-205 contains the control cables of turbine bypass valves whose spurious opening may cause SLBO. The fire compartments of FA2-203 and FA2-204 contain the control cables of MSRV (main steam relief valves) whose spurious opening may cause SLBI. The SLBI caused by spurious opening of MSRV can be prevented by closing the dedicated main steam relief valve isolation valve. However, the SLBO caused by spurious opening of turbine bypass valves cannot be isolated. The CCDP of SLBO is greater than the CCDP of SLBI, and therefore, the CDF of FA2-205 is two orders of magnitude higher than those of FA2-203 and FA2-204.

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/RY.

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 has the potential to damage A-train mitigation system function of metal clad switchgear 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 two steam generators. CCDP of this fire scenario is low; and has been estimated to be 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 random failure, and it may result in loss of secondary system cooling.
- 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 CDF of this scenario is 4.4E-08/RY and account for 2.5% of total CDF. The LRF of this scenario is 1.0E-08/RY and accounts for 4.5% of total LRF.

The reason why the CDF of FA2-202 fire scenario is higher than those of FA2-203 and FA2-204 fire scenarios is the same as the reason described in FA2-205 fire scenario.

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/RY.

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 be 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 random failure or failure of support system such as ESWS.
- Operator may fail to connect emergency feedwater system to EFW pit, and it may result in the loss of secondary system cooling.
- 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 CDF of this scenario is 3.7E-08/RY and account for 2.1% of total CDF. The LRF of this scenario is 7.2E-09/RY and accounts for 3.2% of total LRF.

The reason why CDF of FA3-104 fire scenario is approximately three times higher than those of FA3-103 (B-class 1E GTG room) and FA3-109 (C-class 1E GTG room) fire scenarios is because the types of available EFW pumps are different. The A-EFW pump and the D-EFW pump are the turbine driven (T/D) pumps and the B-EFW pump and the C-EFW pump are the motor driven (M/D) pumps. The compartment fire in FA3-104 may impact one T/D EFW pump. The compartment fire in FA3-103 and FA3-109 may impact one M/D EFW pump individually. In both cases of the single compartment fire, two T/D EFW pumps and one M/D EFW pump would be available. The latter case (two T/D EFW pumps and one M/D pump are available) results in higher reliability of the EFW system than the former case (one T/D EFW pump and two M/D pumps are available) because the operation of M/D pumps requires many support systems such as HVAC, ESWS and essential chilled water system. Therefore the CCDP of FA3-104 fire scenario is approximately three times higher than those of FA3-103 and FA3-109 fire scenarios. As a result, CDF of FA3-104 fire scenario is approximately three times higher than those of FA3-103 and FA3-109 fire scenarios. Additionally, FA3-111 (D-class 1E GTG room) fire scenario has approximately same CDF with FA3-104.

<u>FA2-205-M-05 (Propagation from FA2-205 to FA2-206) fire</u>

This fire scenario is the fire propagation from FA2-205 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. FA2-206 contains cables of C-train mitigation system. Fire ignition frequency of FA2-205 is 2.3E-03/RY.

FA2-205 contains the cables of safety depressurization valve, and FA2-206 contains safety depressurization valve isolation valve. This fire scenario has the potential to cause spurious opening of both valves due to the control cable damage, and it may result in SLOCA. The fire scenario also has the potential to damage D-train of metal clad switchgear, control center and dc control center, and it may result in loss of C and D-trains mitigation functions. The fire scenario also damages the control cables of accumulator outlet valve or nitrogen line isolation valve of every accumulator, and it may result in loss of accumulator function. CCDP of this fire scenario is low; and has been estimated to be 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.
- If safety injection system becomes unavailable by random failure or failure of support system such as ESWS, reactor has the potential to cause core damage and large release.

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

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

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

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

Postulated fire scenario is as follows.

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

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

The CDF of FA1-101-17 (NW quadrant of C/V 3F) fire scenario is approximately two orders of magnitudes higher than those of other symmetrical quadrants in CV 3F areas.

It is because that feed and bleed would be unavailable by the effects of transient fire in FA1-101-17. Both power cables for safety depressurization valves A and B are installed in FA1-101-17, but those cables are not installed in other symmetrical quadrants of CV 3F areas.

Therefore, it is not possible to credit the feed and bleed to mitigate a transient event which would be caused by the transient fire in FA1-101-17. In case of fires that occur in other symmetrical quadrants of CV 3F areas, the availability of feed and bleed will not degrade. The unavailability of feed and bleed for the transient event is 3.8E-03. The CDF of FA1-101-17 fire scenario is approximately two orders of magnitudes higher than those of other quadrants' fire scenarios.

The top 10 cutsets of CDF including the above sequences are shown in Table 19.1-60. 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 19.1-61.

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

- All 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 Table 19.1-62 and Table 19.1-63, respectively. For CCF, Human error and Component importance, top 10 important events based on FV importance and RAW are shown in Table 19.1-64 through 19.1-69.

The most significant basic 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 one 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, three class 1E buses fail to be isolated from the faulted offsite power. Eventually, three class 1E buses will lose vital power. One class 1E 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, class 1E buses fail to be isolated from the faulted offsite power. Eventually, three safety buses will lose vital power. One class 1E 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 AAC gas turbine generator to class 1E 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 AAC power to class 1E 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 feed and bleed (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 has 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 one hour, RCP seal LOCA is assumed 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 incoming circuit breaker, and failure of operator action of connecting AAC GTG to class 1E bus have been identified as risk significant failures and human errors.

In transient scenario, turbine driven EFW pump, operator actions of opening the valve of EFW pit discharge cross tie-line and FAB have been identified as 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 grows and causes the functional damage of safety components. A sensitivity analysis has, therefore, been performed using failure 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. Using a failure probability of 0.1 for fire suppression system, CDF reduced to 10 percent.

A sensitivity analysis has also been performed 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 for cavity flooding after fire events. A sensitivity case has been performed assuming that the fire pumps can supply fire water to reactor cavity flooding system and spray header after core melt. If the firewater pump can be used, LRF will decrease by approximately 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

Internal fire PRA find out the following insights.

The total CDF value of fire PRA is almost equivalent to the total CDF value of Internal PRA. This is because the credit for mitigation function of fire detection and suppression system has not been taken in US-APWR fire PRA.

Most significant fire scenario is LOOP due to yard fire, and the next is SLBO (Turbine-bypass valve spurious open) due to FA6-101-01 (Turbine Building Other Floor) fire. CDF values of these fire scenarios are 70 percent of total CDFs.

The probability of cable hot-short due to fire damage was set to 1.0 conservatively. Despite of such assumption, the contribution to total fire risk of US-APWR was a little. That is because dominant fire initiating event was LOOP and other initiating events caused by the cable hot-short have not contributed significantly to the total fire risk.

Sensitivity analysis has been performed about the fire frequency of gas turbine, the fire mitigation probability of fire detection and suppression system, the probability of fire-induced cable hot-short occurrence, the probability of main control room evacuation due to fire and the effects of transient combustibles in inside containment areas. Except the effect of fire detection and suppression system, their effects were not so high.

Operator actions at remote shutdown console during main control room evacuation are the only human actions special to fire PRA. A sensitivity analysis has been performed conservatively using failure probability 1.0 to determine the effects of manual operation from remote shutdown console. As a result, changes in total value of fire induced CDF is small.

In situ combustibles inside containment vessel are not so much, and therefore, it has been conservatively assumed that transient materials are placed. It has been confirmed through the sensitivity analysis that the amount of combustible materials will not affect to the fire circumstances of fire compartments where redundant safety function have been installed.

The total LRF value of internal fire PRA is approximately twice of the total LRF value of internal events PRA. Additionally, although mitigation features are lost by the fire, CCFP (Conditional Containment Failure Probability) value of internal fire PRA remained in about 0.13 slightly larger than the CCFP value of internal events PRA.

Most significant fire scenario is LOOP due to yard fire, and the LRF value of this fire scenario is about 25 percent of total LRF of internal fire PRA. The second significant fire scenario is TRANS (general transient) due to FA1-101-17 (C/V 3F northwestern part floor zone) fire.

Sensitivity analysis has been performed about the fire protection water supply system as mitigation feature for severe accident. As a result, it has been confirmed that the LRF value of internal fire PRA is greatly decreased if the fire protection water supply system can be used.

Electrical room in turbine building has been divided to two fire compartments by the fire barrier. It has resulted in the reduction of the fire risk.

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. 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

n. Flooding from the ESW system is assumed to be isolated within 15 minutes. If the isolation is failed, flood water released from the ESWS is assumed to be propagated to other areas (including areas in the upper floors) in the east side (or west side) non-restricted area in the R/B. Flooding from the ESW system is assumed to be detectable using the leak detectors. The probability of ESWS flood without isolation within 15 minutes is judged to be very small, considering the flood frequency and failure probability of the leak detectors. The procedures would be provided by the time of fuel loading

o. 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 19.1-70. Fussell-Vesely importance and risk achievement worth are shown in Table 19.1-71 and Table 19.1-72 respectively. Importance of common cause failures, human errors and hardware failure are shown in Table 19.1-73 through 19.1-78. 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 19.1-79 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 19.1-80 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 19.1-81. Table 19.1-82 provides the assumed duration of the various POSs. Table 19.1-83 is a planned maintenance schedule created supposing the actual outage. The status of RCS penetrations and the availabilities of gravity injection and steam generators as mitigation functions are provided in Table 19.1-84.

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.

The reactivity insertion event due to boron dilution has been judged to be insignificant to risk because of the following factors:

- Strict administrative controls are in place to prevent boron dilution. When carrying out a boron dilution, the operator performs two operations: (1) changing from the automatic makeup mode to the dilution mode and (2) operating the start switch. Dilution cannot start unless both of these steps are performed. The requirement for two distinct actions reduces the likelihood of inadvertent dilution caused by operator action. For the US-APWR, planned boron dilutions are under strict administrative controls.
- The CVCS design inherently limits the maximum boron dilution rate so boron dilution transients proceed relatively slowly. The consequences of re-criticality are minor unless they continue for very long period of time. Boron dilution events are highly recoverable.

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.

Indications of temperature and water level are provided to detect unfavorable events that occur during shutdown. Indications are listed below.

- Indications of temperature

As for inaccurate hot leg temperature measurement after loss of decay heat removal, reactor coolant hot leg temperature instruments are located in the flow path during RHR operation, so this parameter can be accurately indicated.

- Indications of water

Three types of instruments are provided in US-APWR design to measure RCS water level for shutdown. The first one is narrow range water level instrument, the second one is mid range water level and the third one is wide range water level. Narrow range and mid range water level instruments that refer pressure at the bottom of cross over leg and pressurizer gas phase are provided to measure RCS water level during midloop operation.

Freeze plug may not be used 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. If the operable charging pumps fail, pumps that were locked out for low temperature overpressure (LTOP) compliance can be used if available.

  – 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. If the operable safety injection pumps fail, pumps that were locked out for low temperature overpressure (LTOP) compliance can be used if available.

  – 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.

<u>Loss of coolant accident (LOCA)</u>

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 which is caused by operator failure to close the isolation valve (RHS-MOV-025A/B/C/D) after draining the refueling cavity and full-flow test of the RHR pump, is assumed. This diversion can happen if the containment spray/residual heat removal pump full-flow test line stop valves (RHS-MOV-025A/B/C/D) 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 for the typical analysis case is 1 shutdown / 2 years = 0.5 events per year assuming a refueling shutdown scheduled every 24 months.

- 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-04/Y.

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. When a loss of RCS inventory event occurs, RCS water level is expected to be recovered by charging injection pump. The suction of this pump is VCT. When the level of VCT becomes low signal level, the suction of this pump automatically changes to RWSAT. If further loss of RCS inventory can be prevented, water volume in the RWSAT is enough to raise the level to enable operation of the standby RHR pump. Thus, this top event does not require RWSAT water makeup. 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. Before the accident, the suction of these pumps is VCT. When the level of VCT becomes low signal level, the suction of these pumps automatically changes to RWSAT. At this timing, with the low VCT level signal, the operator begins to prepare RWSAT water makeup. The operator will open manual valve VLV-026 and VLV-028 to establish the flow path from RWSP to RWSAT. As soon as the RWSAT low level signal is actuated, the operator starts the refueling water recirculation pump to make up 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. 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.

- 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 for the typical analysis case is 1 shutdown / 2 years = 0.5 events per year assuming a refueling shutdown scheduled every 24 months.

- The human error rate for OVDR is evaluated by THERP methodology. The failure probability is 3.0E-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:

$$[0.5 \times 3.0E\text{-}03 \times 2.5E\text{-}03] = 3.7E\text{-}06/Y.$$

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.

Loss of RHR caused by failing to maintain water level (FLML)

This sequence does not apply to POS 8-1.

This category is loss of RHR operation during mid-loop operation caused by loss of coolant inventory. Two sub-categories are considered. One is over-drain (OVDR) and another is failure to maintain water level (FLML).

If the charging injection system or the letdown line system fail and the low-pressure letdown isolation valve fail to close after RCS water level has decreased to the level of the RV nozzle center, FLML is assumed to occur. Since POS 4-1 and POS 8-1 is the beginning of mid-loop operation, and RCS water level is decreasing and is not kept constant, it is assumed that this FLML event is not applicable. On the other hand, in POS 4-2, POS 4-3, POS 8-2 and POS 8-3, FLML is considered as an initiating event.

The frequency of IE = (The probability of failure of charging injection system + the frequency of failure of letdown line) × The probability of automatic isolation failure of low-pressure letdown line

a. Frequency of plant shutdown for the typical analysis case is 1 shutdown / 2 years = 0.5 events per year assuming a refueling shutdown scheduled every 24 months.
b. The loss of charging injection system is evaluated by the fault tree. The failure frequency obtained from quantifying this FT is 4.5E-04. Assumptions applied during the quantification are as follows.
   - Charging pump A: running

- Charging pump B: out of service
- Supply to a charging pump is expected only from VCT.

c. As failure of the letdown line, the external leakage or spurious operation of components on the line from letdown line to VCT was assumed. The failure frequency obtained from quantification under this assumption is 7.5E-06.

d. Although the duration time of POS 4-2 is expected to be 12 hours, the evaluation is conservatively based upon 24 hours duration.

e. The failure probability of automatic isolation of low-pressure letdown line is evaluated by the fault tree. (Success Criteria is two out of two air-operated valves.) The failure probability obtained from quantifying this FT is 2.5E-03.

f. Therefore, the frequency of IE becomes the following.
= [0.5 x (4.5E-04 + 7.5E-06) × 2.5E-03] = 5.7E-07/Y

<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 for the typical analysis case is 1 shutdown / 2 years = 0.5 events per year assuming a refueling shutdown 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. 1.9E-05

Therefore, the frequency of loss of RHR caused by other failures during POS 8-1 is:

[0.5 x 1.9E-05] =9.5E-06/Y.

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.

<u>Loss of CCW/Essential service water (LOCS)</u>

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 year assuming a refueling shutdown scheduled every 24 months.

- 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/Y.

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.

<u>Loss of offsite power (LOOP)</u>

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 AAC power attempt to start up and supply ac power. If the gas turbines or AAC power fail to start or run for the required mission, decay heat removal is lost.

- The frequency of a LOOP is estimated as 1.96E-01/Y. This is the frequency of the LOOP per reactor year as described in Reference 19.1-41.

- Based on a POS 8-1 duration of 56 hours (Table 19.1-82), the probability of a LOOP during POS 8-1 is:

  1.96E-01 / 8760 × 56 = 1.25E-03

- The frequency of plant shutdown for the typical analysis case is 1 shutdown / 2 years = 0.5 events per year assuming a refueling shutdown scheduled every 24 months.

Therefore, the frequency of a LOOP during POS 8-1 is:

1.25E-03 x 0.5 = 6.2E-04/Y

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 AAC power

  If operation of the gas turbine generators fails, alternate power supply can supply the emergency power. The operation time of the alternate 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 six hours is taken as 0.91 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, one 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 19.1-85.

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 19.1-86 shows a summary of system unavailability of frontline systems. Table 19.1-87 shows a summary of system unavailability of support systems. LPSD initiating event frequencies are shown in Table 19.1-88.

Detailed accident sequence quantification was performed only for POS 8-1 and the results are shown in Table 19.1-89. The LPSD CDF for POS 8-1 is 6.0E-08/RY. The dominant accident sequences for POS 8-1 are given in Table 19.1-90. The top 50 component level failure combinations (cutsets) associated with these sequences is shown in Table 19.1-91.

The top seven accident sequences contribute 92 percent toward the Level 1 LPSD CDF in POS 8-1. These dominant sequences are as follows:

- 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 27 percent of the CDF

- LOCA initiating event, with success of isolation and failures of RCS injection, which contributes 27 percent of the CDF

- LOCS initiating event, with failure of injection to RCS using alternate component cooling, which contributes 12 percent of the CDF

- LOOP initiating event, with failure of the power supplying by all of ac power, which contributes 9.5 percent of the CDF

- LOCA initiating event, with success of isolation and RCS makeup and failure of RHRS and RCS injection, which contributes 6.1 percent of the CDF

- LORH initiating event, with failures of RCS injection, which contributes 5.9 percent of the CDF

- LOCA initiating event, with failures of isolation and RCS injection, which contributes 3.9 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- 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 event tree in Figure 19.1-20. In this sequence, power supply by the class 1E gas turbine generators succeeds to start and run automatically following the initiating event. The decay heat removal function by the SGs are unavailable since the SG nozzle lids are closed in POS 8-1. Gravitational injection is also unavailable because RCS is not under atmospheric pressure after loss of decay heat removal function. Failures of decay heat removal by the RHRS and injection to the RCS by charging pump and SI pumps occur and the core damaged. The major contributor to CDF is a combination of:

  - Operator fails to actuate RHRS (Basic event ID: RSSOO02P)

  - Operator fails to actuate SI pump (basic event ID: HPIOO02S-DP2)

  - Operator fails to actuate CVCS (basic event ID: CHIOO02P+RWS-DP3)

- LOCA with success of isolation and failure of RCS makeup

This is sequence #11 of the LOCA event tree in Figure 19.1-16. In this sequence, a LOCA event occurs in POS 8-1. The isolation of the source of the LOCA is successful. RCS makeup fails and decay heat removal by the RHRS fails. Decay heat removal by SGs and gravitational injection are both unavailable in POS 8-1. 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: CHIOO02P)

- Operator fails to actuate SI pump (basic event ID: HPIOO02S-DP2)

- LOCS initiating event, with failure of the alternate component cooling

  This is sequence #3 of the LOCS event tree in Figure 19.1-19. This sequence has a loss of CCW/essential service water initiator. The mitigation systems such as RHRS, SG, CVCS, and high head injection system that are supported by CCW/essential service water system are unavailable for this initiating event. 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)

- LOOP with failure of the power supplying by all of ac power

  This is sequence #37 of the event tree in Figure 19.1-20. This is station blackout sequence. Class 1E gas turbine generators and AAC gas turbine generators fail following the initiating event. The recovery of offsite power is not successful either. All mitigation systems that 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 with success of isolation and RCS makeup

This is sequence #6 of the LOCA event tree in Figure 19.1-16. 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. Decay heat removal function by the SGs and the gravitational injection are unavailable for the same reason described above. Consequently, failure of 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: RSSOO02LINE+P)
- Operator fails to actuate SI pump (basic event ID: HPIOO02S-DP2)
- Operator fails to actuate CVCS (basic event ID: CHIOO02RWS-DP3)

- LORH initiating event, with failures of RCS injection, which contributes 5.9 percent of the CDF

This is sequence #5 of the LORH event tree in Figure 19.1-18. In this sequence, the initiating event is followed by failures of charging pump and SI pumps to inject water to the RCS. Decay heat removal function by the SGs and the gravitational injection are unavailable for the same reason described above. Consequently, failures of injection to the RCS lead to core damage. The major contributor to CDF is a combination of:

- Operator fails to actuate SI pump (basic event ID: HPIOO02S)
- Operator fails to actuate CVCS (basic event ID: CHIOO02P+RWS-DP2)

- LOCA [loss-of-coolant accident] with failure of isolation and RCS makeup

This is sequence #15 of the LOCA event tree in Figure 19.1-16. In this sequence, 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 out of flow the RCS. 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: CHIOO02P+RWS-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. Table 19.1-91 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

The values of the reduction factors of each sequences are evaluated as described below.

- When there are more mitigation systems available than those in POS 8-1 and the number of the operator tasks including those of POS 8-1 (which are not successful) in the same sequence is two or less, the value of 0.1 is applied as the reduction factor. However, the combinations of ‘CV and GI’ or ‘GI and SC’ are exceptions and a value of 0.2 is applied. This is because these mitigation functions require refill of the RWST, and therefore, the dependency between these tasks are high.
- When there are more mitigation systems available than those in POS 8-1 and the number of the operator tasks including those of POS 8-1 (which are not successful) in the same sequence is three, the value of 0.2 is applied as the reduction factor. However, when the sequences that include combination of ‘CV and GI’ or ‘GI and SC’ are exceptions and a value of 0.5 is applied.

- When there are more mitigation systems available than those in POS 8-1 and the number of the operator tasks including those of POS 8-1 (which are not successful) in the same sequence is four, the value of 0.5 is applied as the reduction factor.

- The value of 1.0 is applied as the reduction factor when there are the same number of available mitigation systems as POS 8-1 or the number of the operator tasks which are not successful in the same sequence is five or more.

- Differences in available time for offsite power recovery are considered. Available time for offsite power recovery varies with POSs since decay heat generation and initial water level varies with POSs. For scenarios that take credit of offsite power recovery, the difference in failure probabilities of offsite power recovery compared to POS 8-1 is factored in the reduction factor.

CDFs of other POSs are given in Table 19.1-89. The overall estimate of CDF for all LPSD POSs is 2.2E-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 91 percent of the Level 1 shutdown core damage frequency of POS 3. These dominant sequences are as follows:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling, which contributes 60 percent of the CDF

- LOCA initiating event, with failures of leakage isolation and RCS injection, which contributes 17 percent of the CDF

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling, which contributes 13 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling

Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, gravitational injection is unavailable during this POS. Decay heat removal by SGs and injection to the RCS by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOCA initiating event, with failures of leakage isolation and RCS injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Gravitational injection is unavailable during this POS. Since isolation of LOCA has failed, decay heat removal via the SGs is also unavailable. Injection to the RCS by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation and decay heat removal via the SGs fail. Gravitational injection is unavailable during this POS. RCS injection by charging pump or SI pumps fails, and eventually, the core is damaged.

(POS 4-1)

The top seven accident sequences contribute 91 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 leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling, which contributes 32 percent of the CDF
- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of RHRS, secondary side cooling and RCS injection, which contributes 23 percent of the CDF
- LOOP initiating event, with no power recovery, which contributes 11 percent of the CDF
- LOCA initiating event, with failures of leakage isolation and RCS injection, which contributes 9 percent of the CDF
- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling, which contributes 7 percent of the CDF
- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of CCWS to restart and RCS injection using alternate component cooling, which contributes 5 percent of the CDF

- LOCS initiating event, with failure of RCS injection 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 leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling

  Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, gravitational injection is unavailable. Decay heat removal by SGs and injection to the RCS by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators followed by failures of RHRS, secondary side cooling and RCS injection

  Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. RHR operation and decay heat removal via SGs fail. Gravitational injection is unavailable during this POS. RCS injection by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOOP initiating event, with no power recovery

  This is a station blackout sequence. Class 1E gas turbine generators and AAC power supply fail following LOOP initiating event. Offsite power does not recover and all mitigation systems supported by ac power are unavailable. Eventually the core is damaged.

- LOCA initiating event, with failures of leakage isolation and RCS injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Gravitational injection is unavailable during this POS. Since isolation of LOCA has failed, decay heat removal via the SGs is also unavailable. Injection to the RCS by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation and decay heat removal via the SGs fail. Gravitational injection is unavailable during this POS. RCS injection by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of CCWS to restart and RCS injection using alternate component cooling

Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. CCWS fails to restart and loss of CCW occurs. Mitigation functions supported by CCWS are unavailable. Gravitational injection is unavailable during this POS. RCS injection by charging pump using the alternate component cooling system fails, and eventually, the 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 supported by CCWS are unavailable. (The SGs require HVAC of EFW system that is supported by essential service water). Gravitational injection is unavailable during this POS. RCS injection by charging pump using the alternate component cooling system fails, and eventually, the core is damaged.

(POS 4-2)

The top five 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 leakage isolation followed by failures of RCS make-up, RCS injection and gravity injection, which contributes 45 percent of the CDF
- LOOP initiating event, with no power recovery, which contributes 24 percent of the CDF
- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and gravity injection which contributes 10 percent of the CDF
- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of RHRS, RCS injection and gravity injection, which contributes 10 percent of the CDF
- LOCA initiating event, with failures of leakage isolation, RCS injection and gravity injection, which contributes 6 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up, RCS injection and gravity injection

  Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since an large opening exists in the RCS, decay heat removal via SGs is unavailable during this POS. Gravity injection and RCS injection by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOOP initiating event, with no power recovery

This is a station blackout sequence. Class 1E gas turbine generators and AAC power supply fail following LOOP initiating event. Offsite power does not recover and all mitigation systems supported by ac power are unavailable. Eventually the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and gravity injection

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation fails. Decay heat removal via SGs is unavailable during this POS. Gravity injection and RCS injection by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators followed by failures of RHRS, gravity injection and RCS injection

  Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. Decay heat removal via SGs is unavailable during this POS. Gravity injection and RCS injections by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOCA initiating event, with failures of leakage isolation, RCS injection and gravity injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Decay heat removal via the SGs is unavailable during this POS. Gravity injection and RCS injection by charging pump or SI pumps fail, and eventually, the core is damaged.

(POS4-3)

The top five accident sequences contribute 91 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 leakage isolation followed by failures of RCS make-up and RCS injection, which contributes 54 percent of the CDF
- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation and RCS injection, which contributes 12 percent of the CDF
- FLML initiating event, with success of the letdown line isolation and failures of RCS makeup and RCS injection, which contributes 10 percent of the CDF
- LOCA initiating event, with failures of leakage isolation and RCS injection, which contributes 8 percent of the CDF
- LOOP initiating event, with no power recovery, which contributes 7 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up and RCS injection

  Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, gravitational injection is unavailable during this POS. Decay heat removal by SGs is also unavailable during this POS since SG nozzles are closed or an opening exists in the RCS. RCS injection by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and gravity injection

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation fail. Decay heat removal via SGs is unavailable during this POS. Gravity injection and RCS injection by charging pump or SI pumps fail, and eventually, the core is damaged.

- FLML initiating event, with success of the letdown line isolation and failures of RCS makeup and RCS injection

  Isolation of letdown line succeeds and further draining is prevented. Since this initiating event is caused by malfunction of the CVCS, RCS makeup and RCS injection by the charging pump is assumed to be unavailable during this event. Gravitational injection and decay heat removal via SGs are unavailable during this POS. RCS injection by SI pumps fails, and eventually, the core is damaged.

- LOCA initiating event, with failures of leakage isolation and RCS injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Gravitational injection and is decay heat removal via the SGs are unavailable during this event. Injection to the RCS by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOOP initiating event, with no power recovery

  This is a station blackout sequence. Class 1E gas turbine generators and AAC power supply fail following LOOP initiating event. Offsite power does not recover and all mitigation systems supported by ac power are unavailable. Eventually the core is damaged.

(POS 8-2)

The top five accident sequences contribute 94 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 leakage isolation followed by failures of RCS make-up, RCS injection and gravity injection, which contributes 52 percent of the CDF
- LOOP initiating event, with no power recovery, which contributes 12 percent of the CDF
- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and gravity injection which contributes 12 percent of the CDF
- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of RHRS, RCS injection and gravity injection, which contributes 11 percent of the CDF
- LOCA initiating event, with failures of leakage isolation, RCS injection and gravity injection, which contributes 8 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up, RCS injection and gravity injection

  Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since an large opening exists in the RCS, decay heat removal via SGs is unavailable during this POS. Gravity injection and RCS injection by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOOP initiating event, with no power recovery

  This is a station blackout sequence. Class 1E gas turbine generators and AAC power supply fail following LOOP initiating event. Offsite power does not recover and all mitigation systems supported by ac power are unavailable. Eventually the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and gravity injection

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation fails. Decay heat removal via SGs is unavailable during this POS. Gravity injection and RCS injection by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators followed by failures of RHRS, gravity injection and RCS injection

  Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. Decay heat removal via SGs is unavailable during this POS.

Gravity injection and RCS injections by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOCA initiating event, with failures of leakage isolation, RCS injection and gravity injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Decay heat removal via the SGs is unavailable during this POS. Gravity injection and RCS injection by charging pump or SI pumps fail, and eventually, the core is damaged.

(POS 8-3)

The top five accident sequences contribute 91 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 leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling, which contributes 51 percent of the CDF
- LOCA initiating event, with failures of leakage isolation and RCS injection, which contributes 15 percent of the CDF
- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling, which contributes 11 percent of the CDF
- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of RHRS, secondary side cooling and RCS injection, which contributes 10 percent of the CDF
- LOCS initiating event, with failure of RCS injection 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 leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling

  Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, gravitational injection is unavailable. Decay heat removal by SGs and injection to the RCS by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOCA initiating event, with failures of leakage isolation and RCS injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Gravitational injection is unavailable during this POS. Since isolation of LOCA has failed, decay heat removal via the SGs is also unavailable. Injection to the RCS by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation and decay heat removal via the SGs fail. Gravitational injection is unavailable during this POS. RCS injection by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators followed by failures of RHRS, secondary side cooling and RCS injection

  Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. RHR operation and decay heat removal via SGs fail. Gravitational injection is unavailable during this POS. RCS injection by charging pump or SI pumps fails, and eventually, the 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 supported by CCWS are unavailable. (The SGs require HVAC of EFW system that is supported by essential service water). Gravitational injection is unavailable during this POS. RCS injection by charging pump using the alternate component cooling system fails, and eventually, the core is damaged.

(POS 9)

The top four accident sequences contribute 91 percent of the Level 1 shutdown core damage frequency of POS 9. These dominant sequences are as follows:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS makeup, RCS injection and secondary side cooling, which contributes 54 percent of the CDF
- LOCA initiating event, with failures of leakage isolation and RCS injection, which contributes 16 percent of the CDF
- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling, which contributes 12 percent of the CDF
- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of RHRS, secondary side cooling and RCS injection, which contributes 10 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling

  Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, gravitational injection is unavailable during this POS. Decay heat removal by SGs and injection to the RCS by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOCA initiating event, with failures of leakage isolation and RCS injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Gravitational injection is unavailable during this POS. Since isolation of LOCA has failed, decay heat removal via the SGs is also unavailable. Injection to the RCS by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation and decay heat removal via the SGs fail. Gravitational injection is unavailable during this POS. RCS injection by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators followed by failures of RHRS, secondary side cooling and RCS injection

  Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. RHR operation and decay heat removal via SGs fail. Gravitational injection is unavailable during this POS. RCS injections by charging pump or SI pumps fails, and eventually, the core is damaged.

(POS 11)

The top six accident sequences contribute 93 percent of the Level 1 shutdown core damage frequency of POS 11. These dominant sequences are as follows:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling, which contributes 29 percent of the CDF

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of RHRS, secondary side cooling and RCS injection, which contributes 23 percent of the CDF

- LOCS initiating event, with failure of RCS injection using alternate component cooling, which contributes 20 percent of the CDF
- LOCA initiating event, with failures of leakage isolation and RCS injection, which contributes 9 percent of the CDF
- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling, which contributes 7 percent of the CDF
- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of CCWS to restart and RCS injection using alternate component cooling, which contributes 5 percent of the CDF

The descriptions of the dominant sequences are provided in the following:

- LOCA initiating event, with success of leakage isolation followed by failures of RCS make-up, RCS injection and secondary side cooling

  Isolation of the source of LOCA is successful. RCS makeup fails, and the RHRS as a mitigation system cannot be restored. Since the RCS is not under atmospheric pressure after loss of decay heat removal function, gravitational injection is unavailable during this POS. Decay heat removal by SGs and injection to the RCS by charging pump or SI pumps fail, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators followed by failures of RHRS, secondary side cooling and RCS injection

  Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. RHR operation and decay heat removal via SGs fail. Gravitational injection is unavailable during this POS. RCS injections by charging pump or SI pumps fails, and eventually, the 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 supported by CCWS are unavailable. (The SGs require HVAC of EFW system that is supported by essential service water). Gravitational injection is unavailable during this POS. RCS injection by charging pump using the alternate component cooling system fails, and eventually, the core is damaged.

- LOCA initiating event, with failures of leakage isolation and RCS injection

  Isolation of the source of LOCA fails and the RHRS cannot be restored. Gravitational injection is unavailable during this POS. Since isolation of LOCA has failed, decay heat removal via the SGs is also unavailable. Injection to the RCS by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOCA initiating event, with success of leakage isolation and RCS makeup followed by failures of RHR operation, RCS injection and secondary side cooling

  Isolation of the source of LOCA and RCS makeup is successful. However, RHR operation and decay heat removal via the SGs fail. Gravitational injection is unavailable during this POS. RCS injection by charging pump or SI pumps fails, and eventually, the core is damaged.

- LOOP initiating event, with success of the power supply by Class 1E gas turbine generators and failures of CCWS to restart and RCS injection using alternate component cooling

  Power supply by Class 1E gas turbine generators succeeds following LOOP initiating event. CCWS fails to restart and loss of CCW occurs. Mitigation functions supported by CCWS are unavailable. Gravitational injection is unavailable during this POS. RCS injection by charging pump using the alternate component cooling system fails, and eventually, the 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 2.5E-07/RY, which is an increase of 14 percent in the base case CDF of 2.2E-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 3.5E-07/RY, which is an increase of 59 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 19.1-84.

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 Table 19.1-92. 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 case produces a CDF of 2.0E-07/RY, which is a decrease of 11 percent in the base case CDF. This result indicates that the assumption of the planned maintenance is not risk-important.

- Case 04: Frequency of outages

The PRA evaluates the LPSD risk from refueling outages scheduled every 24 months as a typical analysis case. Sensitivity studies were performed to evaluate the LPSD risk assuming different outage types and frequencies. The results and assumed conditions of the sensitivity cases are shown below.

Case	Shutdown frequency			LPSD CDF
	Refueling outages (Type C outage)	Forced outages with drain (Type B outage)	Forced outages without drain (Type C outage)	
Base case	0.5 /Y	-	-	2.2E-07 /RY
Case 04-1	0.67 /Y	-	-	2.9E-07 /RY
Case 04-2	0.5 /Y	0.5 /Y	0.29 /Y	3.4E-07 /RY
Case 04-3	0.5 /Y	0.05 /Y	1.5 /Y	3.6E-07 /RY

The first case, case 04-1, evaluates the LPSD risk assuming a shorter refueling outage cycle. If refueling outages are scheduled every 18 months, the shutdown frequency will be 0.67 per year and the CDF increases to 2.9E-07 /RY.

The second and third case, cases 04-02 and 04-3, evaluates the impact of forced outages to the LPSD risk. In the sensitivity analysis, forced outages with drain are assumed to involve POS 3, POS 4-1, POS 4-2, POS 9 and POS 11. Forced outages without drain are assumed to involve only POS 3 and POS 11.

Case 04-2 assumes force outages with drain to occur with a frequency of 0.5 per year. In this case, drained maintenance is performed once per year, either by refueling outage or forced outage. This gives a conservative condition for drained maintenance since US-APWR does not plan to perform steam generator inspection every year. The resulting CDF is 3.4E-07 /RY.

Case 04-3 assumes forced outages without drain to occur with a frequency of 1.5 per year. The total frequency of shutdown per year is approximately two in this sensitivity case. The resulting CDF is 3.6E-07 /RY.

- Case 05: 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 2.8E-08/RY, which is decrease of 87 percent in 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 06: All HEPs set to mean value

  In this sensitivity analysis, mean HEPs, rather than lower bound value, are applied for human actions that will have frequent training. The resulting CDF is 7.9E-07/RY, which is 3.5 times of base case CDF.

- Case 07: 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 9.4E-06/RY, which is approximately 43 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 08: 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 7.7E-08/RY, which is decrease of 65 percent in the base CDF. This indicates that assumption on dependency of human error provide meaningful sensitivity to result of PRA during shutdown.

- Case 09: Sensitivity to higher dependency of human error

  This sensitivity study evaluates impact of setting higher dependency level between operator actions, which assumes that changing window on display is not effective. That is, dependency level is considered to be performed in the same location.

This sensitivity produces a CDF of 4.8E-07/RY, which is approximately 22 times of the base case CDF.

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 Table19.1-93 and the RAW that value is greater than 2 is shown in Table19.1-94.

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 operators have failed to establish decay heat removal by the RHRS and via the SGs. If the operator fails to start the standby SI pumps, RCS injection function by the safety injection system is lost. The CDF of POS 8-1 is decreased by a factor of 58% if the probability of this failure is set to 0.0.

CHIOO02P+RWS-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 conditions where the operators have failed to establish decay heat removal by RHRS and also fails to establish RCS injection by SI pumps. If the operator fails to establish charging injection, RCS injection function by the charging pumps is lost. The CDF of POS 8-1 is decreased by a factor of 27% if the probability of this failure is set to 0.

RSSOO02P (Operator fails to start standby RHR pump (HE)) – This basic event applies to conditions where the power has recovered after LOOP initiating event.

If the operator fails to restart the RHR pumps, decay heat removal function by the RHRS is lost. The CDF of POS 8-1 is decreased by a factor of 24% if the probability of this failure is set to 0.0.

CHIOO02P (Operator fails to start standby charging pump (HE)) – This basic event applies to conditions where loss of RCS inventory due to LOCA or over-drain has 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 24% 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 to cool the charging pump, RCS injection function by charging pumps is lost. The CDF of POS 8-1 is decreased by a factor of 12% 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:

RTPBTSWCCF (CCF of basic software) – The CDF of POS 8-1 would increase approximately 3.7E+04 times if the probability of this failure were set to 1.0. If this failure occurs, all the mid-loop water level sensors will be inoperable and result in failure of automatic and manual actions that depend on the water level sensors.

SWSCF3PMYR001ABC-ALL (CCF of essential service water pumps A, B and C to run) – The CDF of POS 8-1 would increase approximately 1.2E+04 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.

CWSCF3PCYR001ABC-ALL (CCF of CCW pump A, B and C to run) – The CDF of POS 8-1 would increase approximately 1.2E+04 times if the probability of this failure were set to 1.0. This failure leads to loss of all CCW trains since CCW train D is unavailable due to the planned maintenance.

CWSCF3RHPF001ABC-ALL (CCF of CCW heat exchanger A, B and C plug) – The CDF of POS 8-1 would increase approximately 1.2E+04 times if the probability of this failure were set to 1.0. This failure leads to loss of all CCW trains since the CCW train D is unavailable due to the planned maintenance.

ACWCVEL306A (External leak from charging pump component cooling line inlet check valve NCS-VLV-306A) – The CDF of POS 8-1 would increase approximately 2.3E+03 times if the probability of this failure were set to 1.0. This failure results in loss of two CCW trains. If this failure occurs, charging injection will be unavailable. Additionally, the RHR pumps and SI pumps cooled by the CCWS train A or B will be unavailable due to loss of CCW.

Common-cause importance

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 Table 19.1-95 and the top 10 RAW is shown in Table 19.1-96.

The most significant CCF basic event based on FV importance is **EPSCF3DLLRDG-ALL**, which represents CCF of all emergency power generators, with a FV importance of 5.6E-2 . The second most significant CCF basic event is CCF of essential service water pumps.

The top four 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 19.1-97 and the top 10 RAW is shown in Table 19.1-98.

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 5.8E-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 **RSSOO02P (Operator fails to start standby RHR pump(HE))**, with a RAW of 9.7E+01. The CDF of POS 8-1 would increase approximately 97 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 19.1-99 and the top 10 RAW basic events are shown in Table 19.1-100.

There are only three single failure basic events that have a FV importance greater than 1.0E-02. The most significant single failure basic event based on FV importance is **EPSDLLRDGP1**, which represents the failure of AAC power generator to run, with a FV importance of 3.2E-02.

There are more than 35 basic events that have a RAW which value is approximately 2.3E+03. These are basics event that represent large external leak from components and piping of the CCWS. The CDF of POS 8-1 would increase approximately 2.3E+03 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 that is available for each POS and the importance results of POS 8-1. SSCs and operator actions that have been identified to be risk important in POS 8-1 were considered to be risk important in other POSs. SSCs and operator actions that have been credited in other POSs but not in POS 8-1 were also considered to be risk important. Important operator actions of POS 8-1 and other POSs are shown in Table 19.1-101 through 19.1-109. Important SSCs of POS 8-1 and other POSs are shown in Table 19.1-110 to Table 19.1-118. These results are used as the input to the reliability assurance program and human factor engineering. Quantification results of POS 8-1 have been considered applicable to identify SSCs (and operator actions) that are important to the overall LPSD risk for the reasons described below.

- POS 8-1 has the largest contribution to the total CDF during LPSD. SSCs that are important for POS 8-1 are important for the total LPSD risk.
- The initiating event that has the largest contribution to risk during POS 8-1 is LOCA and the initiating event that has the second largest contribution is loss of offsite power event. This tendency is the same in all other POSs. This implies that the risk profile is similar for all POSs.
- POS 8-1 has the least number of mitigation functions. POSs other than POS 8-1 have additional mitigation functions that are not available during POS 8-1 (e.g. RCS cooling by SGs and gravity injection). Since number of mitigation functions credited in the POS is equal or more than that of POS 8-1, the risk importance of SSCs quantified for POS 8-1 will have lower or similar values in other POSs. It is unlikely that SSCs that are below the quantitative thresholds in POS 8-1 to become risk important in other POSs.
- SSCs that are used for mitigation systems not credited in POS 8-1 may be risk important if all POS were quantified together. SSCs of mitigation functions unique to other POS are all included in the list of risk important SSCs to assure that the list includes all risk important SSCs.

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 9.3E-09/RY - 1.8E-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 1.8E-07/RY. The EF for the POS 8-1 CDF is 4.4. The point estimate CDF for POS 8-1 is 6.0E-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 2.2E-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 Table19.1-83. 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).

The fire-induced pathways and the method for isolating them against LOCA, OVDR and FLML are as below.

(1) The fire-induced pathways of LOCA and the method for isolation

The pathways and the method for isolation are as follows.

a. Spurious open of a safety depressurization Valve (SDV)

RCS operating conditions in POS 3 and 11 are under high pressure and high temperature. Therefore, the spurious open of a safety depressurization valve (SDV) due to fire will result in LOCA.

In this case, the isolation of LOCA pathway could be accomplished by closing the SDV isolation valve by operator manual action.

b. Flow diversion of reactor coolant to a holdup tank (spurious open of CVS-LCV-121A)

In POS 3, 9 and 11, reactor coolant will be extracted through RHRS and is fed to a volume control tank (VCT) by way of three-way valve “CVS-LCV-121A”. The extracted reactor coolant will be returned to RCS from VCT. However, reactor coolant will be fed to a holdup tank (HT) if CVS-LCV-121A is spuriously opened to HT due to the fire. Therefore, the fire-induced flow diversion of reactor coolant to HT will result in LOCA.

In this case, the isolation of LOCA pathway could be accomplished by automatic closing of RHS-AOV-024B and C.

The following LOCA will not be caused by the impact of fire.

a. Spurious open of SDV during the POSs except POS-3 and 11

In the POSs except POS-3 and 11, pressure and temperature are maintained at atmospheric pressure and 140°F respectively. Therefore, even if a SDV might open spuriously due to fire, reactor coolant will not flow out from RCS.

b. Flow diversion of reactor coolant to a holdup tank (HT) during the POSs except POS-3, 9 and 11

LOCA due to reactor coolant flow diversion to HT is identified and evaluated as an initiating event in POS 3, 9 and 11. In POS 4-1 and 8-1, OVDR is identified and evaluated as an initiating event. In POS 4-2, 4-3, 8-2, and 8-3, FLML is identified and evaluated as an initiating event.

c. RCP seal LOCA

In POS 3 and 11, seal injection flow or cooling water of CCWS to RCPs is required in order to ensure the RCP normal running. If both functions of seal injection and CCWS cooling will be failed concurrently by a fire, RCP seal LOCA will be occurred. However, US-APWR fire protection design prevents to cause such fire induced damage scenario.

d. LOCA caused by spurious open of RHS-MOV-025A (B, C, D)

LOCA scenario caused by spurious open of RHS-MOV-025A (B, C, D) due to human errors is included in Internal Event PRA model. However, such scenario by the spurious open of valves is not considered in the fire PRA. The reason that such scenario is not possible due to the fire is as follows.

- It is expected that spurious opening of RHS-MOV-025 A (B, C, D) will not occur even if the control circuit of these valves might be damaged by fire. This is because the mal-opening of these valves will be prevented administratively by the key-locked control of control circuit at MCC (Motor Control Center).
- Inter-cable hot shorts of the power cables which run from MCC to the location of RHS-MOV-025A (B, C, D) will be prevented by installing each cable in independent metal conduit. Therefore, spurious opening of RHS-MOV-025A (B, C, D) due to the inter-cable hot short of three-phase power supply will not occur.

(2) The fire-induced pathways of OVDR and the method for isolation

The fire-induced pathways and the method for isolation are as follows.

a. Spurious open of CVS-PCV-104

In POS 4-1, and 8-1, the letdown flow rate will increase if fire causes spurious open of the flow control valve “CVS-PCV-104” on the letdown line. In this case, RCS water level will decrease to lower level than mid-loop water level. This results in OVDR.

b. Failure of changing the flow pathway by the valve "CVS-LCV-121A"

In POS 4-1 and 8-1, pathway of three-way valve “CVS-LCV-121A” is opened to HT. If fire would cause the failure of three way valve function to switch-over the flow pathway to VCT, reactor coolant will continue to be fed to HT and RCS water level will decrease to the lower level than the mid-loop water level. This results in OVDR.

In both cases, the isolation of OVDR pathway could be accomplished by automatic closing of RHS-AOV-024B and C.

(3) The cause of FLML and the method for isolation

The causes of FLML are the increase of letdown flow or loss of charging flow. Details of causes of FLML and method for isolation are as follows.

a. Increase of letdown flow

- Spurious control of CVS-PCV-104

In POS 4-2, 4-3, 8-2 and 8-3, the letdown flow will increase if fire causes spurious open of the flow control valve “CVS-PCV-104” on the letdown line. In this case, RCS water level will decrease to lower level than mid-loop water level. This results in FLML.

- Flow diversion of reactor coolant to a holdup tank (HT)

In POS 4-2, 4-3, 8-2 and 8-3, reactor coolant will be extracted through RHRS and is fed to a volume control tank (VCT) by way of three-way valve “CVS-LCV-121A”. The extracted reactor coolant will be returned to RCS from VCT. However, reactor coolant will be fed to a holdup tank (HT) if CVS-LCV-121A is spuriously opened for HT due to the fire. Therefore, the fire-induced flow diversions of reactor coolant to HT will result in FLML.

b. Loss of charging flow

- Spurious open of CVS-LCV-121B or CVS-LCV-121C

In POS 4-2, 4-3, 8-2 and 8-3, water flow to supply to charging pumps will be lost if either valve of CVS-LCV-121B or CVS-LCV-121B installed on volume control tank outlet is closed spuriously due to the fire. Also the injection flow to RCS will be lost. In this case, RCS water level will decrease to lower level than mid-loop water level. This results in FLML.

- Spurious trip of a charging pump

In POS 4-2, 4-3, 8-2 and 8-3, injection flow to RCS will be lost if the fire causes the trip of charging pump spuriously. In this case, RCS water level will decrease to lower level than mid-loop water level. This results in FLML.

- Spurious closing of MOV/AOV on charging line

In POS 4-2, 4-3, 8-2 and 8-3, injection flow to RCS will be lost if fire causes the closure of MOV or AOV on charging line spuriously. In this case, RCS water level will decrease to lower level than mid-loop water level. This results in FLML.

In these cases, the isolation of FLML pathway could be accomplished by automatic closing of RHS-AOV-024B and C.

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-08/RY. The uncertainty range for the POS 8-1 is 1.5E-09 – 6.3E-08/RY for the 5% to 95% interval. CDFs of other POSs by bounding analysis are lower than CDF of POS 8-1. 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 Table19.1-83. 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. The uncertainty range for the POS 8-1 is 4.2E-10/RY – 6.8E-08/RY for the 5% to 95% interval. CDFs of other POSs by bounding analysis are lower than CDF of POS 8-1. Important SSCs for internal flood at LPSD are RHR, CCWS and supporting power supply systems. Risk from internal flood at LPSD has been 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 insights and assumptions are summarized in Table 19.1-119.

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 site-specific PRA models and results in the COLA phase will be utilized to support elements of the reactor oversight process including the mitigating systems performance index and the significance determination 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: 1.0E-06/RY
- Internal fire: 1.8E-06/RY
- Internal flood: 1.4E-06/RY
- LPSD: 2.2E-07/RY

Based on SMA, the plant HCLPF value is 0.50 g.

LRFs were determined as follows:

- Internal events at power: 9.9E-08/RY
- Internal fire: 2.3E-07/RY
- Internal flood: 2.8E-07/RY
-
- LPSD: 2.2E-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	<u>Prevention</u> - 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	<u>Redundancy</u> - Independent four train design of RHRS is adapted to enhance reliability of RHR function. <u>Diversity</u> - As a countermeasure for loss of RHR, RCS makeup by gravity injection from spent fuel pit is available when the RCS in atmospheric pressure. <u>Prevention</u> - 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	<u>Physical separation</u> - 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	<u>Physical separation</u> - 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	EF (Note)	Reference
1	LLOCA	Large Pipe Break LOCA	1.2E-06	10	NUREG/CR-6928 (Reference19.1-16)
2	MLOCA	Medium Pipe Break LOCA	5.0E-04	10	NUREG/CR-6928
3	SLOCA	Small Pipe Break LOCA	3.6E-03	10	NUREG/CR-6928
4	VSLOCA	Very Small Pipe Break LOCA	1.5E-03	10	NUREG/CR-6928
5	SGTR	Steam Generator Tube Rupture	4.0E-03	-	NUREG/CR-6928
6	RVR	Reactor Vessel Rupture	1.0E-07	3	WASH-1400 (Reference19.1-22)
7	SLBO	Steam Line Break/Leak (Downstream MSIV : Turbine side)	1.0E-02	10	NUREG/CR-5750 (Reference19.1-46)
8	SLBI	Steam Line Break/Leak (Upstream MSIV : CV side)	1.0E-03	10	NUREG/CR-5750
9	FWLB	Feed-water Line Break	3.4E-03	10	NUREG/CR-5750
10	TRANS	General Transient	8.0E-01	3	NUREG/CR-6928
11	LOFF	Loss of Feed-water Flow	1.9E-01	3	NUREG/CR-6928
12	LOCCW	Loss of Component Cooling Water	2.4E-05	10	Fault tree Analysis
13	PLOCW	Partial Loss of Component Cooling Water	3.2E-03	10	NUREG/CR-6928
14	LOOP	Loss of Offsite Power	4.0E-02	3	NUREG/CR-6928
15	LOAC	Loss of Vital ac Bus	9.0E-03	3	NUREG/CR-6928
16	LODC	Loss of Vital DC Bus	1.2E-03	3	NUREG/CR-6928

Note; Error factors (EF) were set based on engineering judgment.

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

Supporting Systems (SSs) / Frontline Systems (FSs)			Essential Service Water System				Component Cooling Water System				Safety Chilled Water System (Safety-related)				Emergency Station Power Supply System (Safety-related)																Emergency Station Power Supply System (Non-safety)				Heating, Ventilating & Air Conditioning System																Instrument Air		Engineered Safety Features Actuation Signal							
			ESWS				CCWS				CWS(S)				Class 1E GTG/ AC6.9kv				AC480V				DC125V (Switchboard)				AC120V (I&C Panelboard)				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		IA		ECCS Actuation Signal				Containment Spray Actuation 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	P1	P2	P1	P2	A	B	C	D	A	B	C	D	A	B	C	D	B	C	A	D	A	B	A	B	C	D	A	B	C	D
Emergency Core Cooling System	Accumulator Injection System	A																	NA																																		NA							
		B																		NA																																		NA						
		C																			NA																																		NA					
		D																				NA																																		NA				
	Safety Injection System	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				
	Containment Spray / Residual Heat Removal System	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
	Containment Natural Convention Cooling System								X	X									X			X											X	X																											
Chemical and Volume Control System	Charging Injection System	A					X	X							X				2		2		X				X								†	†															NA									
		B							X	X								X	2		2					X				X							†	†																NA								
	Boric Acid Transfer	A																															X																				NA									
		B																																X																				NA								
Main Steam / Feedwater System	Emergency Feed water System	A																	X	X		X					X																						NA											
		B														X			X	X		X		X				X																			X													
		C															X		X		X	X			X				X																			X												
		D																	X		X	X								X																				NA										
	Main Steam line Isolation System	A																					X																												NA	NA								
		B																					X																												NA	NA								
		C																								X																									NA	NA								
		D																								X																									NA	NA								
	Main Steam Pressure Control System	A																	X	X			X	X																											NA	NA								
		B																	X	X			X	X																											NA	NA								
		C																			X	X			X	X																									NA	NA								
		D																			X	X			X	X																									NA	NA								
Reactor Coolant System	Pressurizer Pressure Control System	A																	1																																										
		B																			1																																								
Reactor Trip System & ESF System		I																									X																																		
		II																										X																																	
		III																											X																																
		IV																												X																															

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
1: 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)																Emergency Station Power Supply System (Non-safety)				Heating, Ventilating & Air Conditioning System																Engineered Safety Features Actuation Signal							
			ESWS				CCWS				CWS(S)				Class 1E GTG/ AC6.9kv				AC480V				DC125V (Switchboard)				AC120V (I&C Panelboard)				AC6.9 kV		AC480 V		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		ECCS Actuation Signal				Containment Spray Actuation 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	P1	P2	P1	P2	A	B	C	D	A	B	C	D	A	B	C	D	B	C	A	D	A	B	C	D	A	B	C	D
Essential Service Water System	ESWS	A					X				NA				X				X				X				X																								X							
		B						X				X				X				X				X				X																								X						
		C							X				X				X				X				X				X																								X					
		D								X				NA				X				X				X				X																								X				
Component Cooling Water System	CCWS	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	NA																NA				NA																												NA							
		B		X																X				X																												X						
		C			X																X				X																												X					
		D				NA																NA				NA																												NA				
Emergency Station Power Supply System	Class 1E GTG/ 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								X																				†															
		B														X								X																				†														
		C															X								X																				†													
		D																X								X																				†												
	DC125V (Switchboard)	A																	X																								†															
		B																		X																								†														
		C																			X																								†													
		D																				X																								†												
	AC120V (I&C Panelboard)	A																	X				X																				†															
		B																		X				X																				†														
		C																			X				X																				†													
		D																				X				X																				†												
Emergency Station Power Supply System (Non-safety)	AC6.9 kV	P1																																																									
		P2																																																									
	AC480V	P1																													X																												
		P2																														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)																Emergency Station Power Supply System (Non-safety)				Heating, Ventilating & Air Condition System																Engineered Safety Features Actuation Signal							
			ESWS				CCWS				CWS(S)				Class 1E GTG/ AC6.9kv				AC480V				DC125V (Switchboard)				AC120V (I&C Panelboard)				AC6.9 kV		AC480 V		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		ECCS Actuation Signal				Containment Spray Actuation 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	P1	P2	P1	P2	A	B	C	D	A	B	C	D	A	B	C	D	B	C	A	D	A	B	C	D	A	B	C	D
Heating, Ventilating & Air Condition System	Safeguard Component Area	A									NA								NA				NA				NA																								X							
		B										NA								NA				NA				NA																								X						
		C											NA								NA				NA				NA																								X					
		D												NA								NA				NA				NA																								X				
	Emergency Power Supply Area	A									NA								NA				NA				NA																								X							
		B										NA								NA				NA				NA																								X						
		C											NA								NA				NA				NA																								X					
		D												NA								NA				NA				NA																								X				
	Class 1E Electrical Room	A									NA								NA								NA																								X							
		B										NA								NA								NA																								X						
		C											NA								NA								NA																								X					
		D												NA								NA								NA																								X				
	Emergency Feedwater Motor-driven Pump Area	B										X								X								X																								X						
		C											X								X								X																								X					
	Emergency Feedwater Turbin-driven Pump Area	A									NA								NA								NA																								X							
		D												NA								NA								NA																								X				
Engineered Safety Features Actuation Signal	ECCS Actuation Signal	A																					X				X																															
		B																						X				X																														
		C																							X				X																													
		D																								X				X																													
	Containment Spray Actuation 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

Table 19.1-7 Dependencies between Initiating Events and Systems (Sheet 1 of 2)

Initiating Event	System dependant on the initiating event	Impact on system
Large Pipe Break LOCA	Accumulator system	A postulated breach in the cold leg piping can cause one train of the accumulator system to be unavailable. The PRA assumes one train (train A) of the accumulator system to be unavailable during this event.
	Containment spray / residual heat removal	Time available for the operators to initiate alternate core cooling is short. Alternate core cooling utilizing the RHRS is therefore assumed unavailable during this event.
	Power supply system	Time available for the operators to connect the AAC to Class 1E bus is short. It is assumed that AAC cannot be utilized to support power to the Class 1E bus during this event.
Medium Pipe Break LOCA	High head injection system	A postulated breach in the direct vessel injection line can cause on high head injection line to be unavailable. The PRA assumes one train (train A) of high head injection system to be unavailable during this event.
	Accumulator system	A postulated breach in the cold leg piping can cause one train of the accumulator system to be unavailable. The PRA assumes one (tank A) of the accumulator to be unavailable during this event.
	Containment spray / residual heat removal	A postulated breach in the cold leg piping can cause one RHRS train to be unavailable for alternate core cooling. The PRA assumes one train (train A) of the RHRS to be unavailable for alternate core cooling during this event.
Small Pipe Break LOCA	High head injection system	A postulated breach in the direct vessel injection line can cause on high head injection line to be unavailable. The PRA assumes one train (train A) of high head injection system to be unavailable during this event.
Very Small Pipe Break LOCA	None	
Steam Generator Tube Rupture	Systems Related to Secondary cooling	The faulted SG will be isolated and RCS heat cannot be removal via the faulted SG. The PRA assumes that SGTR occurs in loop A and heat removal via the faulted SG is unavailable during this event.

Table 19.1-7 Dependencies between Initiating Events and Systems (Sheet 2 of 2)

Initiating Event	System dependant on the initiating event	Impact on system
Reactor Vessel Rupture	Systems related to Core Injection	Catastrophic failure of the reactor vessel such that cooling cannot be maintained or recovered is assumed. The PRA assumes that none of the systems can mitigate this event.
Steam Line Break Down Stream MSIV	None	Heat removal from SGs can be performed if main steam isolation valves actuate.
Steam Line Break Upstream MSIV	Systems Related to Secondary cooling	Uncontrolled steam release occurs in the steam line where breach has occurred. The PRA assumes that heat removal via one of the SG (Loop A) is unavailable during the event.
Feedwater Line Break	Systems Related to Secondary cooling	Water supply to the SG associated with the faulted feedwater line is unavailable. The PRA assumes that heat removal via one of the SG (Loop A) is unavailable during the event.
General Transient	None	
Loss of Feedwater Flow	Main feedwater system	Main feedwater flow is unavailable by definition of the event. Heat removal via SGs utilizing main feedwater supply is unavailable during the event.
Loss of Component Cooling Water	Component cooling water system, Essential service water system	CCWS or ESWS is unavailable by definition. The PRA assumes that all trains of the CCWS and ESWS are unavailable during the event.
Partial Loss of Component Cooling Water	Component cooling water system, Essential service water system	One subtrain of the CCWS or ESWS is unavailable by definition of the event. The PRA assumes that two trains (train A and B) of the CCWS and ESWS are unavailable during the event.
Loss of Offsite Power	Power supply system	Offsite power is unavailable by definition of the event. The PRA assumes that offsite power is unavailable at the initial stage of this event.
Loss of Vital ac Bus	Emergency power supply system	One Class 1E 120 V ac bus is unavailable by definition of the event. The PRA assumes that all components supported by the faulted Class 1E 120 V ac bus (bus B) are unavailable during this event.
Loss of Vital dc Bus	Emergency power supply system	One Class 1E 125 V dc bus is unavailable by definition of the event. The PRA assumes that all components supported by the faulted Class 1E 125 V dc bus (bus A) are unavailable during this event.

Table 19.1-8 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 19.1-8 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)
Charging Injection System	
CHI	Failure of CIS (VSLOCA)
Boric Acid Transfer	
EBI	Failure of Boric Acid Transfer (ATWS)
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 19.1-8 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)
EFW	Failure of EFW (ATWS)
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)
PZS	Failure of Decompress RCS (ATWS)
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 19.1-8 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)
RTA1	Failure of Reactor Trip (LOOP)
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)
SCO1	Failure of RCP Seal Cooling (LOOP)
SCK	Failure of RCP Seal Cooling (PLOCW)

Table 19.1-8 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)
MTC	Moderator Temperature Coefficient
TTP	Failure of Turbine Trip (ATWS)
DEP	Failure of Equalization of RCS and Secondary Side Pressure (SGTR)

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 1 of 20)
Large Pipe Break LOCA (>8 inches)

Event Heading ID	Description	Node ID	Fault Tree Information (3)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
HIA	High head injection system	1	HPI-LL	HPI-LL	-
ACA	Accumulator system	1	ACC-0LL	ACC-0LL	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS-LL	-
CRC	CS/RHR (Alternate core cooling)	1	-	-	RSS-RHR-LL(1)
		2	-	-	ZZ0(1)
CXC	CS/RHR (Heat removal)	1	RSS-CSS-HR(2)	RSS-CSS-HR-LL	-
		2	RSS-RHR-HRLM(2)	RSS-RHR-HRLM-LL	-
FNA	Alternate containment cooling	1	NCC	NCC-LL	-

Note(1): CS/RHR (alternate core cooling) is conservatively assumed to be unavailable during this initiating event heading. The probability of basic event ”RSS-RHR-LL", which represents the failure of this function, is set as 1. The probability of basic event ”ZZ0", which represents the failure of this function, is set as 0.

Note(2): RSS-CSS-HR is the fault tree that represents failure of heat removal function for containment spray, while RSS-RHR-HRLM is the fault tree that represents failure of heat removal function by alternate core cooling.

Note(3): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 2 of 20) Medium Pipe Break LOCA (2 – 8 inches)

Event Heading ID	Description	Node ID	Fault Tree Information [3]		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
HIB	High head injection system	1	HPI-ML	HPI-ML	-
ACA	Accumulator system	1	ACC-0LL	ACC-0LL	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CRD	CS/RHR (Alternate core cooling)	1	RSS-RHR-LM	RSS-RHR-LM	-
CXC	CS/RHR (Heat removal)	1	RSS-CSS-HR[1]	RSS-CSS-HR	-
		2	RSS-RHR-HRLM[1]	RSS-RHR-HRLM	-
SRA	RCS depressurization by secondary side cooling	1	MSP-SL	MSP-SL	-
FNA1	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-ML-DP2[2]		-
		3	NCC-ML-DP3[2]		-

Note(1): RSS-CSS-HR is the fault tree that represents failure of heat removal function for containment spray, while RSS-RHR-HRLM is the fault tree that represents failure of heat removal function by alternate core cooling.

Note(2): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(3): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 3 of 20) Small Pipe Break LOCA (1/2 – 2 inches)

Event Heading ID	Description	Node ID	Fault Tree Information (3)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL	-
HIB	High head injection system	1	HPI-ML	HPI-ML	-
BLA	Safety depressurization valve	1	FAB	FAB	-
ACC	Accumulator system	1	ACC-0SL	ACC-0SL	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CRB	CS/RHR (Alternate core cooling)	1	RSS-RHR-SL	RSS-RHR-SL	-
CXB	CS/RHR (Heat removal)	1	RSS-CSS-HR(1)	RSS-CSS-HR	-
		2	RSS-RHR-HRSL(1)	RSS-RHR-HRSL	-
SRA	RCS depressurization by secondary side cooling	1	MSP-SL	MSP-SL	-
FNA2	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-SL-DP2(2)		-
		3	NCC-SL-DP3(2)		-
		4	NCC-SL-DP4(2)		-

Note(1): RSS-CSS-HR is the fault tree that represents failure of heat removal function for containment spray, while RSS-RHR-HRSL is the fault tree that represents failure of heat removal function by alternate core cooling.

Note(2): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(3): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 4 of 20)
Very Small Pipe Break LOCA (<1/2 inches)

Event Heading ID	Description	Node ID	Fault Tree Information (3)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL	-
CHI	Charging injection	1	CHI-VS	CHI-VS	-
HIF	High head injection system	1	HPI-SL	HPI-SL	-
		2			-
BLA	Safety depressurization valve	1	FAB	FAB	-
ACC	Accumulator system	1	ACC-0SL	ACC-0SL	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CRB1	CS/RHR (Alternate core cooling)	1	RSS-RHR-SL	RSS-RHR-SL	-
CXB1	CS/RHR (Heat removal)	1	RSS-CSS-HR(1)	RSS-CSS-HR	-
		2	RSS-RHR-HRSL(1)	RSS-RHR-HRSL	-
SRA1	RCS depressurization by secondary side cooling	1	MSP-SL	MSP-SL	-
FNA5	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-VS-DP2(2)		-
		3	NCC-VS-DP3(2)		-
		4	NCC-VS-DP4(2)		-

Note(1): RSS-CSS-HR is the fault tree that represents failure of heat removal function for containment spray, while RSS-RHR-HRSL is the fault tree that represents failure of heat removal function by alternate core cooling.

Note(2): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(3): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 5 of 20)
Steam Generator Tube Rupture [1/2]

Event Heading ID	Description	Node ID	Fault Tree Information [9]		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
HIC	High head injection system	1	HPI-SL	HPI-SL	-
EFC	Heat removal via SGs	1	EFW-SG	EFW-SG	-
SGI	Isolation of faulted SG	1	MSP-OS	MSP-OS	-
DEP	Equalize RCS and secondary side pressure	1	DEP-SG	DEP-SG	-
SRB	RCS depressurization by secondary side cooling	1	MSP-SG-DP1[1]	MSP-SG	-
PZR	RCS depressurization by SDV	1	PZR-SGT-DP1[2]	PZR-SGT	-
HT	Injection control	1	HIT-SG-DP1[3]	HIT	-
CRA	CS/RHR (RHR operation)	1	RSS-RHR-SG-DP1[4]	RSS-RHR-SG	-
BLA1	Safety depressurization valve	1	FAB	FAB	-
		2	FAB-SG-DP2[5]		-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CXD	CS/RHR (Heat removal)	1	RSS-CSS-HR[6]	RSS-CSS-HR	-
		2	RSS-RHR-HRSG-DP2[6] [7]	RSS-RHR-HRSG	-
FNA8	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-SG-DP2[8]		-
		3	NCC-SG-DP3[8]		-

Note(1): This fault trees is the same with “MSP-SG” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): This fault trees is the same with “PZR-SGT” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(3): This fault trees is the same with “HIT” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(4): This fault trees is the same with “RSS-RHR-SG” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(5): This fault trees is the same with “FAB” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(6): RSS-CSS-HR is the fault tree that represents failure of heat removal function for containment spray, while RSS-RHR-HRSG-DP2 is the fault tree that represents failure of heat removal function by RHR operation.

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 6 of 20)
Steam Generator Tube Rupture [2/2]

Note(7): This fault trees is the same with “RSS-RHR-HRSG” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(8): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(9): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 7 of 20) Steam Line Break Downstream MSIV

Event Heading ID	Description	Node ID	Fault Tree Information [2]		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
HIC	High head injection system	1	HPI-SL	HPI-SL	-
MSO	Main steam line isolation	1	MSR-O-00	MSR-O-00	-
EFB	Heat removal via SGs	1	EFW-SLBO	EFW-SLBO	-
BLA	Safety depressurization valve	1	FAB	FAB	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CXA	CS/RHR (Heat removal)	1	RSS-CSS-HR	RSS-CSS-HR	-
FNA6	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-SF-DP2[1]		-

Note(1): This fault trees is the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 8 of 20)
Steam Line Break Upstream MSIV

Event Heading ID	Description	Node ID	Fault Tree Information (2)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
HIC	High head injection system	1	HPI-SL	HPI-SL	-
MSI	Main steam line isolation	1	MSR-I-00	MSR-I-00	-
EFD	Heat removal via SGs	1	EFW-SB	EFW-SB	-
BLA	Safety depressurization valve	1	FAB	FAB	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CXA	CS/RHR (Heat removal)	1	RSS-CSS-HR	RSS-CSS-HR	-
FNA6	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-SF-DP2(1)		-

Note(1): This fault trees is the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 9 of 20) Feedwater Line Break

Event Heading ID	Description	Node ID	Fault Tree Information (2)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
HIC	High head injection system	1	HPI-SL	HPI-SL	-
MSI	Main steam line isolation	1	MSR-I-00	MSR-I-00	-
EFD	Heat removal via SGs	1	EFW-SB	EFW-SB	-
BLA	Safety depressurization valve	1	FAB	FAB	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CXA	CS/RHR (Heat removal)	1	RSS-CSS-HR	RSS-CSS-HR	-
FNA6	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-SF-DP2(1)		-

Note(1): This fault trees is the same with "NCC" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 10 of 20) General Transient

Event Heading ID	Description	Node ID	Fault Tree Information (3)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL	-
MFW	Main feed water recovery	1	MFW	MFW	-
FBA1	Feed and Bleed	1	HPI-FAB-TR-DP1(1)	HPI-FAB	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CXA	CS/RHR (Heat removal)	1	RSS-CSS-HR	RSS-CSS-HR	-
FNA4	Alternate containment cooling	1	NCC-TR-DP1(2)	NCC	-
		2	NCC-TR-DP2(2)		-

Note(1): This fault trees is the same with “HPI-FAB” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(3): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 11 of 20)
Loss of Feedwater Flow

Event Heading ID	Description	Node ID	Fault Tree Information (2)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL	-
FBA	Feed and bleed	1	HPI-FAB	HPI-FAB	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS	-
CXA	CS/RHR (Heat removal)	1	RSS-CSS-HR	RSS-CSS-HR	-
FNA3	Alternate containment cooling	1	NCC	NCC	-
		2	NCC-LF-DP2(1)		-

Note(1): This fault trees is the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 12 of 20)
Loss of Component Cooling Water

Event Heading ID	Description	Node ID	Fault Tree Information [2]		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL-LC	-
SRV	Stuck open safety valve LOCA	1	POV	POV	-
SCA	Alternate component cooling	1	ACW	ACW	-
SEL	RCP seal LOCA	1	-	-	RCP-SEAL[1]
		2	-	-	ZZ0[1]

Note(1):The probability of basic event ”RCP-SEAL", which represents the occurrence of RCP seal LOCA, is set as 1. The probability of basic event ”ZZ0", which represents the occurrence of RCP seal LOCA, is set as 0. Please refer to the description of 6A.14.2.

Note(2): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 13 of 20)
Partial Loss of Component Cooling Water [1/2]

Event Heading ID	Description	Node ID	Fault Tree Information (7)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL-PC	-
SRV	Stuck open safety valve LOCA	1	POV	POV	-
SCK	RCP seal cooling	1	SEC-PLOCW	SEC-PLOCW	-
SEL	RCP seal LOCA	1	-	-	RCP-SEAL(1)
		2	-	-	ZZ0(1)
HIC	High head injection system	1	HPI-SL	HPI-SL-PC	-
BLA	Safety depressurization valve	1	FAB	FAB	-
ACC	Accumulator system	1	ACC-0SL	ACC-0SL	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS-PC	-
CRB2	CS/RHR (Alternate core cooling)	1	RSS-RHR-SL	RSS-RHR-SL-PC	-
		2	RSS-RHR-SLPL-DP2(2)		-
CXB2	CS/RHR (Heat removal)	1	RSS-CSS-HR(3)	RSS-CSS-HR-PC	-
		2	RSS-RHR-HRSL(3)	RSS-RHR-HRSL-PC	-
		3	RSS-RHR-HRSLP-DP3(3) (4)		-
SRA2	RCS depressurization by secondary side cooling	1	MSP-SL	MSP-SL-PC	-
		2	MSP-SL-PL-DP2(5)		-
FNA7	Alternate containment cooling	1	NCC	NCC-PC	-
		2	NCC-PL-DP2(6)		-
		3	NCC-PL-DP3(6)		-
		4	NCC-PL-DP4(6)		-
		5	NCC-PL-DP5(6)		-
		6	NCC-PL-DP6(6)		-
		7	NCC-PL-DP7(6)		-

Note(1): The probability of basic event "RCP-SEAL", which represents the occurrence of RCP seal LOCA, is set as 1. The probability of basic event "ZZ0", which represents the occurrence of RCP seal LOCA, is set as 0. Please refer to the description of 6A.14.2.

Note(2): These fault trees are the same with "RSS-RHR-SL" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 14 of 20)
Partial Loss of Component Cooling Water [2/2]

Note(3): RSS-CSS-HR is the fault tree that represents failure of heat removal function for containment spray, while RSS-RHR-HRSL is the fault tree that represents failure of heat removal function by alternate core cooling.

Note(4): This fault trees is the same with “RSS-RHR-HRSL” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(5): These fault trees are the same with “MSP-SL” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(6): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(7): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 15 of 20)
Loss of Offsite Power [1/3]

Event Heading ID	Description	Node ID	Fault Tree Information [12]		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA1	Reactor trip	1	RTP-LO	RTP-LO	-
OPS	Emergency power source	1	OPS	OPS	-
ADG	Alternate ac power source	1	SDG	SDG	-
EFO	Heat removal via SGs	1	EFW-LO	EFW-LO-LP1 EFW-LO-LP2 EFW-LO-LP3	-
		2			
SRV	Stuck open safety valve LOCA	1	POV	POV	-
PRB	Offsite power recovery within one hour	1	-		OPS----PRBF[1]
		2	-		OPS----PRBS[1]
PRC	Offsite power recovery within three hour	1	-		OPS----PRCF[1]
		2	-		OPS----PRCS[1]
CWR	CCWS restart	1	CWS-R4[2]	CWS-R4-LP1 CWS-R4-LP2	-
		3			-
		2	CWS-R2[2]	CWS-R2	-
SCO1	RCP seal cooling	1	ACW	ACW-LP1 ACW-LP2	-
		3			-
		2	ACW-DP2[3]	ACW-LP2	-
SEL	RCP seal LOCA	1	-		RCP-SEAL[4]
		2	-		ZZ0[4]
HIK	High head injection system (with emergency power source (include AAC))	1	HPI-SL	HPI-SL	-
FBA2	Feed and Bleed	1	HPI-FAB[5]	HPI-FAB-LP1 HPI-FAB-LP2	-
		2	FAB[5]	FAB	-
		3	HPI-FAB-LP-DP3[5] [6]	HPI-FAB-LP2	-
ACC	Accumulator system	1	ACC-0SL	ACC-0SL	-

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 16 of 20)
Loss of Offsite Power [2/3]

Event Heading ID	Description	Node ID	Fault Tree Information (12)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS-LP1 RSS-CSS-LP2	-
CRB3	CS/RHR (Alternate core cooling)	1	RSS-RHR-SL	RSS-RHR-SL-LP1 RSS-RHR-SL-LP2	-
		2	RSS-RHR-SL-LP-DP2(7)	RSS-RHR-SL-LP2	-
CXB3	CS/RHR (Heat removal)	1	RSS-CSS-HR(8)	RSS-CSS-HR-LP1 RSS-CSS-HR-LP2	-
		2	RSS-RHR-HRSL(8)	RSS-RHR-HRSL-LP1 RSS-RHR-HRSL-LP2	-
		3	RSS-RHR-HRSL-LP-DP3(8) (9)	RSS-RHR-HRSL-LP2	-
SRA4	RCS depressurization by secondary side cooling	1	MSP-LO	MSP-LO-LP1 MSP-LO-LP2	-
		2	MSP-LO-DP2(10)	MSP-LO-LP2	-
FNA9	Alternate containment cooling	1	NCC	NCC-LP1 NCC-LP2	-
		2	NCC-LP-DP2(11)	NCC-LP1 NCC-LP2	-
		3	NCC-LP-DP3(11)	NCC-LP1 NCC-LP2	-
		4	NCC-LP-DP4(11)	NCC-LP1 NCC-LP2	-
		5	NCC-LP-DP5(11)	NCC-LP1 NCC-LP2	-
		6	NCC-LP-DP6(11)	NCC-LP2	-
		7	NCC-LP-DP7(11)	NCC-LP2	-
		8	NCC-LP-DP8(11)	NCC-LP2	-
		9	NCC-LP-DP9(11)	NCC-LP2	-

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 17 of 20)
Loss of Offsite Power [3/3]

Note(1): Please refer to the description of 6A.14.7.

Note(2): CWS-R4 is FT of failure of re-start of all CCWS pumps under success condition of emergency power source, and CWS-R2 is also FT of failure of re-start of two CCWS pumps under of success condition of AAC.

Note(3): This fault trees is the same with "ACW" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(4): The probability of basic event "RCP-SEAL", which represents the occurrence of RCP seal LOCA, is set as 1. The probability of basic event "ZZ0", which represents the occurrence of RCP seal LOCA, is set as 0. Please refer to the description of 6A.14.2.

Note(5): HPI-FAB is FT of both failures of SDV open and HHIS. FAB is FT of only failure of SDV.

Note(6): This fault trees is the same with "HPI-FAB" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(7): This fault trees is the same with "RSS-RHR-SL" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(8): RSS-CSS-HR is the fault tree that represents failure of heat removal function for containment spray, while RSS-RHR-HRSL is the fault tree that represents failure of heat removal function by alternate core cooling.

Note(9): This fault trees is the same with "RSS-RHR-HRSL" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(10): This fault trees is the same with "MSP-LO" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(11): These fault trees are the same with "NCC" except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(12): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 18 of 20)
Loss of Vital AC Bus

Event Heading ID	Description	Node ID	Fault Tree Information (3)		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL-AC	-
MFW	Main feed water recovery	1	MFW	MFW	-
FBA1	Feed and Bleed	1	HPI-FAB-TR-DP1(1)	HPI-FAB-AC	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS-AC	-
CXA	CS/RHR (Heat removal)	1	RSS-CSS-HR	RSS-CSS-HR-AC	-
FNA4	Alternate containment cooling	1	NCC-TR-DP1(2)	NCC-AC	-
		2	NCC-TR-DP2(2)		-

Note(1): This fault trees is the same with “HPI-FAB” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(3): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 19 of 20) Loss of Vital DC Bus

Event Heading ID	Description	Node ID	Fault Tree Information [3]		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
EFA	Heat removal via SGs	1	EFW-SL	EFW-SL-DC	-
MFW	Main feed water recovery	1	MFW	MFW	-
FBA1	Feed and Bleed	1	HPI-FAB-TR-DP1[1]	HPI-FAB-DC	-
CSA	CS/RHR (Containment spray)	1	RSS-CSS	RSS-CSS-DC	-
CXA	CS/RHR (Heat removal)	1	RSS-CSS-HR	RSS-CSS-HR-DC	-
FNA4	Alternate containment cooling	1	NCC-TR-DP1[2]	NCC-DC	-
		2	NCC-TR-DP2[2]		-

Note(1): This fault trees is the same with “HPI-FAB” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(2): These fault trees are the same with “NCC” except that human action dependencies with prior tasks in the accident scenario is taken into considered. Refer section 9.4 of chapter 9 for detail.

Note(3): See Attachment 6A

Table 19.1-9 Descriptions of Event Headings and Branches (Sheet 20 of 20)
Anticipated transient without scram

Event Heading ID	Description	Node ID	Fault Tree Information [1]		Basic Event ID
			Fault Tree Identifier	Fault Tree Analysis Case	
RTA	Reactor trip	1	RTP-MF	RTP-MF	-
TTP	Turbine trip	1	TTP	TTP	-
MTC	Moderator Temperature Coefficient	1	MTC	MTC	-
PZS	Pressurizer Safety Valve	1	PZS	PZS	-
EFE	Emergency Feed Water System	1	EFW-AT	EFW-AT	-
EBI	Boric Acid Transfer	1	EBI	EBI	-

Note(1): See Attachment 6A

Table19.1-10 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 19.1-11 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
Boric acid transfer	EBI

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 19.1-12 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	--	-	--

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 19.1-13 Mitigating systems for Safety Functions in each Initiating Event (Sheet 1 of 2)

Initiating Events	Plant Safety Functions				
	Reactivity Control	RCS Pressure Control	RCS Inventory Control	Decay Heat Removal Function	Containment Heat Removal and CI
Large Pipe Break LOCA	--	--	ACC＋HHIS	HHIS	CS/RHRS
Medium Pipe Break LOCA	--	--	ACC＋HHIS	HHIS	CS/RHRS
Small Pipe Break LOCA	RPS		HHIS	EFWS	CS/RHRS
Very Small Pipe Break LOCA	RPS		CVCS	EFWS	--
Reactor Vessel Rupture	--	--	--	--	--
Steam Generator Tube Rupture	RPS	MSRV or SDV	ISO or HHIS	EFWS	--
Steam Line Break Downstream MSIV	RPS	--	--	EFWS and ISO	--
Steam Line Break Upstream MSIV	RPS	--	--	EFWS and ISO	--
Feedwatar Line Break	RPS	--	--	EFWS and ISO	--
General Transient	RPS	--	--	EFWS or MFW	--
Loss of Feedwater Flow	RPS	--	--	EFWS	--
Loss of Component Cooling Water	RPS	--	HHIS	EFWS	CS/RHRS
Partial Loss of Component Cooling Water	RPS	--	HHIS With CCWS	EFWS	CS/RHRS With CCWS
Loss of Offsite Power	RPS	--	HHIS With ac power	EFWS	CS/RHRS With ac power
Loss of Vital AC Bus	RPS	--	--	EFWS or MFW	--
Loss of Vital DC Bus	RPS	--	--	EFWS or MFW	--
Anticipated Transient without Scram	RPS or DAS, CVCS+TTP	PRSV+EFWS	--	-	--

Table 19.1-13 Mitigating systems for Safety Functions in each Initiating Event (Sheet 2 of 2)

RPS: Reactor Protection System
CS/RHRS: Containment Spray/Residual Heat removal System
ISO: Isolation
ACC: Accumulators
EFWS: Emergency Feedwater System
DAS: Diverse Actuation System
HHIS: High Head Injection System
CVCS: Chemical and Volume Control System
PRSV: Pressurizer Safety Valves
MSRV: Main Steam Relief Valves
SDV: Safety Depressurization Valves
TTP: Turbine Trip

Table 19.1-14 Mitigating Systems for Safety Functions in each Alternate Operator Action

Alternative Operator Actions	Failed System	Plant Safety Functions					Notes
		Reactivity Control	RCS Pressure Control	RCS Inventory Control	Decay Heat Removal Function	Containment Heat Removal and CI	
Feed and bleed / Safety depressurization valve	Secondary Side Cooling	--	SDV	HHIS	HHIS and SDV		CS/RHR operation is required
CS/RHR (Alternate core cooling)	HHIS	--		CS/RHR	CS/RHR	CS/RHR	ACC operation is required
Alternate containment cooling	Containment Spray	--	--	--	CCW through the containment fan cooler unit	CCW through the containment fan cooler unit	
RCS depressurization by secondary side cooling	HHIS	--	EFWS and MSRV	--	EFWS and MSRV	--	
Preparation for RHR operation in SGTR	Isolation of Faulted SG	--	EFWS and MSRV and SDV and SI stop	CVCS	--	--	RHR operation is available
RCP seal cooling / Alternate component cooling	CCWS	--	--	--	--	--	Action to avoid RCP seal LOCA
Alternate ac power source	Emergency Power Generator	--	--	--	--	--	Action for support system recovery

RPS: Reactor Protection System
CS/RHRS: Containment Spray/Residual Heat removal System
ISO: Isolation
ACC: Accumulators
EFWS: Emergency Feedwater System
DAS: Diverse Actuation System
HHIS: High Head Injection System
CVCS: Chemical and Volume Control System
PRSV: Pressurizer Safety Valves
MSRV: Main Steam Relief Valves
SDV: Safety Depressurization Valves

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 1 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
1.1	To judge required number of safety injection pumps and accumulators for large and medium pipe break LOCA.	Hot leg 8 inch break	2	2	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	The results show that the core cooling can be maintained with only one(1) SI pump for 8 inch break. However, in consideration of large uncertainties of MAAP analysis for the short-term behavior in large pipe break LOCA, the success criteria for the number of accumulators are conservatively assumed two(2), which is also applied to medium pipe break LOCA. Regarding the success criteria for SI pumps, one(1) pump is assumed to be sufficient for medium pipe break LOCA and two(2) pumps are assumed to be necessary for large pipe break LOCA in consideration of uncertainties.
		Hot leg 8 inch break	2	1	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	
		Hot leg 8 inch break	2	0	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	
		Hot leg 8 inch break	1	2	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	
		Hot leg 8 inch break	1	1	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	
		Hot leg 8 inch break	1	0	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 2 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accum ulators	EFW pumps	CS pumps	Other measures		
1.1		Cold leg double ended guillotine break	2	2	-	-	-	WCOBRA/TRAC (M1.0) PCT=1763° F < 2200° F	
1.2	To judge required number of safety injection pumps and accumulators for DVI-line break LOCA.	Cold leg 4 inch break	1	2	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	The results show that the core cooling can be maintained with only one(1) SI pump for 4 inch break. DVI-line break LOCA should be distinguished from the normal medium pipe break LOCA because one(1) train of HHIS is not available for DVI-line break. However, the conclusion in the discussion in the No.1.1 analysis can be applied to the DVI-line break LOCA because two(2) accumulators and one(1) SI pump are conservatively sufficient for core cooling in DVI-line break LOCA.
		Cold leg 4 inch break	1	1	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	
		Cold leg 4 inch break	1	0	4	4	-	MAAP4.0.6 PCT=643° F < 1400° F	

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 3 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accum ulators	EFW pumps	CS pumps	Other measures		
1.3	To judge the necessity of SG cooling by EFW for medium and small pipe break LOCA.	Hot leg 4 inch break	1	2	0	4	-	MAAP4.0.6 PCT=640° F < 1400° F	The results show that the cooling of SG secondary side with EFW is not necessary for LOCA whose break size is more than 2 inches. Therefore EFW is required only for LOCA whose break size is less than 2 inches.
		Hot leg 3 inch break	1	2	0	4	-	MAAP4.0.6 PCT=639° F < 1400° F	
		Hot leg 2 inch break	1	2	0	4	-	MAAP4.0.6 PCT=639° F < 1400° F	

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 4 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
1.4	To check the duration of time before core uncovers under the condition that high head injection is not available for LOCA, i.e. to judge the margin for time in implementing alternate core cooling and in offsite power recovery.	Hot leg 8 inch break	0	4	4	4	-	MAAP4.0.6 The duration of time before core uncovers is 30min. PCT > 1400° F	The results show that it takes about 30 minutes from onset of the accident before core uncovers even when 8 inch break occurs. This indicates that alternate core cooling is expected within 30 minutes. When RCP seal LOCA occurs after onset of SBO or LOCCW, etc., the analysis results show that it takes about 2 hours from onset of RCP seal LOCA before core uncovers even in the largest leak. This indicates that, after RCP seal LOCA occurs, offsite power recovery is expected within 2 hours.
		Hot leg 2 inch break	0	4	4	4	-	MAAP4.0.6 The duration of time before core uncovers is 1.3hr. PCT > 1400° F	
		Hot leg 1 inch break	0	4	4	4	-	MAAP4.0.6 The duration of time before core uncovers is 5.4hr. PCT > 1400° F	

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 5 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
1.4		Cold leg 480 gpm/loop leak	0	4	4	4	-	MAAP4.0.6 The duration of time before core uncovers is 2.4hr. PCT > 1400° F	
		Cold leg 300 gpm/loop leak	0	4	4	4	-	MAAP4.0.6 The duration of time before core uncovers is 3.9hr. PCT > 1400° F	

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 6 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
1.5	To judge effectiveness of coolant injection into RV using CS/RHR pumps with SG cooling as alternate core cooling for LOCA.	Hot leg 8 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 4 MSRVs @10min	MAAP4.0.6 PCT=643° F < 1400° F	The results show that the core cooling can be maintained with alternate core cooling using one(1) CS/RHR pump within 30 minutes when break size is less than 8 inches. For small size break, the secondary side cooling is necessary to make the coolant injection into RV effective. This is achieved by opening three(3) MSRVs. As described above, it can be concluded that the success criteria for alternate core cooling are one(1) CS/RHR pump and secondary side cooling by three(3) MSRVs within 30 minutes.
		Hot leg 8 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 4 MSRVs @30min	MAAP4.0.6 PCT=643° F < 1400° F	
		Hot leg 8 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 3 MSRVs @10min	MAAP4.0.6 PCT=643° F < 1400° F	
1.5		Hot leg 2 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 4 MSRVs @10min	MAAP4.0.6 PCT=639° F < 1400° F	

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 7 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
1.5		Hot leg 2 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 3 MSRVs @30min	MAAP4.0.6 PCT=639° F < 1400° F	
2.1	To judge required number of CS/RHR pumps and heat exchangers as containment spray injection for LOCA.	Hot leg double ended guillotine break	4	4	4	1	-	MAAP4.0.6 C/V pressure is at most about 50 psia < 216 psia (containment ultimate pressure)	The results show that containment heat removal can be maintained with one(1) containment spray pump without an excessive increase of containment pressure for any size of break. Therefore the success criteria for the number of containment spray pumps are evaluated to be one(1) for any accident sequences.
		Hot leg 8 inch break	4	4	4	1	-	MAAP4.0.6 C/V pressure is at most about 50 psia < 216 psia	
		Hot leg 2 inch break	4	4	4	1	-	MAAP4.0.6 C/V pressure is at most about 50 psia < 216 psia	

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 8 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
2.2	To check the duration of time before containment pressure exceeds the containment ultimate pressure under the condition that containment spray injection is not available for small pipe break LOCA, i.e. to judge the margin for time in implementing alternate containment heat removal.	Hot leg 2 inch break	4	4	4	0	-	MAAP4.0.6 The duration of time before the C/V pressure exceeds twice the containment design pressure is 25hr. C/V pressure > 216 psia (containment ultimate pressure)	The results show that it takes more than 24 hours from onset of the accident before the containment pressure exceeds twice the containment design pressure for accident sequences with any break size. Because the containment ultimate pressure is higher than twice the containment design pressure, the time to containment ultimate pressure has a longer duration. This indicates that alternate containment heat removal is expected within 24 hours or more.
		Hot leg 1 inch break	4	4	4	0	-	MAAP4.0.6 The duration of time before the C/V pressure exceeds twice the containment design pressure is 30hr. C/V pressure > 216 psia	

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 9 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
2.3	To judge effectiveness of coolant injection into RV using CS/RHR pumps as alternate containment heat removal for LOCA.	Hot leg double ended guillotine break	4	4	4	0	Alternate containment heat removal : 1 CS/RHR pump @30min	MAAP4.0.6 C/V pressure is at most about 40 psia < 216 psia (containment ultimate pressure)	The results show that the containment heat removal can be maintained without excessive increase in containment pressure. In the medium and large pipe break LOCA sequences, containment heat removal is achieved by coolant injection into RV using one(1) CS/RHR pump. In the small pipe break LOCA sequence, although coolant injection into RV using CS/RHR pumps is not available because RCS pressure keeps relatively high due to operation of HHI, containment heat removal is possible by secondary side cooling with four(4) MSRVs opened.
		Hot leg 8 inch break	4	4	4	0	Alternate containment heat removal : 1 CS/RHR pump and 4 MSRVs @30min	MAAP4.0.6 C/V pressure is at most about 40 psia < 216 psia	

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 10 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accum ulators	EFW pumps	CS pumps	Other measures		
2.3		Hot leg 2 inch break	4	4	4	0	Alternate containment heat removal : 1 CS/RHR pump and 4 MSRVs @30min	MAAP4.0.6 C/V pressure is at most about 40 psia < 216 psia	As discussed in the No.1.5 analysis, if SI pumps are not available, coolant injection into RV using CS/RHR must be effective even in small pipe break LOCA sequences. Therefore the alternate containment heat removal by coolant injection into RV is judged to be effective for any accident sequences.

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 11 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
3.1	To judge required number of EFW pumps and SGs to which water is fed by EFW for loss of feedwater flow.	Loss of feedwater flow	0	4	1 pump to 1 SG	0	-	MAAP4.0.6 PCT=669° F < 1400° F	The results show that the core does not uncover and that the core cooling can be maintained with only one(1) train of EFWS. When water is fed to three(3) SGs by opening the cross-tie of EFWS, the core also does not uncover. In consideration of large uncertainties of MAAP analysis for the RV downcomer water mixture model, the success criteria for the number of SGs to be fed are assumed two(2), which is also applied to other initiating events because loss of feedwater flow is the most severe of the initiating events that require secondary side cooling.
		Loss of feedwater flow	0	4	1 pump to 3 SGs (open cross-tie)	0	-	MAAP4.0.6 PCT=671° F < 1400° F	

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 12 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accum ulators	EFW pumps	CS pumps	Other measures		
3.2	To judge required number of EFW pumps and SGs to which water is fed by EFW for station blackout.	Station blackout	0	4	1 pump to 1 SG	0	-	MAAP4.0.6 PCT=672° F < 1400° F	The results show that the accident progression of station blackout is similar to that of loss of feedwater flow from the viewpoint of secondary side cooling and that the core cooling can be maintained with only one(1) train of EFWS. Considering uncertainty, the success criteria are conservatively assumed to be the same as in case of loss of feedwater flow.

Table19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 13 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accum ulators	EFW pumps	CS pumps	Other measures		
3.3	To check the duration of time before SGs are dried out under the condition that EFW is not available for loss of feedwater flow and station blackout, i.e. to judge the margin for time in implementing feed and bleed.	Loss of feedwater flow	0	4	0	0	-	MAAP4.0.6 The duration of time before core uncovers is 1.1 hr. PCT > 1400° F	The results show that it takes about 47 minutes and 1.1 hours from onset of the accident before SGs are dried out and before core uncovers, respectively, for loss of feedwater flow. The accident progression for station blackout is slower than for loss of feedwater flow from the analysis results. This indicates that there is sufficient time for implementing feed and bleed.
		Station blackout	0	4	0	0	-	MAAP4.0.6 The duration of time before core uncovers is 2.4 hr. PCT > 1400° F	

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 14 of 14)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
3.4	To judge effectiveness of feed and bleed for accident sequences without EFW.	Loss of feedwater flow	1	4	0	4	Feed and bleed : 1 SDV @SG dry out	MAAP4.0.6 PCT=1233° F < 1400° F	The results show that the core cooling can be maintained with the recovery of the water level in the core by implementing feed and bleed although the core uncovers temporarily before the RCS pressure decreases to the shut off pressure of HHI after the SDV opens. Therefore the success criteria for feed and bleed are assumed one(1) SDV and one(1) SI pump.

Table 19.1-16 List of Success Criteria (Sheet 1 of 26)
Large Pipe Break LOCA (>8 inches) Event Success Criteria

	Core injection function			Decay heat removal & containment heat removal function		
	Accumulator system	High head injection system	CS/RHR (Alternate core cooling)	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/3 ACCs(1)	2/4 SIPs (1)	-	1/4 CS/RHR pump and heat exchanger	-	-
2	2/3 ACCs(1)	2/4 SIPs (1)	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Note(1): RCS cold leg pipe break is assumed for large pipe break LOCA. Accumulator injection via the broken line is unavailable, and high head injection via DVI lines is available.

Note(2): Require operator action to change line-up to low pressure injection mode from CS/RHR(Containment spray) mode. For large pipe break LOCA, this mitigation system is assumed to be unavailable because there is not enough time to operate before core damage.

Table 19.1-16 List of Success Criteria (Sheet 2 of 26)
Medium Pipe Break LOCA (2 – 8 inches) Event Success Criteria

	Core injection function			Decay heat removal & containment heat removal function			
	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	RCS depressurization by secondary side cooling	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/3 ACCs(3)	1/3 SIP (1)	-	-	1/4 CS/RHR pump and heat exchanger	-	-
2	2/3 ACCs(3)	1/3 SIP (1)	-	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units
3	2/3 ACCs(3)	1/3 SIP (1)	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	1/3 CS/RHR pump and heat exchanger (3)	-
4	2/3 ACCs(3)	-	1/3 CS/RHR pump(3)	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	1/3 CS/RHR pump and heat exchanger (3)	-
5	2/3 ACCs(3)	-	1/3 CS/RHR pump(3)	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Note(1): DVI pipe break is assumed for high head injection system. High head injection via the broken line is unavailable.
Note(2): Require operator action to change line-up to low pressure injection mode from CS/RHR(Containment spray) mode.
Note(3): RCS cold leg pipe break is assumed for alternate core cooling and accumulator injection. Alternate core cooling and accumulator injection via the broken line is unavailable.

Table 19.1-16 List of Success Criteria (Sheet 3 of 26)
Small Pipe Break LOCA (1/2 – 2 inches) Event Success Criteria [1/3]

	Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	1/4 CS/RHR pump and heat exchanger	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	1/4 CS/RHR pump (3)	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	-	1/4 CS/RHR pump and heat exchanger (3)	-

Table 19.1-16 List of Success Criteria (Sheet 4 of 26) Small Pipe Break LOCA (1/2 – 2 inches) Event Success Criteria [2/3]

	Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling
4	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC (3)	-	1/4 CS/RHR pump (3)	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	-	1/4 CS/RHR pump and heat exchanger (3)	-
5	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC (3)	-	1/4 CS/RHR pump (3)	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units
6	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	-	-	1/2 SDV	1/4 CS/RHR pumps and heat exchangers	-	-

Table 19.1-16 List of Success Criteria (Sheet 5 of 26)
Small Pipe Break LOCA (1/2 – 2 inches) Event Success Criteria [3/3]

	Reactor trip	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling
7	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	-	-	1/2 SDV	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Note(1): DVI pipe break is assumed for high head injection. High head injection via the broken line is unavailable.
Note(2): Require operator action to change line-up to low pressure injection mode from CS/RHR(Containment spray) mode.
Note(3): Even if RCS cold leg pipe break is assumed for alternate core cooling and accumulator injection, alternate core cooling and accumulator injection via RCS cold leg pipe is available because of a little spilled water.

Table 19.1-16 List of Success Criteria (Sheet 6 of 26)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [1/4]

	Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP OR 1/2 CHP	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	1/4 CS/RHR pump and heat exchanger	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP OR 1/2 CHP	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 7 of 26)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [2/4]

	Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP OR 1/2 CHP	1/4 CS/RHR pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	-	1/4 CS/RHR pump and heat exchanger	-
4	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC	-	1/4 CS/RHR pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSRVs opened	-	-	1/4 CS/RHR pump and heat exchanger	-

Table 19.1-16 List of Success Criteria (Sheet 8 of 26)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [3/4]

	Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling
5	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC	-	1/4 CS/RHR pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/4 SGs and 3/4 EFWs pumps and 3/4 MSRV opened	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units
6	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	-	-	-	1/2 SDV	1/4 CS/RHR pump and heat exchanger	-	-

Table 19.1-16 List of Success Criteria (Sheet 9 of 26)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [4/4]

	Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling
7	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	-	-	-	1/2 SDV	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Note(1): Require operator action to change line-up to low pressure injection mode from CS/RHR(Containment spray) mode.

Table 19.1-16 List of Success Criteria (Sheet 10 of 26)
Steam Generator Tube Rupture Event Success Criteria [1/3]

	Condition		Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function			
	Isolation of faulted SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling (2) and RCS depressurization by SDV (3) and Injection control (4)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (5) and CS/RHR (Heat removal)	Alternate containment cooling
1	Succeeded	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-
2	Failed	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS	1/4 SIP	-	X	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	1/4 CS/RHR pump and heat exchanger	-

Table 19.1-16 List of Success Criteria (Sheet 11 of 26)
Steam Generator Tube Rupture Event Success Criteria [2/3]

	Condition		Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function			
	Isolation of faulted SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling (2) and RCS depressurization by SDV (3) and Injection control (4)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (5) and CS/RHR (Heat removal)	Alternate containment cooling
3	Failed	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS	1/4 SIP	1/2 SDV	X	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	1/4 CS/RHR pump and heat exchanger	-	-
4	Failed	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS	1/4 SIP	1/2 SDV	X	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 12 of 26)
Steam Generator Tube Rupture Event Success Criteria [3/3]

	Condition		Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function			
	Isolation of faulted SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling (2) and RCS depressurization by SDV (3) and Injection control (4)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (5) and CS/RHR (Heat removal)	Alternate containment cooling
5	Succeeded	Failed	66/69 control rods and 2/4 RPSs OR 1/1 DAS	1/4 SIP	1/2 SDV	-	-	1/4 CS/RHR pump and heat exchanger	-	-
6	Succeeded	Failed	66/69 control rods and 2/4 RPSs OR 1/1 DAS	1/4 SIP	1/2 SDV	-	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Note(1): Closing the following valves for faulted SG isolation, EFW isolation valve and {(main steam relief valve or main steam relief valve block valve) and (MSIV or turbine bypass valve) and main steam safety valve}.
Note(2): 1/3 SG and 1/3 EFW pumps and 1/3 MSRV opened, OR 1/3 SG and 1/4 EFW pumps and isolation valves of pump discharge tie-line opened and 1/3 MSRV opened
Note(3): 1/2 SDV
Note(4): 1/2 CHP and Injection control
Note(5): Requires operator action to change line-up to RHR operation mode

Table 19.1-16 List of Success Criteria (Sheet 13 of 26)
Steam Line Break Downstream MSIV Event Success Criteria

	Rector shutdown function	Decay heat removal function				Containment heat removal function	
	Reactor trip	Heat removal via SGs	Main steam line isolation	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/4 MSIVs closed	-	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and heat exchangers	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 14 of 26)
Steam Line Break Upstream MSIV Event Success Criteria

	Rector shutdown function	Decay heat removal function				Containment heat removal function	
	Reactor trip	Heat removal via SGs	Main steam line isolation	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/3 intact loop MSIVs closed OR 1/1 broken loop Main steam check valve closed	-	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and heat exchanger	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 15 of 26)
Feedwater Line Break Event Success Criteria

	Rector shutdown function	Decay heat removal function				Containment heat removal function	
	Reactor trip	Heat removal via SGs	Main steam line isolation	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	3/3 intact loop MSIVs closed OR 1/1 broken loop Main steam check valve closed	-	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and heat exchanger	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 16 of 26)
General Transient Event Success Criteria

	Rector shutdown function	Decay heat removal function		Decay heat removal function / Containment heat removal function	Containment heat removal function	
	Reactor trip	Feed and Bleed	Heat removal via SGs	Main feed water recovery	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and 1/4 MFW pump	-	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	-	1/4 CS/RHR pump and heat exchanger	-
4	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 17 of 26)
Loss of Feedwater Flow Event Success Criteria

	Rector shutdown function	Decay heat removal function		Containment heat removal function	
	Reactor trip	Heat removal via SGs	Feed and bleed	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP and 1/2 SDV	1/4 CS/RHR pump and heat exchanger	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP and 1/2 SDV	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 18 of 26)
Loss of Component Cooling Water Event Success Criteria

	Condition	Rector shutdown function	Core injection function	Decay heat removal function
	Stuck open safety valve LOCA(1)	Reactor trip	Alternate component cooling (Seal injection) (2)	Heat removal via SGs
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 CHP and 1/2 Fire protection water supply pump OR 1/1 Non-essential chilled water pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened

Note(1): Occurrence of stuck open safety valve LOCA during this initiating event is assumed to result in core damage.
Note(2): RCP seal LOCA is assumed to occur, when alternate component cooling fails.

Table 19.1-16 List of Success Criteria (Sheet 19 of 26)
Partial Loss of Component Cooling Water Event Success Criteria [1/3]

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA OR RCP seal LOCA (6)	Reactor trip	High head injection system(1) and Safety depressurization valve (2)	RCS depressurization by secondary side cooling(3) and Accumulator system(4) and CS/RHR (Alternate core cooling) (5)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-
2	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	X	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	1/4 CS/RHR pump and heat exchanger		

Table 19.1-16 List of Success Criteria (Sheet 20 of 26)
Partial Loss of Component Cooling Water Event Success Criteria [2/3]

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA OR RCP seal LOCA (6)	Reactor trip	High head injection system(1) and Safety depressurization valve (2)	RCS depressurization by secondary side cooling(3) and Accumulator system(4) and CS/RHR (Alternate core cooling) (5)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
3	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	X	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	2/4 CCWPs and 2/4 Containment fan cooler units
4	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	X	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	1/4 CS/RHR pump and heat exchanger	

Table 19.1-16 List of Success Criteria (Sheet 21 of 26)
Partial Loss of Component Cooling Water Event Success Criteria [3/3]

Note(1): 1/4 SIP
Note(2): 1/2 SDV
Note(3): 3/4 SG and 3/4 EFW pumps and 3/4 MSRV opened
Note(4): 1/4 ACC
Note(5): 1/4 CS/RHR pumps
Note(6): RCP seal LOCA is assumed to occur when RCP seal cooling by the stand-by charging pump fails.

Table 19.1-16 List of Success Criteria (Sheet 22 of 26)
Loss of Offsite Power Event Success Criteria [1/2]

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA or RCP seal LOCA (4)	Reactor trip	Feed and Bleed	RCS depressurization by secondary side cooling (1) and Accumulator system (2) and CS/RHR (Alternate core cooling) (3)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-
2	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	1/4 CS/RHR pump and heat exchanger		

**Table 19.1-16 List of Success Criteria (Sheet 23 of 26)
Loss of Offsite Power Event Success Criteria [2/2]**

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA or RCP seal LOCA (4)	Reactor trip	Feed and Bleed	RCS depressurization by secondary side cooling (1) and Accumulator system (2) and CS/RHR (Alternate core cooling) (3)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-
2	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	1/4 CS/RHR pump and heat exchanger		

Note(1): 3/4 SG and 3/4 EFW pumps and 3/4 MSRV opened
Note(2): 1/4 ACC
Note(3): 1/4 CS/RHR pumps
Note(4): RCP seal LOCA is assumed to occur when all CCW pumps fail to restart and alternate component cooling fails.

Table 19.1-16 List of Success Criteria (Sheet 24 of 26)
Loss of Vital AC Bus Event Success Criteria

	Core injection function	Decay heat removal & containment heat removal function			
	Feed and Bleed	Heat removal via SGs	Main feed water recovery	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-
2	-	-	2/4s SG and 1/4 MFW pump	-	-
3	1/4 SIP and 1/2 SDV	-	-	1/4 CS/RHR pump and heat exchanger	-
4	1/4 SIP and 1/2 SDV	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 25 of 26)
Loss of Vital DC Bus Event Success Criteria

	Core injection function	Decay heat removal & containment heat removal function			
	Feed and Bleed	Heat removal via SGs	Main feed water recovery	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pumps and isolation valves of pump discharge tie-line opened	-	-	-
2	-	-	2/4 SGs and 1/4 MFW pump	-	-
3	1/4 SIP and 1/2 SDV	-	-	1/4 CS/RHR pump and heat exchanger	-
4	1/4 SIP and 1/2 SDV	-	-	-	2/4 CCWPs and 2/4 Containment fan cooler units

Table 19.1-16 List of Success Criteria (Sheet 26 of 26)
Anticipated transient without scram Event Success Criteria

	Reactivity control				RCS Pressure Control	
	Reactor trip	Turbine trip	Moderator temperature coefficient	Boric acid injection	Pressurizer Safety Valves	Heat removal via SGs
1	2/4 RPSs and 66/69 control rods OR DAS and 66/69 control rods	-	-	-		-
2	-	2/4 RPSs and 4 /4 turbine stop valves OR DAS and 4 /4 turbine stop valves	MTC within allowable range(95% of fuel cycle)	1/2 Boric acid transfer pump and 1/2 charging pump	4/4 Pressurizer Safety Valves open	4/4 SGs with 4/4 EFW pumps

Table 19.1-17 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 19.1-17 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	
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.	
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.	
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	
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	
PMAD	Motor-Driven Pump (Standby) Fail to Start	β	1.5E-03 (/d)	0.9	6.0E+02	NUREG/CR-6928 Table 5-1	
PMEL	Motor-Driven Pump External Leak Large	γ	8.0E-09 (/h)	0.3	3.8E+07	NUREG/CR-6928 Table 5-1	
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	
PTAD	Turbine-Driven Pump (Standby) Fail to Start	β	7.0E-03 (/d)	0.4	5.7E+01	NUREG/CR-6928 Table 5-1	
PTEL	Turbine-Driven Pump External Leak Large	γ	9.0E-09 (/h)	0.3	3.3E+07	NUREG/CR-6928 Table 5-1	
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	
PDAD	Diesel-Driven Pump (Standby) Fail to Start	β	4.0E-03 (/d)	0.3	7.5E+01	NUREG/CR-6928 Table 5-1	
PDEL	Diesel-Driven Pump External Leak Large	γ	1.5E-08 (/h)	0.3	2.0E+07	NUREG/CR-6928 Table 5-1	
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	
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	
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	

Table 19.1-17 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 19.1-18 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 19.1-19 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 19.1-20 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)	2.7E-04
HPI-ML	Failure of SIS (1 OUT OF 3 DVI)	1.8E-04
HPI-SL	Failure of SIS (1 OUT OF 4 DVI)	1.5E-04
HPI-SL-LP1	Failure of SIS (LOOP:LOSS OF OFFSITE POWER)	2.0E-04
HPI-SL-LP2	Failure of SIS (LOOP)	1.5E-04
HPI-SL-PC	Failure of SIS (PLOCW)	4.7E-04
Charging Injection System		
CHI-VS	Charging Injection System (VSLOCA : EFW Success)	3.2E-04
CS/RHR System (CV Spray Injection)		
RSS-CSS	Failure of CV Spray Injection Mode (Other Initiating Events)	1.3E-04
RSS-CSS-AC	Failure of CV Spray Injection (LOAC)	1.5E-04
RSS-CSS-DC	Failure of CV Spray Injection (LODC)	1.6E-04
RSS-CSS-LL	Failure of CV Spray Injection (LLOCA)	1.4E-04
RSS-CSS-LP1	Failure of CV Spray Injection (LOOP:LOSS OF OFFSITE POWER)	1.9E-04
RSS-CSS-LP2	Failure of CV Spray Injection (LOOP)	1.3E-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)	2.1E-04
RSS-CSS-HR-AC	Failure of Heat Removal (LOAC)	2.4E-04
RSS-CSS-HR-DC	Failure of Heat Removal (LODC)	2.5E-04
RSS-CSS-HR-LL	Failure of Heat Removal (LLOCA)	2.2E-04
RSS-CSS-HR-LP1	Failure of Heat Removal (LOOP:LOSS OF OFFSITE POWER)	2.7E-04
RSS-CSS-HR-LP2	Failure of Heat Removal (LOOP)	2.1E-04
RSS-CSS-HR-PC	Failure of Heat Removal (PLOSW)	8.5E-04

Table 19.1-20 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)	7.8E-03
RSS-RHR-HRLM-LL	Failure of Heat Removal (LLOCA)	7.8E-03
RSS-RHR-HRSL	Failure of Heat Removal (Other Initiating Events)	7.7E-03
RSS-RHR-HRSL-LP1	Failure of Heat Removal (LOOP:LOSS OF OFFSITE POWER)	7.8E-03
RSS-RHR-HRSL-LP2	Failure of Heat Removal (LOOP)	7.7E-03
RSS-RHR-HRSL-PC	Failure of Heat Removal (PLOSW)	8.5E-03
CS/RHR System (Alternate Core Cooling)		
RSS-RHR-LM	Failure of Heat Removal (MLOCA)	7.7E-03
RSS-RHR-SG	Failure of Heat Removal (SGTR)	7.8E-03
RSS-RHR-SL	Failure of Heat Removal (Other Initiating Events)	7.6E-03
RSS-RHR-SL-LP1	Failure of Heat Removal (LOOP:LOSS OF OFFSITE POWER)	7.7E-03
RSS-RHR-SL-LP2	Failure of Heat Removal (LOOP)	7.6E-03
RSS-RHR-SL-PC	Failure of Heat Removal (PLOSW)	8.3E-03
CS/RHR System (RHR Operation)		
RSS-RHR-HRSG	Failure of Heat Removal (SGTR)	7.9E-03
Emergency Feed Water System (EFW)		
EFW-AT	Failure of EFW (ATWS)	9.5E-02
EFW-LO-LP1	Failure of EFW (LOOP)	6.7E-05
EFW-LO-LP2	Failure of EFW (LOOP: SBO and loss of AAC)	1.6E-03
EFW-LO-LP3	Failure of EFW (LOOP: Total Loss of ac Power)	1.6E-03
EFW-SB	Failure of EFW (SLB Inside CV)	4.1E-05
EFW-SG	Failure of EFW (SGTR)	4.1E-05
EFW-SL	Failure of EFW (Other Initiating Events Including General Transients and Loss of Main Feed Water)	3.1E-05
EFW-SL-AC	Failure of EFW (LOAC)	3.5E-04
EFW-SLBO	Failure of EFW (SLB Outside CV)	3.3E-04
EFW-SL-DC	Failure of EFW (LODC)	3.4E-05
EFW-SL-LC	Failure of EFW (LOCWS)	1.6E-03
EFW-SL-PC	Failure of EFW (PLOCW)	3.5E-04

Table 19.1-20 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		
PZR-FAB	Failure of Bleed operation (Other Initiating Events)	2.7E-03
PZR-SGT	Failure of Decompress RCS (SGTR)	6.3E-03
Alternate Containment Cooling		
NCC	Failure of Alternate Containment Cooling (Other Initiating Events)	3.4E-02
NCC-AC	Failure of Alternate Containment Cooling (LOAC)	3.4E-02
NCC-DC	Failure of Alternate Containment Cooling (LODC)	3.6E-02
NCC-LL	Failure of Alternate Containment Cooling (LLOCA)	3.4E-02
NCC-LP1	Failure of Alternate Containment Cooling (LOOP)	1.3E-01
NCC-LP2	Failure of Alternate Containment Cooling (LOOP: No breakdown)	3.3E-02
NCC-PC	Failure of Alternate Containment Cooling (PLOCW)	3.4E-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)	5.0E-02
Reactor Trip		
RTP-LO	Failure of Reactor Trip (LOOP)	1.0E-07
RTP-MF	Failure of Reactor Trip (Other Initiating Events)	1.5E-07
Main Steam isolation		
MSR-O-00	Failure of Main Steam isolation (SLBO)	6.3E-04
MSR-I-00	Failure of Main Steam isolation (SLBI, FWLB)	4.4E-08
Isolate Rupture SG		
MSP-OS	Failure of Isolate Rupture SG (SGTR)	2.1E-05

Table 19.1-20 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)	3.9E-05
Alternative GTG Power		
SDG	Failure of Alternative GTG Power (LOOP)	2.5E-02
Alternate CCW		
ACW	Failure of Alternate CCW	6.7E-03
ACW-LP1	Failure of Alternate CCW (LOOP)	8.2E-03
ACW-LP2	Failure of Alternate CCW (LOOP: Alternative GTG)	8.2E-03
SEC-PLOCW	Failure of Alternative GTG Power (LOCWS)	4.6E-03
CCW Re-Start		
CWS-R2	Failure of CCW Re-Start (Alternative GTG)	2.7E-02
CWS-R4-LP1	Failure of CCW Re-Start (LOOP)	2.2E-04
CWS-R4-LP2	Failure of CCW Re-Start (LOOP : No breakdown)	1.7E-04
Other Headings		
HIT	Failure of Injection Control (SGTR)	2.7E-02
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)	2.4E-05
TTP	Failure of Turbine Trip	1.0E-02
MTC	Moderator Temperature Coefficient	5.0E-02
PZS	Failure of Pressurizer Safety Valve Operation	1.0E-02
EBI	Failure of Boric Acid Transfer	2.6E-02

Table 19.1-21 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
Heating Ventilation and Conditioning System		
HVA-EFW-A	EFW area HVAC B Train	4.4E-02
HVA-EFW-B	EFW area HVAC C Train	8.9E-03
Component Cooling Water System		
CWS-00A	A Train	7.4E-04
CWS-00B	B Train	3.1E-02
CWS-00C	C Train	9.6E-04
CWS-00D	D Train	3.1E-02
CWS-VS-00A1	Charging Pump Cooling A Train	6.5E-05
CWS-VS-00C1	Charging Pump Cooling C Train	7.2E-05
Essential Service Water System		
SWS-01A	A Train	6.0E-04
SWS-01B	B Train	1.7E-02
SWS-01C	C Train	8.2E-04
SWS-01D	D Train	1.7E-02
S SIGNAL		
SGN-SA	A Train	1.1E-03
SGN-SB	B Train	1.1E-03
SGN-SC	C Train	1.1E-03
SGN-SD	D Train	1.1E-03
S SIGNAL (Manual DAS Failure)		
SGN-SA-DAS	A Train	7.2E-05
SGN-SB-DAS	B Train	7.2E-05
SGN-SC-DAS	C Train	7.2E-05
SGN-SD-DAS	D Train	7.2E-05
P SIGNAL		
SGN-PA	A Train	1.2E-03
SGN-PB	B Train	1.2E-03
SGN-PC	C Train	1.2E-03
SGN-PD	D Train	1.2E-03

Table 19.1-21 Summary of US-APWR Support System Fault Tree Failure Probabilities (Sheet 2 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
A (B-D) Class 1E 6.9kV Bus		
EPS-69KA	A Train	2.5E-05
EPS-69KB	B Train	2.4E-04
EPS-69KC	C Train	2.4E-04
EPS-69KD	D Train	2.5E-05
Non-Class 1E 6.9kV Bus		
EPS-69KA-P1	A Train (Power Source only AAC)	6.5E-02
EPS-69KD-P2	D Train (Power Source only AAC)	6.5E-02
A (B-D) Class 1E 480V Load Center Bus		
EPS-480A	A Train	4.5E-05
EPS-480B	B Train	2.6E-04
EPS-480C	C Train	2.6E-04
EPS-480D	D Train	4.5E-05
Non-Class 1E 480V Load Center Bus		
EPS-480A-P1	A Train (Power Source only AAC)	6.5E-02
EPS-480D-P2	D Train (Power Source only AAC)	6.5E-02
A1 (D1) Class 1E 480V Load Center Bus		
EPS-48A1	A1 Train	5.8E-05
EPS-48D1	D1 Train	5.8E-05
A (B-D) Class 1E 480V Motor Control Center Bus		
EPS-MCA	A Train	5.5E-05
EPS-MCB	B Train	2.7E-04
EPS-MCC	C Train	2.7E-04
EPS-MCD	D Train	5.5E-05
Non Class 1E 480V Motor Control Center Bus		
EPS-MCA-P1	A Train (Power Source only AAC)	6.5E-02
EPS-MCD-P2	D Train (Power Source only AAC)	6.5E-02
A1 (D1) Class 1E 480V Motor Control Center Bus		
EPS-MCA1	A1 Train	6.7E-05
EPS-MCD1	D1 Train	6.7E-05

Table 19.1-21 Summary of US-APWR Support System Fault Tree Failure Probabilities (Sheet 3 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
A (B-D) DC Switchboard		
EPS-SBA	A Train	5.8E-06
EPS-SBB	B Train	5.8E-06
EPS-SBC	C Train	5.8E-06
EPS-SBD	D Train	5.8E-06
EPS-SBA-P1	A Train (Power Source only AAC)	6.2E-06
EPS-SBD-P2	D Train (Power Source only AAC)	6.2E-06
A1 (D1) DC Switchboard		
EPS-SBA1	A Train	1.8E-05
EPS-SBD1	D Train	1.8E-05
MOV 480V MCC Bus		
EPSMVMC1A	A Train	6.2E-06
EPSMVMCB	B Train	6.3E-06
EPSMVMCC	C Train	6.2E-06
EPSMVMC1D	D Train	6.3E-06
I&C Penelboard		
EPS-VITALA	A Train	5.8E-06
EPS-VITALB	B Train	6.5E-06
EPS-VITALC	C Train	6.5E-06
EPS-VITALD	D Train	5.8E-06
I&C Penelboard (No VITAL POWER)		
EPS-VITALA-L	A Train	1.5E-04
EPS-VITALB-L	B Train	1.5E-04
EPS-VITALC-L	C Train	1.5E-04
EPS-VITALD-L	D Train	1.5E-04
Non-Class 1E 6.9kV Bus		
EPS-P1-69K	P1 Train	2.4E-04
EPS-P2-69K	P2 Train	2.4E-04
Non-Class 1E Load Center Bus		
EPS-P1-480	P1 Train	2.6E-04
EPS-P2-480	P2 Train	2.6E-04
Non-Class 1E 480V Motor Control Center Bus		
EPS-P11-MC	P11 Train	2.7E-04
EPS-P21-MC	P21 Train	2.7E-04

Table 19.1-22 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	3.3E-10	0.0%
MLOCA	Medium Pipe Break LOCA	1.6E-08	1.6%
SLOCA	Small Pipe Break LOCA	7.8E-08	7.6%
VSLOCA	Very Small Pipe Break LOCA	1.1E-09	0.1%
SGTR	Steam Generator Tube Rupture	1.1E-08	1.0%
RVR	Reactor Vessel Rupture	1.0E-07	9.7%
SLBO	Steam Line Break/Leak (Downstream MSIV : Turbine Side)	3.6E-08	3.5%
SLBI	Steam Line Break/Leak (Upstream MSIV : CV Side)	1.7E-10	0.0%
FWLB	Feedwater Line Break	6.0E-10	0.1%
TRANS	General Transient	1.9E-08	1.9%
LOFF	Loss of Feedwater Flow	2.6E-08	2.5%
LOCCW	Loss of Component Cooling Water	2.1E-07	20.5%
PLOCW	Partial Loss of Component Cooling Water	1.7E-08	1.6%
LOOP	Loss of Offsite Power	4.7E-07	45.2%
ATWS	ATWS	4.6E-08	4.5%
LOAC	Loss of Vital ac Bus	2.2E-09	0.2%
LODC	Loss of Vital dc Bus	6.7E-11	0.0%
TOTALS =		1.0E-06	

Table 19.1-23 Core Damage for At-Power Events – Conditional Core Damage Probability Given Initiating Event Occurrence

	Initiating Event	CDF (/RY)	Percent Contribution	Initiating Event Frequency (/RY)	CCDP
1	LOOP	4.7E-07	45.2%	4.0E-02	1.2E-05
2	LOCCW	2.1E-07	20.5%	2.4E-05	8.6E-03
3	RVR	1.0E-07	9.7%	1.0E-07	1.0E+00
4	SLOCA	7.8E-08	7.6%	3.6E-03	2.2E-05
5	ATWS	4.6E-08	4.5%	1.0E+00	4.6E-08
6	SLBO	3.6E-08	3.5%	1.0E-02	3.6E-06
7	LOFF	2.6E-08	2.5%	1.9E-01	1.4E-07
8	TRANS	1.9E-08	1.9%	8.0E-01	2.4E-08
9	PLOCW	1.7E-08	1.6%	3.2E-03	5.2E-06
10	MLOCA	1.6E-08	1.6%	5.0E-04	3.2E-05
11	SGTR	1.1E-08	1.0%	4.0E-03	2.7E-06
12	LOAC	2.2E-09	0.2%	9.0E-03	2.4E-07
13	VSLOCA	1.1E-09	0.1%	1.5E-03	7.1E-07
14	FWLB	6.0E-10	0.1%	3.4E-03	1.8E-07
15	LLOCA	3.3E-10	0.0%	1.2E-06	2.7E-04
16	SLBI	1.7E-10	0.0%	1.0E-03	1.7E-07
17	LODC	6.7E-11	0.0%	1.2E-03	5.7E-08
TOTAL		1.0E-06		2.1E+00	

Table 19.1-24 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 1 of 5)

Rank	Sequence ID	Sequence Name	Sequence Frequency (/RY)	Percent Contrib.	Percent Contrib. Total
1	19LOOP_C-0048	19LOOP_C-OPS-ADG-PRB-PRC-SEL	3.4E-07	32.9%	32.9%
2	15LOCCW-0003	15LOCCW-SCA-SEL	1.7E-07	15.9%	48.8%
3	07RVR-0001	07RVR-	1.0E-07	9.7%	58.5%
4	19LOOP_A-0004	19LOOP_A-CWR-SCO1-SEL	9.0E-08	8.7%	67.1%
5	15LOCCW-0006	15LOCCW-EFA-SEL	4.0E-08	3.8%	71.0%
6	03SLOCA-0027	03SLOCA-HIB-CSA-CRB	3.9E-08	3.8%	74.7%
7	14LOFF-0007	14LOFF-EFA-FBA	2.5E-08	2.4%	77.2%
8	10SLBO-0017	10SLBO-MSO-BLA	2.4E-08	2.3%	79.5%
9	20ATWS-0007	20ATWS-RTA-TTP	2.4E-08	2.3%	81.8%
10	13TRANS-0008	13TRANS-EFA-MFW-FBA1	1.7E-08	1.7%	83.4%
11	03SLOCA-0012	03SLOCA-HIB-SRA	1.2E-08	1.2%	84.6%
12	20ATWS-0004	20ATWS-RTA-EFE	1.2E-08	1.2%	85.8%
13	19LOOP_A-0048	19LOOP_A-EFO-FBA2	1.1E-08	1.1%	86.9%
14	03SLOCA-0003	03SLOCA-CXB-FNA2	1.0E-08	1.0%	87.9%
15	10SLBO-0028	10SLBO-HIC-MSO	8.8E-09	0.9%	88.7%
16	03SLOCA-0017	03SLOCA-HIB-CRB	7.9E-09	0.8%	89.5%
17	15LOCCW-0004	15LOCCW-SRV	6.8E-09	0.7%	90.1%
18	16PLOCW-0030	16PLOCW-SCK-SEL-HIC-CSA-CRB2-FNA7	6.6E-09	0.6%	90.8%
19	20ATWS-0006	20ATWS-RTA-MTC	6.2E-09	0.6%	91.4%
20	03SLOCA-0010	03SLOCA-CSA-CRB-FNA2	5.8E-09	0.6%	91.9%

Table 19.1-24 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 2 of 5)

Rank	Sequence ID	Sequence Name	Sequence Frequency (/RY)	Percent Contrib.	Percent Contrib. Total
21	19LOOP_C-0006	19LOOP_C-OPS-ADG-CWR-SCO1-SEL	5.8E-09	0.6%	92.5%
22	02MLOCA-0036	02MLOCA-HIB-CSA-CRD	5.4E-09	0.5%	93.0%
23	19LOOP_B-0005	19LOOP_B-OPS-CWR-SCO1-SEL	4.6E-09	0.4%	93.5%
24	03SLOCA-0028	03SLOCA-HIB-CSA-CRB-FNA2	4.3E-09	0.4%	93.9%
25	02MLOCA-0026	02MLOCA-HIB-CRD	4.2E-09	0.4%	94.3%
26	05SGTR-0010	05SGTR-SGI-HT	4.1E-09	0.4%	94.7%
27	19LOOP_C-0046	19LOOP_C-OPS-ADG-PRB-CWR-SEL	3.9E-09	0.4%	95.1%
28	19LOOP_B-0049	19LOOP_B-OPS-EFO-FBA2	3.5E-09	0.3%	95.4%
29	20ATWS-0003	20ATWS-RTA-EBI	3.2E-09	0.3%	95.7%
30	02MLOCA-0011	02MLOCA-ACA	3.2E-09	0.3%	96.0%
31	16PLOCW-0019	16PLOCW-SCK-SEL-HIC-CRB2	3.0E-09	0.3%	96.3%
32	16PLOCW-0082	16PLOCW-EFA-BLA	3.0E-09	0.3%	96.6%
33	05SGTR-0012	05SGTR-SGI-SRB	2.8E-09	0.3%	96.9%
34	05SGTR-0011	05SGTR-SGI-PZR	2.2E-09	0.2%	97.1%
35	21LOAC-0008	21LOAC-EFA-MFW-FBA1	2.1E-09	0.2%	97.3%
36	16PLOCW-0012	16PLOCW-SCK-SEL-CSA-CRB2-FNA7	1.9E-09	0.2%	97.5%
37	19LOOP_A-0042	19LOOP_A-SRV-CWR	1.9E-09	0.2%	97.6%
38	10SLBO-0016	10SLBO-MSO-CSA-FNA6	1.8E-09	0.2%	97.8%
39	19LOOP_A-0054	19LOOP_A-EFO-CWR-SEL	1.7E-09	0.2%	98.0%
40	19LOOP_D-0017	19LOOP_D-OPS-ADG-EFO-PRB-SEL	1.7E-09	0.2%	98.1%

Table 19.1-24 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 3 of 5)

Rank	Sequence ID	Sequence Name	Sequence Frequency (/RY)	Percent Contrib.	Percent Contrib. Total
41	13TRANS-0007	13TRANS-EFA-MFW-CSA-FNA4	1.6E-09	0.2%	98.3%
42	02MLOCA-0003	02MLOCA-CXC-FNA1	1.4E-09	0.1%	98.4%
43	20ATWS-0005	20ATWS-RTA-PZS	1.2E-09	0.1%	98.6%
44	19LOOP_B-0053	19LOOP_B-OPS-EFO-FBA2-CSA-FNA9	1.0E-09	0.1%	98.7%
45	04VSLOCA-0020	04VSLOCA-CHI-HIF-CSA-CRB1-FNA5	9.2E-10	0.1%	98.7%
46	19LOOP_B-0048	19LOOP_B-OPS-EFO-CSA-FNA9	8.7E-10	0.1%	98.8%
47	05SGTR-0009	05SGTR-SGI-CRA-BLA1	8.5E-10	0.1%	98.9%
48	10SLBO-0007	10SLBO-EFB-BLA	8.4E-10	0.1%	99.0%
49	02MLOCA-0021	02MLOCA-HIB-SRA	8.3E-10	0.1%	99.1%
50	02MLOCA-0010	02MLOCA-CSA-CRD-FNA1	8.0E-10	0.1%	99.1%
51	16PLOCW-0029	16PLOCW-SCK-SEL-HIC-CSA-CRB2	6.0E-10	0.1%	99.2%
52	02MLOCA-0037	02MLOCA-HIB-CSA-CRD-FNA1	5.9E-10	0.1%	99.3%
53	16PLOCW-0014	16PLOCW-SCK-SEL-HIC-SRA2	5.4E-10	0.1%	99.3%
54	05SGTR-0018	05SGTR-EFC-BLA1	5.2E-10	0.05%	99.4%
55	16PLOCW-0087	16PLOCW-EFA-HIC	4.6E-10	0.04%	99.4%
56	12FWLB-0007	12FWLB-EFD-BLA	4.4E-10	0.04%	99.5%
57	13TRANS-0012	13TRANS-EFA-MFW-FBA1-CSA-FNA4	4.1E-10	0.04%	99.5%
58	14LOFF-0006	14LOFF-EFA-CSA-FNA3	4.0E-10	0.04%	99.5%
59	03SLOCA-0043	03SLOCA-EFA-BLA	3.1E-10	0.03%	99.6%
60	14LOFF-0011	14LOFF-EFA-FBA-CSA-FNA3	3.0E-10	0.03%	99.6%

Table 19.1-24 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 4 of 5)

Rank	Sequence ID	Sequence Name	Sequence Frequency (/RY)	Percent Contrib.	Percent Contrib. Total
61	01LLOCA-0021	01LLOCA-HIA-CRC	2.9E-10	0.03%	99.6%
62	19LOOP_C-0087	19LOOP_C-OPS-ADG-SRV-PRB	2.3E-10	0.02%	99.6%
63	16PLOCW-0005	16PLOCW-SCK-SEL-CXB2-FNA7	2.3E-10	0.02%	99.7%
64	19LOOP_B-0055	19LOOP_B-OPS-EFO-CWR-SEL	2.2E-10	0.02%	99.7%
65	19LOOP_D-0015	19LOOP_D-OPS-ADG-EFO-CWR-SEL	2.1E-10	0.02%	99.7%
66	10SLBO-0032	10SLBO-HIC-MSO-CSA-FNA6	1.6E-10	0.02%	99.7%
67	05SGTR-0022	05SGTR-HIC-EFC	1.6E-10	0.01%	99.7%
68	19LOOP_A-0047	19LOOP_A-EFO-CSA-FNA9	1.5E-10	0.01%	99.7%
69	19LOOP_A-0007	19LOOP_A-SRV-CXB3-FNA9	1.3E-10	0.01%	99.8%
70	11SLBI-0007	11SLBI-EFD-BLA	1.3E-10	0.01%	99.8%
71	04VSLOCA-0035	04VSLOCA-EFA-BLA	1.3E-10	0.01%	99.8%
72	19LOOP_A-0031	19LOOP_A-SRV-HIK-CSA-CRB3	1.3E-10	0.01%	99.8%
73	16PLOCW-0095	16PLOCW-EFA-HIC-CSA-CRB2-FNA7	1.3E-10	0.01%	99.8%
74	03SLOCA-0006	03SLOCA-CSA-SRA-FNA2	1.1E-10	0.01%	99.8%
75	10SLBO-0021	10SLBO-MSO-BLA-CSA-FNA6	1.1E-10	0.01%	99.8%
76	19LOOP_A-0014	19LOOP_A-SRV-CSA-CRB3-FNA9	1.0E-10	0.01%	99.8%
77	12FWLB-0023	12FWLB-HIC-EFD	1.0E-10	0.01%	99.8%
78	05SGTR-0019	05SGTR-EFC-SGI	9.0E-11	0.01%	99.9%
79	05SGTR-0021	05SGTR-HIC-SGI	7.7E-11	0.01%	99.9%
80	14LOFF-0010	14LOFF-EFA-FBA-CSA	6.9E-11	0.01%	99.9%

Table 19.1-24 US-APWR PRA Dominant Core Damage Frequency Sequence (Sheet 5 of 5)

Rank	Sequence ID	Sequence Name	Sequence Frequency (/RY	Percent Contrib.	Percent Contrib. Total
81	10SLBO-0031	10SLBO-HIC-MSO-CSA	6.7E-11	0.01%	99.9%
82	19LOOP_A-0052	19LOOP_A-EFO-FBA2-CSA-FNA9	5.8E-11	0.01%	99.9%
83	19LOOP_D-0009	19LOOP_D-OPS-ADG-EFO-FBA2	5.7E-11	0.01%	99.9%
84	10SLBO-0023	10SLBO-HIC-EFB	5.3E-11	0.01%	99.9%
85	22LODC-0008	22LODC-EFA-MFW-FBA1	5.2E-11	0.005%	99.9%
86	19LOOP_A-0051	19LOOP_A-EFO-FBA2-CSA	5.2E-11	0.005%	99.9%
87	03SLOCA-0048	03SLOCA-EFA-HIB	4.4E-11	0.004%	99.9%
88	19LOOP_A-0045	19LOOP_A-EFO-CXB3-FNA9	4.2E-11	0.004%	99.9%
89	19LOOP_B-0046	19LOOP_B-OPS-EFO-CXB3-FNA9	3.8E-11	0.004%	99.9%
90	16PLOCW-0094	16PLOCW-EFA-HIC-CSA-CRB2	3.8E-11	0.004%	99.9%
91	05SGTR-0017	05SGTR-EFC-CSA-FNA8	3.5E-11	0.003%	99.9%
92	16PLOCW-0081	16PLOCW-EFA-CSA-FNA7	3.4E-11	0.003%	99.9%
93	19LOOP_A-0016	19LOOP_A-SRV-HIK-SRA4	3.4E-11	0.003%	99.9%
94	10SLBO-0014	10SLBO-MSO-CXA-FNA6	3.2E-11	0.003%	99.9%
95	19LOOP_B-0043	19LOOP_B-OPS-SRV-CWR	3.0E-11	0.003%	99.9%
96	12FWLB-0027	12FWLB-HIC-EFD-CSA-FNA6	3.0E-11	0.003%	99.9%
97	12FWLB-0006	12FWLB-EFD-CSA-FNA6	3.0E-11	0.003%	99.9%
98	13TRANS-0011	13TRANS-EFA-MFW-FBA1-CSA	3.0E-11	0.003%	99.9%
99	14LOFF-0004	14LOFF-EFA-CXA-FNA3	2.9E-11	0.003%	99.9%
100	16PLOCW-0066	16PLOCW-SRV-HIC-CSA-CRB2	2.9E-11	0.003%	100.0%

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 1 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.8E-07	17.4	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
2	1.4E-07	13.6	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			RCP----SEAL	RCP SEAL LOCA
3	1.0E-07	9.7	!07RVR	REACTOR VESSEL RUPTURE
4	3.8E-08	3.7	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
5	3.5E-08	3.4	!03SLOCA	SMALL PIPE BREAK LOCA
			RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 2 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	2.8E-08	2.7	!19LOOP EPSCF4DLSRDG-ALL EPSOO02RDG OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS POWER RECOVERY (1H) POWER RECOVERY (3H) RCP SEAL LOCA
7	2.1E-08	2.1	!20ATWS RTPDASF SGNBTHWCCF	ANTICIPATED TRANSIENT DAS FAILURE DIGITAL I&C HARDWARE CCF
8	1.3E-08	1.2	!19LOOP EPSCF2DLLRDGP-ALL EPSCF4DLLRDG-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) POWER RECOVERY (1H) POWER RECOVERY (3H) RCP SEAL LOCA
9	1.1E-08	1.1	!15LOCCW EFWCF2PTAD001AD-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER EFS-RPP-001A,D (EFW PUMP) FAIL TO START (CCF) RCP SEAL LOCA

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 3 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	1.1E-08	1.1	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)
11	6.8E-09	0.66	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4SEFFDG-ALL	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
12	6.0E-09	0.59	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			CWSCF4PCBD001-R-ALL	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)
			RCP----SEAL	RCP SEAL LOCA
13	6.0E-09	0.58	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN
			RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 4 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
14	5.7E-09	0.56	!10SLBO HPIOO01SDVDAS SGNBTSWCCF2	STEAM LINE BREAK DOWNSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS GROUP-2 APPLICATION SOFTWARE CCF
15	5.7E-09	0.56	!10SLBO SGNBTSWCCF2 SGNOO01S	STEAM LINE BREAK DOWNSTREAM MSIV GROUP-2 APPLICATION SOFTWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
16	5.0E-09	0.49	!20ATWS RTPCRDF RTPMTCF	ANTICIPATED TRANSIENT ROD INJECTION FAILURE (4< RODS) UNFAVORABLE MODERATOR TEMPERATURE
17	5.0E-09	0.48	!15LOCCW CHICF2PMBD001-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-RPP-001A,B (CHI PUMP) FAIL TO START (CCF) RCP SEAL LOCA
18	4.9E-09	0.47	!02MLOCA RWSCF4SUPR001-ALL	MEDIUM PIPE BREAK LOCA SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
19	4.5E-09	0.44	!10SLBO HPIOO02FWBD-S MSRCF4AVCD515-ALL	STEAM LINE BREAK DOWNSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)
20	4.0E-09	0.38	!19LOOP EPSOO02RDG OPS----PRBS RCP----SEAL SGNBTSWCCF2	LOSS OF OFFSITE POWER (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS POWER RECOVERY SUCCESS (1H) RCP SEAL LOCA GROUP-2 APPLICATION SOFTWARE CCF

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 5 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
21	3.7E-09	0.36	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBFC52EPS-ALL	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
22	3.0E-09	0.29	!03SLOCA	SMALL PIPE BREAK LOCA
			HPICF4PMAD001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)
			RSSOO02LNUP	(HE) FAIL TO OPERATE ALTERNATE CORE COOLING
23	2.8E-09	0.27	!19LOOP	LOSS OF OFFSITE POWER
			EPSCBFO52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)
			EPSOO01UATRAT	(HE) FAIL TO SEPARATE 52/UATA,D,52/RATA,D (BREAKER) AT LOCAL
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
24	2.8E-09	0.27	!19LOOP	LOSS OF OFFSITE POWER
			EPSCBFO52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)
			EPSOO01UATRAT	(HE) FAIL TO SEPARATE 52/UATA,D,52/RATA,D (BREAKER) AT LOCAL
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 6 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
25	2.7E-09	0.27	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWCF2PTSR001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)
			RCP----SEAL	RCP SEAL LOCA
26	2.7E-09	0.26	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTAD001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO START
			RCP----SEAL	RCP SEAL LOCA
27	2.7E-09	0.26	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			RCP----SEAL	RCP SEAL LOCA
28	2.7E-09	0.26	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 7 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
29	2.6E-09	0.26	!19LOOP	LOSS OF OFFSITE POWER
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCS	POWER RECOVERY SUCCESS (3H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
30	2.6E-09	0.26	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
31	2.6E-09	0.25	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLADDGP-ALL	EPS AAC GTG A,B FAIL TO START (CCF)
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 8 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
32	2.5E-09	0.24	!19LOOP EPSCF4DLLRDG-234 EPSOO02RDG RCP----SEAL SWSTMPE001B	LOSS OF OFFSITE POWER EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS RCP SEAL LOCA EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
33	2.5E-09	0.24	!19LOOP EPSCBFO52UAT-ACD RCP----SEAL SWSTMPE001B	LOSS OF OFFSITE POWER EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF) RCP SEAL LOCA EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
34	2.5E-09	0.24	!19LOOP EPSCBFO52RAT-ACD RCP----SEAL SWSTMPE001B	LOSS OF OFFSITE POWER EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF) RCP SEAL LOCA EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
35	2.4E-09	0.24	!15LOCCW RCP----SEAL SGNBTSWCCF3	LOSS OF COMPONENT COOLING WATER RCP SEAL LOCA NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF

Table 19.1-25 US-APWR PRA Dominant Cutsets (Sheet 9 of 9)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
36	2.2E-09	0.21	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			ACWTMPZ351A	VWS-APP-351A (A-CONDENSER WATER PUMP) TEST & MAINTENANCE
			RCP----SEAL	RCP SEAL LOCA
37	2.1E-09	0.2	!03SLOCA	SMALL PIPE BREAK LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
			SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
38	2.1E-09	0.2	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE
			RCP----SEAL	RCP SEAL LOCA
39	2.1E-09	0.2	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWTMTA001D	EFS-RPP-001D (D-EFW PUMP) TEST & MAINTENANCE
			RCP----SEAL	RCP SEAL LOCA
40	2.0E-09	0.19	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLSRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 1 of 39)
Large Pipe Break LOCA (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.3E-10	40.8	!01LLOCA HPICF4PMAD001-ALL RSS-RHR-LL	LARGE PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) ALTERNATE CORE COOLING FAILURE
2	1.2E-11	3.6	!01LLOCA RSS-RHR-LL RWSCF4SUPR001-ALL	LARGE PIPE BREAK LOCA ALTERNATE CORE COOLING FAILURE SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
3	1.1E-11	3.5	!01LLOCA HPICF4PMAD001-234 RSS-RHR-LL	LARGE PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) ALTERNATE CORE COOLING FAILURE
4	1.1E-11	3.5	!01LLOCA HPICF4PMAD001-123 RSS-RHR-LL	LARGE PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) ALTERNATE CORE COOLING FAILURE
5	1.1E-11	3.5	!01LLOCA HPICF4PMAD001-134 RSS-RHR-LL	LARGE PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) ALTERNATE CORE COOLING FAILURE
6	1.1E-11	3.5	!01LLOCA HPICF4PMAD001-124 RSS-RHR-LL	LARGE PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) ALTERNATE CORE COOLING FAILURE
7	1.0E-11	3.1	!01LLOCA HPICF4PMSR001-ALL RSS-RHR-LL	LARGE PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF) ALTERNATE CORE COOLING FAILURE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 2 of 39)
Large Pipe Break LOCA (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
8	6.3E-12	1.9	!01LLOCA EPSCF4DLLRDG-ALL OPSLOOP RSS-RHR-LL	LARGE PIPE BREAK LOCA EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP ALTERNATE CORE COOLING FAILURE
9	4.4E-12	1.3	!01LLOCA RSS-RHR-LL RWSCF4SUPR001-234	LARGE PIPE BREAK LOCA ALTERNATE CORE COOLING FAILURE SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
10	4.4E-12	1.3	!01LLOCA RSS-RHR-LL RWSCF4SUPR001-134	LARGE PIPE BREAK LOCA ALTERNATE CORE COOLING FAILURE SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 3 of 39)
Medium Pipe Break LOCA (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	4.9E-09	30.1	!02MLOCA RWSCF4SUPR001-ALL	MEDIUM PIPE BREAK LOCA SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
2	1.8E-09	11.4	!02MLOCA RWSCF4SUPR001-123	MEDIUM PIPE BREAK LOCA SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
3	8.3E-10	5.1	!02MLOCA NCCOO02CCW RSSCF4MVOD145-ALL	MEDIUM PIPE BREAK LOCA (HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)
4	5.0E-10	3.1	!02MLOCA ACCCF4CVOD102-ALL	MEDIUM PIPE BREAK LOCA SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)
5	5.0E-10	3.1	!02MLOCA ACCCF4CVOD103-ALL	MEDIUM PIPE BREAK LOCA SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)
6	4.1E-10	2.5	!02MLOCA HPICF4PMAD001-ALL RSSOO02LNUP	MEDIUM PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) (HE) FAIL TO OPERATE ALTERNATE CORE COOLING
7	2.9E-10	1.8	!02MLOCA SGNBTSWCCF2 SGNOO01S	MEDIUM PIPE BREAK LOCA GROUP-2 APPLICATION SOFTWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
8	1.9E-10	1.6	!02MLOCA NCCOO02CCW RSSCF4PMAD001-ALL	MEDIUM PIPE BREAK LOCA (HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 4 of 39)
Medium Pipe Break LOCA (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
9	1.4E-10	0.88	!02MLOCA HPICF4PMAD001-ALL MSPOO02STRV	MEDIUM PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) (HE) FAIL TO DEPRESSURIZE RCS BY SECONDARY SIDE COOLING
10	1.3E-10	0.83	!02MLOCA ACCCF4CVOD102-134	MEDIUM PIPE BREAK LOCA SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 5 of 39)
Small Pipe Break LOCA (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	3.5E-08	44.8	!03SLOCA RWSCF4SUPR001-ALL	SMALL PIPE BREAK LOCA SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
2	6.0E-09	7.6	!03SLOCA NCCOO02CCW RSSCF4MVOD145-ALL	SMALL PIPE BREAK LOCA (HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)
3	3.0E-09	3.8	!03SLOCA HPICF4PMAD001-ALL RSSOO02LNUP	SMALL PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) (HE) FAIL TO OPERATE ALTERNATE CORE COOLING
4	2.1E-09	2.6	!03SLOCA SGNBTSWCCF2 SGNOO01S	SMALL PIPE BREAK LOCA GROUP-2 APPLICATION SOFTWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
5	1.3E-09	1.7	!03SLOCA NCCOO02CCW RSSCF4PMAD001-ALL	SMALL PIPE BREAK LOCA (HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)
6	1.0E-09	1.3	!03SLOCA HPICF4PMAD001-ALL MSPOO02STRV	SMALL PIPE BREAK LOCA SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF) (HE) FAIL TO DEPRESSURIZE RCS BY SECONDARY SIDE COOLING

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 6 of 39)
Small Pipe Break LOCA (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	5.7E-10	0.73	!03SLOCA EPSCF4CBSO52LC-ALL	SMALL PIPE BREAK LOCA EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)
8	5.7E-10	0.73	!03SLOCA EPSCF4CBSO52STL-ALL	SMALL PIPE BREAK LOCA EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)
9	5.7E-10	0.73	!03SLOCA EPSCF4CBSO52STH-ALL	SMALL PIPE BREAK LOCA EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)
10	4.4E-10	0.56	!03SLOCA SGNBTHWCCF SGNOO01S	SMALL PIPE BREAK LOCA DIGITAL I&C HARDWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 7 of 39)
Very Small Pipe Break LOCA (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	2.4E-10	22.2	!04VSLOCA EPSCF4CBSO52STH-ALL	VERY SMALL PIPE BREAK LOCA EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)
2	2.4E-10	22.2	!04VSLOCA EPSCF4CBSO52STL-ALL	VERY SMALL PIPE BREAK LOCA EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)
3	1.7E-10	15.5	!04VSLOCA EPSCF4DLLRDG-ALL EPSOO02RDG OPSLOOP	VERY SMALL PIPE BREAK LOCA EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
4	5.4E-11	5.1	!04VSLOCA CWSCF4RHPR-FF	VERY SMALL PIPE BREAK LOCA NCS-RHX-001A,B,C,D (A,B,C,D-CCW HX) PLUG / FOUL (CCF)
5	3.5E-11	3.2	!04VSLOCA EPSCF4DLADDG-ALL EPSOO02RDG OPSLOOP	VERY SMALL PIPE BREAK LOCA EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
6	2.6E-11	2.4	!04VSLOCA EPSCF4DLSRDG-ALL EPSOO02RDG OPSLOOP	VERY SMALL PIPE BREAK LOCA EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 8 of 39)
Very Small Pipe Break LOCA (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.8E-11	1.7	!04VSLOCA SWSCF4PMYR-FF	VERY SMALL PIPE BREAK LOCA EWS-OPP-001A,B,C,D (A,B,C,D-ESW PUMP) FAIL TO RUN (CCF)
8	1.2-11	1.1	!04VSLOCA EPSCF2DLLRDGP-ALL EPSCF4DLLRDG-ALL OPSLOOP	VERY SMALL PIPE BREAK LOCA EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
9	1.0E-11	0.95	!04VSLOCA CWSCF4PCYR-FF	VERY SMALL PIPE BREAK LOCA NCS-RPP-001A,B,C,D (A,B,C,D-CCW PUMP) FAIL TO RUN (CCF)
10	9.1-12	0.85	!04VSLOCA EFWCF2CVOD008-ALL HPIOO02FWBD-S	VERY SMALL PIPE BREAK LOCA EFS-VLV-008A,B FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 9 of 39)
Steam Generator Tube Rupture (Sheet 1 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.3E-09	12.1	!05SGTR	STEAM GENERATOR TUBE RUPTURE
			HITOO02	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW
			MSPMLWTH	WATER HUMMER IN STEAM LINE
			SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE
2	3.0E-10	2.8	!05SGTR	STEAM GENERATOR TUBE RUPTURE
			MSPMLWTH	WATER HUMMER IN STEAM LINE
			PZROO02PORV	(HE) FAIL TO OPERATE RCS FORCED DEPRESSURIZATION
			SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE
3	1.3-10	1.2	!05SGTR	STEAM GENERATOR TUBE RUPTURE
			MSPMLWTH	WATER HUMMER IN STEAM LINE
			MSPOO02STRV-SG	(HE) FAIL TO DEPRESSURIZE RCS BY SECONDARY SIDE COOLING
			SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE
4	1.2E-10	1.1	!05SGTR	STEAM GENERATOR TUBE RUPTURE
			HITOO02-DP3	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW
			MSPOO0250B2-DP2	(HE) FAIL TO CLOSE NMS-50B2 (MANUAL VALVE)
			MSRAVCD500E	NMS-TCV-500E FAIL TO CLOSE
			MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A
5	1.2E-10	1.1	!05SGTR	STEAM GENERATOR TUBE RUPTURE
			HITOO02-DP3	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW
			MSPOO0250B1-DP2	(HE) FAIL TO CLOSE NMS-50B1 (MANUAL VALVE)
			MSRAVCD500H	NMS-TCV-500H FAIL TO CLOSE
			MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 10 of 39)
Steam Generator Tube Rupture (Sheet 2 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	1.2E-10	1.1	!05SGTR HITOO02-DP3 MSPOO0250B1-DP2 MSRAVCD500P MSROO02515A	STEAM GENERATOR TUBE RUPTURE (HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW (HE) FAIL TO CLOSE NMS-50B1 (MANUAL VALVE) NMS-TCV-500P FAIL TO CLOSE (HE) FAIL TO CLOSE NMS-SMV-515A
7	1.2E-10	1.1	!05SGTR HITOO02-DP3 MSPOO0250A2-DP2 MSRAVCD500K MSROO02515A	STEAM GENERATOR TUBE RUPTURE (HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW (HE) FAIL TO CLOSE NMS-50A2 (MANUAL VALVE) NMS-TCV-500K FAIL TO CLOSE (HE) FAIL TO CLOSE NMS-SMV-515A
8	1.2E-10	1.1	!05SGTR HITOO02-DP3 MSPOO0250C2-DP2 MSRAVCD500F MSROO02515A	STEAM GENERATOR TUBE RUPTURE (HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW (HE) FAIL TO CLOSE NMS-50C2 (MANUAL VALVE) NMS-TCV-500F FAIL TO CLOSE (HE) FAIL TO CLOSE NMS-SMV-515A
9	1.2E-10	1.1	!05SGTR HITOO02-DP3 MSPOO0250C1-DP2 MSRAVCD500J MSROO02515A	STEAM GENERATOR TUBE RUPTURE (HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW (HE) FAIL TO CLOSE NMS-50C1 (MANUAL VALVE) NMS-TCV-500J FAIL TO CLOSE (HE) FAIL TO CLOSE NMS-SMV-515A

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 11 of 39)
Steam Generator Tube Rupture (Sheet 3 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	1.2E-10	1.1	!05SGTR HITOO02-DP3 MSPOO0250C2-DP2 MSRAVCD500M MSROO02515A	STEAM GENERATOR TUBE RUPTURE (HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW (HE) FAIL TO CLOSE NMS-50C2 (MANUAL VALVE) NMS-TCV-500M FAIL TO CLOSE (HE) FAIL TO CLOSE NMS-SMV-515A

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 12 of 39)
Reactor Vessel Rupture

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.0E-07	100	!07RVR	REACTOR VESSEL RUPTURE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 13 of 39)
Steam Line Break/Leak (Turbine Side) (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	5.7E-09	16.1	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
			SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
2	5.7E-09	16.1	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			HPIOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
3	4.5E-09	12.7	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
			MSRCF4AVCD515-ALL	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)
4	1.3E-09	3.8	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
			MSRCF4AVCD515-14	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)
5	1.3E-09	3.8	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
			MSRCF4AVCD515-12	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)
6	1.3E-09	3.8	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
			MSRCF4AVCD515-24	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 14 of 39)
Steam Line Break/Leak (Turbine Side) (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.3E-09	3.8	!10SLBO HPIOO02FWBD-S MSRCF4AVCD515-34	STEAM LINE BREAK DOWNSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)
8	1.3E-09	3.8	!10SLBO HPIOO02FWBD-S MSRCF4AVCD515-13	STEAM LINE BREAK DOWNSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)
9	1.3E-09	3.8	!10SLBO HPIOO02FWBD-S MSRCF4AVCD515-23	STEAM LINE BREAK DOWNSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)
10	1.2E-09	3.4	!10SLBO HPIOO01SDVDAS SGNBTHWCCF	STEAM LINE BREAK DOWNSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS DIGITAL I&C HARDWARE CCF

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 15 of 39)
Steam Line Break/Leak (CV Side) (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	6.15E-12	3.5	!11SLBI EFWCF2CVOD008-ALL HPIOO02FWBD-S	STEAM LINE BREAK UPSTREAM MSIV EFS-VLV-008A,B FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
2	4.3E-12	2.4	!11SLBI EFWCF4CVOD018-ALL HPIOO02FWBD-S	STEAM LINE BREAK UPSTREAM MSIV EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
3	4.3E-12	2.4	!11SLBI EFWCF4CVOD012-ALL HPIOO02FWBD-S	STEAM LINE BREAK UPSTREAM MSIV EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
4	3.8E-12	2.2	!11SLBI EFWPTAD001D SGNBTSWCCF2 SGNOO01S	STEAM LINE BREAK UPSTREAM MSIV EFS-RPP-001D (D-EFW PUMP) FAIL TO START GROUP-2 APPLICATION SOFTWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
5	3.8E-12	2.2	!11SLBI EFWPTAD001D HPIOO01SDVDAS SGNBTSWCCF2	STEAM LINE BREAK UPSTREAM MSIV EFS-RPP-001D (D-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS GROUP-2 APPLICATION SOFTWARE CCF
6	3.5E-12	2.0	!11SLBI HPIOO02FWBD-S RTPCF4ICYRRT7001-ALL	STEAM LINE BREAK UPSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE SG WATER LEVEL SENSOR (NARROW RANGE) CCF

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 16 of 39)
Steam Line Break/Leak (CV Side) (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	3.4E-12	2.0	!11SLBI EFWOO01006AB EFWPTAD001A HPIOO02FWBD-S SWSTMPE001B	STEAM LINE BREAK UPSTREAM MSIV (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
8	3.0E-12	1.8	!11SLBI HPIOO01SDVDAS OPSLOOP SGNBTSWCCF2	STEAM LINE BREAK UPSTREAM MSIV (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP GROUP-2 APPLICATION SOFTWARE CCF
9	3.0E-12	1.8	!11SLBI OPSLOOP SGNBTSWCCF2 SGNOO01S	STEAM LINE BREAK UPSTREAM MSIV CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP GROUP-2 APPLICATION SOFTWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
10	2.8E-12	1.6	!11SLBI EFWOO01006AB EFWPTAD001A HPIOO02FWBD-S VCWCHBD001B	STEAM LINE BREAK UPSTREAM MSIV (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 17 of 39)
Feedwater Line Break (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	2.1E-11	3.4	!12FWLB EFWCF2CVOD008-ALL HPIOO02FWBD-S	FEED WATER LINE BREAK EFS-VLV-008A,B FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
2	1.4E-11	2.4	!12FWLB EFWCF4CVOD018-ALL HPIOO02FWBD-S	FEED WATER LINE BREAK EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
3	1.4E-11	2.4	!12FWLB EFWCF4CVOD012-ALL HPIOO02FWBD-S	FEED WATER LINE BREAK EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
4	1.3E-11	2.1	!12FWLB EFWPTAD001D SGNBTSWCCF2 SGNOO01S	FEED WATER LINE BREAK EFS-RPP-001D (D-EFW PUMP) FAIL TO START GROUP-2 APPLICATION SOFTWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
5	1.3E-11	2.1	!12FWLB EFWPTAD001D HPIOO01SDVDAS SGNBTSWCCF2	FEED WATER LINE BREAK EFS-RPP-001D (D-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS GROUP-2 APPLICATION SOFTWARE CCF
6	1.2E-11	2.0	!12FWLB HPIOO02FWBD-S RTPCF4ICYRRT7001-ALL	FEED WATER LINE BREAK (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE SG WATER LEVEL SENSOR (NARROW RANGE) CCF

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 18 of 39)
Feedwater Line Break (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.2E-11	1.9	!12FWLB EFWOO01006AB EFWPTAD001A HPIOO02FWBD-S SWSTMPE001B	FEED WATER LINE BREAK (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
8	1.0E-11	1.7	!12FWLB HPIOO01SDVDAS OPSLOOP SGNBTSWCCF2	FEED WATER LINE BREAK (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP GROUP-2 APPLICATION SOFTWARE CCF
9	1.0E-11	1.7	!12FWLB OPSLOOP SGNBTSWCCF2 SGNOO01S	FEED WATER LINE BREAK CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP GROUP-2 APPLICATION SOFTWARE CCF (HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
10	9.6E-12	1.6	!12FWLB EFWOO01006AB EFWPTAD001A HPIOO02FWBD-S VCWCHBD001B	FEED WATER LINE BREAK (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 19 of 39)
General Transient (Sheet 1 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	7.2E-10	3.7	!13TRANS	GENERAL TRANSIENT
			EFWCF2CVOD008-ALL	EFS-VLV-008A,B FAIL TO OPEN (CCF)
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
2	5.2E-10	2.7	!13TRANS	GENERAL TRANSIENT
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			RTPBTSWCCF	BASIC SOFTWARE CCF
3	5.0E-10	2.6	!13TRANS	GENERAL TRANSIENT
			EFWCF4CVOD012-ALL	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
4	5.0E-10	2.6	!13TRANS	GENERAL TRANSIENT
			EFWCF4CVOD018-ALL	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
5	4.1E-10	2.2	!13TRANS	GENERAL TRANSIENT
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
			RTPCF4ICYRRT7001-ALL	SG WATER LEVEL SENSOR (NARROW RANGE) CCF

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 20 of 39)
General Transient (Sheet 2 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	4.0E-10	2.1	!13TRANS	GENERAL TRANSIENT
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
			SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
7	4.0E-10	2.1	!13TRANS	GENERAL TRANSIENT
			EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE
			RTPBTSWCCF	BASIC SOFTWARE CCF
8	3.9E-10	2.0	!13TRANS	GENERAL TRANSIENT
			EFWCF2CVOD008-ALL	EFS-VLV-008A,B FAIL TO OPEN (CCF)
			HPIOO02FWBD-DP2	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWOO02R	(HE) FAIL TO RECOVER MFWS
9	3.4E-10	1.8	!13TRANS	GENERAL TRANSIENT
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
			VCWCHBD001B	VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 21 of 39)
General Transient (Sheet 3 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	3.1E-10	1.6	!13TRANS	GENERAL TRANSIENT
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
			SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 22 of 39)
Loss of Feedwater Flow (Sheet 1 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.7E-09	6.6	!14LOFF EFWCF2CVOD008-ALL HPIOO02FWBD	LOSS OF FEED WATER FLOW EFS-VLV-008A,B FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
2	1.2E-09	4.7	!14LOFF EFWCF4CVOD012-ALL HPIOO02FWBD	LOSS OF FEED WATER FLOW EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
3	1.2E-09	4.7	!14LOFF EFWCF4CVOD018-ALL HPIOO02FWBD	LOSS OF FEED WATER FLOW EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF) (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
4	9.8E-10	3.8	!14LOFF HPIOO02FWBD RTPCF4ICYRRT7001-ALL	LOSS OF FEED WATER FLOW (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP SG WATER LEVEL SENSOR (NARROW RANGE) CCF
5	9.6E-10	3.7	!14LOFF EFWOO01006AB EFWPTAD001A HPIOO02FWBD SWSTMPE001B	LOSS OF FEED WATER FLOW (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 23 of 39)
Loss of Feedwater Flow (Sheet 2 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	8.0E-10	3.1	!14LOFF	LOSS OF FEED WATER FLOW
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			VCWCHBD001B	VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START
7	7.3E-10	2.8	!14LOFF	LOSS OF FEED WATER FLOW
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
8	6.4E-10	2.5	!14LOFF	LOSS OF FEED WATER FLOW
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			VCWTMPZ001B	VWS-PPP-001B (B-ESSENTIAL CHILLED WATER PUMP) TEST & MAINTENANCE
9	6.1E-10	2.4	!14LOFF	LOSS OF FEED WATER FLOW
			EFWCF4MVFC017-ALL	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 24 of 39)
Loss of Feedwater Flow (Sheet 3 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	6.1E-10	2.4	!14LOFF	LOSS OF FEED WATER FLOW
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			VCWCHBD001B	VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 25 of 39)
Loss of Component Cooling Water (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.4E-07	66.3	!15LOCCW ACWOO02CT-DP2 ACWOO02FS RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER (HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM RCP SEAL LOCA
2	1.1E-08	5.3	!15LOCCW EFWCF2PTAD001AD-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER EFS-RPP-001A,D (EFW PUMP) FAIL TO START (CCF) RCP SEAL LOCA
3	5.0E-09	2.4	!15LOCCW CHICF2PMBD001-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-RPP-001A,B (CHI PUMP) FAIL TO START (CCF) RCP SEAL LOCA
4	2.7E-09	1.3	!15LOCCW EFWCF2PTSR001AD-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER EFS-RPP-001A,D (EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF) RCP SEAL LOCA
5	2.7E-09	1.3	!15LOCCW EFWOO01006AB EFWPTAD001A RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 26 of 39)
Loss of Component Cooling Water (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	2.7E-09	1.3	!15LOCCW EFWOO01006AB EFWPTAD001D RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001D (D-EFW PUMP) FAIL TO START RCP SEAL LOCA
7	2.4E-09	1.2	!15LOCCW RCP----SEAL SGNBTSWCCF3	LOSS OF COMPONENT COOLING WATER RCP SEAL LOCA NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF
8	2.2E-09	1.1	!15LOCCW ACWOO02FS ACWTMPZ351A RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM VWS-APP-351A (A-CONDENSER WATER PUMP) TEST & MAINTENANCE RCP SEAL LOCA
9	2.1E-09	1.0	!15LOCCW EFWOO01006AB EFWTMTA001A RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE RCP SEAL LOCA
10	2.1E-09	1.0	!15LOCCW EFWOO01006AB EFWTMTA001D RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001D (D-EFW PUMP) TEST & MAINTENANCE RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 27 of 39)
Loss of Partial Component Cooling Water (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.8E-09	11.1	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
			SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
2	9.1E-10	5.5	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
3	6.9E-10	4.2	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
4	3.9E-10	2.4	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			RCP----SEAL	RCP SEAL LOCA
			SGNBTHWCCF	DIGITAL I&C HARDWARE CCF
			SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS
5	3.5E-10	2.1	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 28 of 39)
Loss of Partial Component Cooling Water (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	3.3E-10	2.0	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE
7	3.2E-10	1.9	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			RCP----SEAL	RCP SEAL LOCA
			RTPBTSWCCF	BASIC SOFTWARE CCF
8	3.2E-10	1.9	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			RCP----SEAL	RCP SEAL LOCA
			RTPDASF	DAS FAILURE
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
9	2.9E-10	1.8	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			RCP----SEAL	RCP SEAL LOCA
10	2.1E-10	1.3	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTLR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION
			HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 29 of 39)
Loss of Offsite Power (Sheet 1 of 4)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.8E-07	38.3	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
2	3.8E-08	8.2	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
3	2.8E-08	6.1	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 30 of 39)
Loss of Offsite Power (Sheet 2 of 4)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
4	1.3E-08	2.7	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
5	1.1E-08	2.4	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)
6	6.8E-09	1.5	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4SEFFDG-ALL	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 31 of 39)
Loss of Offsite Power (Sheet 3 of 4)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	6.0E-09	1.3	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			CWSCF4PCBD001-R-ALL	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)
			RCP----SEAL	RCP SEAL LOCA
8	4.0E-09	0.85	!19LOOP	LOSS OF OFFSITE POWER
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBS	POWER RECOVERY SUCCESS (1H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
9	3.7E-09	0.78	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBFC52EPS-ALL	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 32 of 39)
Loss of Offsite Power (Sheet 4 of 4)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	2.8E-09	0.6	!19LOOP	LOSS OF OFFSITE POWER
			EPSCBFO52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)
			EPSOO01UATRAT	(HE) FAIL TO SEPARATE 52/UATA,D,52/RATA,D (BREAKER) AT LOCAL
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 33 of 39)
Anticipated Transient Without Scram (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	2.1E-08	46.1	!20ATWS RTPDASF SGNBTHWCCF	ANTICIPATED TRANSIENT DAS FAILURE DIGITAL I&C HARDWARE CCF
2	5.0E-09	10.8	!20ATWS RTPCRDF RTPMTCF	ANTICIPATED TRANSIENT ROD INJECTION FAILURE (4< RODS) UNFAVORABLE MODERATOR TEMPERATURE
3	1.8E-09	3.9	!20ATWS EBIOO02CVS RTPCRDF	ANTICIPATED TRANSIENT (HE) FAIL TO START BRIC ACID TRANSFER ROD INJECTION FAILURE (4< RODS)
4	1.2E-09	2.6	!20ATWS RTPCRDF SWSTMPE001B	ANTICIPATED TRANSIENT ROD INJECTION FAILURE (4< RODS) EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
5	1.2E-09	2.5	!20ATWS RTPCF4AXFFRT-ALL RTPDASF RTPMTCF	ANTICIPATED TRANSIENT REACTOR TRIP BREAKER A1,A2,B1,B2,C1,C2,D1,D2 (CCF) DAS FAILURE UNFAVORABLE MODERATOR TEMPERATURE
6	1.0E-09	2.2	!20ATWS RTPCRDF VCWCHBD001B	ANTICIPATED TRANSIENT ROD INJECTION FAILURE (4< RODS) VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 34 of 39)
Anticipated Transient Without Scram (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.0E-09	2.2	!20ATWS RTPBTSWCCF RTPDASF	ANTICIPATED TRANSIENT BASIC SOFTWARE CCF DAS FAILURE
8	1.0E-09	2.2	!20ATWS RTPCRDF TTPTSVF	ANTICIPATED TRANSIENT ROD INJECTION FAILURE (4< RODS) TURBINE STOP VALVE FAILURE
9	8.0E-10	1.7	!20ATWS RTPCRDF VCWTMPZ001B	ANTICIPATED TRANSIENT ROD INJECTION FAILURE (4< RODS) VWS-PPP-001B (B-ESSENTIAL CHILLED WATER PUMP) TEST & MAINTENANCE
10	6.6E-10	1.4	!20ATWS EFWPTAD001D RTPCRDF	ANTICIPATED TRANSIENT EFS-RPP-001D (D-EFW PUMP) FAIL TO START ROD INJECTION FAILURE (4< RODS)

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 35 of 39)
Loss of Vital ac Bus (Sheet 1 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	3.8E-10	17.6	!21LOAC EFWOO01006AB EFWPTAD001A HPIOO02FWBD MFWHARD	LOSS OF VITAL AC BUS (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP MFW SYSTEM FAILURE
2	2.9E-10	13.4	!21LOAC EFWOO01006AB EFWTMTA001A HPIOO02FWBD MFWHARD	LOSS OF VITAL AC BUS (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP MFW SYSTEM FAILURE
3	2.0E-10	9.4	!21LOAC EFWOO01006AB EFWPTAD001A HPIOO02FWBD-DP2 MFWOO02R	LOSS OF VITAL AC BUS (HE) FAIL TO CHANGEOVER EFW PIT EFS-RPP-001A (A-EFW PUMP) FAIL TO START (HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP (HE) FAIL TO RECOVER MFWS
4	1.9E-10	8.9	!21LOAC RTPDASF SGNBTHWCCF	LOSS OF VITAL AC BUS DAS FAILURE DIGITAL I&C HARDWARE CCF

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 36 of 39)
Loss of Vital ac Bus (Sheet 2 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
5	1.6E-10	7.2	!21LOAC	LOSS OF VITAL AC BUS
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE
			HPIOO02FWBD-DP2	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWOO02R	(HE) FAIL TO RECOVER MFWS
6	1.4E-10	6.4	!21LOAC	LOSS OF VITAL AC BUS
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
7	8.9E-11	4.1	!21LOAC	LOSS OF VITAL AC BUS
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTLR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 37 of 39)
Loss of Vital ac Bus (Sheet 3 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
8	7.4E-11	3.4	!21LOAC	LOSS OF VITAL AC BUS
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION
			HPIOO02FWBD-DP2	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWOO02R	(HE) FAIL TO RECOVER MFWS
9	5.5E-11	2.6	!21LOAC	LOSS OF VITAL AC BUS
			EFWMVOD103A	EFS-MOV-103A FAIL TO OPEN
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
10	4.8E-11	2.2	!21LOAC	LOSS OF VITAL AC BUS
			EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT
			EFWPTLR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION
			HPIOO02FWBD-DP2	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWOO02R	(HE) FAIL TO RECOVER MFWS

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 38 of 39)
Loss of Vital dc Bus (Sheet 1 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	2.5E-11	37.3	!22LODC	LOSS OF VITAL DC BUS
			RTPDASF	DAS FAILURE
			SGNBTHWCCF	DIGITAL I&C HARDWARE CCF
2	1.3E-12	2.0	!22LODC	LOSS OF VITAL DC BUS
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
3	1.2E-12	1.8	!22LODC	LOSS OF VITAL DC BUS
			RTPBTSWCCF	BASIC SOFTWARE CCF
			RTPDASF	DAS FAILURE
4	1.1E-12	1.6	!22LODC	LOSS OF VITAL DC BUS
			EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
5	1.1E-12	1.6	!22LODC	LOSS OF VITAL DC BUS
			EFWCF2CVOD008-ALL	EFS-VLV-008A,B FAIL TO OPEN (CCF)
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE

Table 19.1-26 US-APWR PRA Dominant Cutsets for Each Initiating Event (Sheet 39 of 39)
Loss of Vital dc Bus (Sheet 2 of 2)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
6	7.7E-13	1.2	!22LODC	LOSS OF VITAL DC BUS
			EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START
			RTPBTSWCCF	BASIC SOFTWARE CCF
7	7.4E-13	1.1	!22LODC	LOSS OF VITAL DC BUS
			EPSTMDGP1	EPS A-AAC GTG TEST & MAINTENANCE
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
8	7.4E-13	1.1	!22LODC	LOSS OF VITAL DC BUS
			EFWCF4CVOD012-ALL	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
9	7.4E-13	1.1	!22LODC	LOSS OF VITAL DC BUS
			EFWCF4CVOD018-ALL	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
10	6.1E-13	0.91	!22LODC	LOSS OF VITAL DC BUS
			HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP
			MFWHARD	MFW SYSTEM FAILURE
			RTPCF4ICYRRT7001-ALL	SG WATER LEVEL SENSOR (NARROW RANGE) CCF

Table 19.1-27 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 1 of 7)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.8E-07	52.6	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
2	3.8E-08	11.2	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
3	2.8E-08	8.3	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-27 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 2 of 7)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
4	1.3E-08	3.7	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
5	6.8E-09	2.0	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4SEFFDG-ALL	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
6	3.7E-09	1.1	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBFC52EPS-ALL	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-27 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 3 of 7)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	2.8E-09	0.82	!19LOOP	LOSS OF OFFSITE POWER
			EPSCBFO52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)
			EPSOO01UATRAT	(HE) FAIL TO SEPARATE 52/UATA,D,52/RATA,D (BREAKER) AT LOCAL
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
8	2.8E-09	0.82	!19LOOP	LOSS OF OFFSITE POWER
			EPSCBFO52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)
			EPSOO01UATRAT	(HE) FAIL TO SEPARATE 52/UATA,D,52/RATA,D (BREAKER) AT LOCAL
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
9	2.7E-09	0.79	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-27 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 4 of 7)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
10	2.6E-09	0.77	!19LOOP EPSCF4DLLRDG-ALL EPSDLLRDGP1-L2 EPSDLLRDGP2-L2 OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION POWER RECOVERY (1H) POWER RECOVERY (3H) RCP SEAL LOCA
11	2.6E-09	0.76	!19LOOP EPSCF2DLADDGP-ALL EPSCF4DLLRDG-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EPS AAC GTG A,B FAIL TO START (CCF) EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) POWER RECOVERY (1H) POWER RECOVERY (3H) RCP SEAL LOCA
12	2.0E-09	0.58	!19LOOP EPSCF2DLSRDGP-ALL EPSCF4DLLRDG-ALL OPS----PRBF OPS----PRCF RCP----SEAL	LOSS OF OFFSITE POWER EPS AAC GTG A,B FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF) EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) POWER RECOVERY (1H) POWER RECOVERY (3H) RCP SEAL LOCA

Table 19.1-27 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 5 of 7)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
13	2.0E-09	0.58	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
14	1.8E-09	0.53	!19LOOP	LOSS OF OFFSITE POWER
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
15	1.8E-09	0.53	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			EPSTMDGP1	EPS A-AAC GTG TEST & MAINTENANCE
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-27 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 6 of 7)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
16	1.8E-09	0.53	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			EPSTMDGP2	EPS B-AAC GTG TEST & MAINTENANCE
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
17	1.4E-09	0.40	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBSC52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
18	1.4E-09	0.40	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4CBSC52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-27 LOOP with Reactor Trip Resulting SBO Sequence Dominant Cutsets (Sheet 7 of 7)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
19	1.2E-09	0.35	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF2SEFFDGP-ALL	EPS AAC GTG A,B SEQUENCER FAIL TO OPERATE (CCF)
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
20	8.5E-10	0.25	!19LOOP	LOSS OF OFFSITE POWER
			EPPBTSWCCF	BO-SIGNAL (TRAIN P1,2) SOFTWARE CCF
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-28 LOCCW with Reactor Trip Sequence Dominant Cutsets (Sheet 1 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.4E-07	84.8	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			RCP----SEAL	RCP SEAL LOCA
2	5.0E-09	3.0	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			CHICF2PMBD001-ALL	CVS-RPP-001A,B (CHI PUMP) FAIL TO START (CCF)
			RCP----SEAL	RCP SEAL LOCA
3	2.4E-09	1.5	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF3	NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF
4	2.2E-09	1.3	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			ACWTMPZ351A	VWS-APP-351A (A-CONDENSER WATER PUMP) TEST & MAINTENANCE
			RCP----SEAL	RCP SEAL LOCA
5	1.2E-09	0.70	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWCF2MVCD316-ALL	NCS-MOV-316A,B FAIL TO CLOSE (CCF)
			RCP----SEAL	RCP SEAL LOCA
6	1.2E-09	0.70	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWCF2MVOD324-ALL	NCS-MOV-324A,B FAIL TO OPEN (CCF)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-28 LOCCW with Reactor Trip Sequence Dominant Cutsets (Sheet 2 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.2E-09	0.70	!15LOCCW ACWCF2MVOD322-ALL RCP----SEAL	LOSS OF COMPONENT COOLING WATER NCS-MOV-322A,B FAIL TO OPEN (CCF) RCP SEAL LOCA
8	5.9E-10	0.36	!15LOCCW CHIORPR170 RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-FE-170 (ORIFICE) PLUG RCP SEAL LOCA
9	5.9E-10	0.36	!15LOCCW CHIORPR150 RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-FE-150 (ORIFICE) PLUG RCP SEAL LOCA
10	5.9E-10	0.36	!15LOCCW CHIORPR160 RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-FE-160 (ORIFICE) PLUG RCP SEAL LOCA
11	5.9E-10	0.36	!15LOCCW CHIORPR180 RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-FE-180 (ORIFICE) PLUG RCP SEAL LOCA
12	5.5E-10	0.34	!15LOCCW ACWOO02FS ACWTMCT371A RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM VWS-AEQ-371A (A-COOLING TOWER) TEST & MAINTENANCE RCP SEAL LOCA
13	4.1E-10	0.25	!15LOCCW ACWOO02FS ACWPMAD351A RCP----SEAL	LOSS OF COMPONENT COOLING WATER (HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM VWS-APP-351A (A-CONDENSER WATER PUMP) FAIL TO START RCP SEAL LOCA

Table 19.1-28 LOCCW with Reactor Trip Sequence Dominant Cutsets (Sheet 3 of 3)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
14	3.5E-10	0.21	!15LOCCW CHIPMBD001A-R CHITMPZ001B RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-RPP-001A (A-CHI PUMP) FAIL TO RE-START CVS-RPP-001B (B-CHI PUMP) TEST & MAINTENANCE RCP SEAL LOCA
15	2.9E-10	0.18	!15LOCCW CHICVOD179B RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-VLV-179B FAIL TO OPEN RCP SEAL LOCA
16	2.9E-10	0.18	!15LOCCW CHICVOD179A RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-VLV-179A FAIL TO OPEN RCP SEAL LOCA
17	2.9E-10	0.18	!15LOCCW CHICVOD182B RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-VLV-182B FAIL TO OPEN RCP SEAL LOCA
18	2.9E-10	0.18	!15LOCCW CHICVOD181C RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-VLV-181C FAIL TO OPEN RCP SEAL LOCA
19	2.9E-10	0.18	!15LOCCW CHICVOD181A RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-VLV-181A FAIL TO OPEN RCP SEAL LOCA
20	2.9E-10	0.18	!15LOCCW CHICVOD182A RCP----SEAL	LOSS OF COMPONENT COOLING WATER CVS-VLV-182A FAIL TO OPEN RCP SEAL LOCA

Table 19.1-29 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 1 of 5)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	1.1E-08	12.3	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)
2	6.0E-09	6.7	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			CWSCF4PCBD001-R-ALL	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)
			RCP----SEAL	RCP SEAL LOCA
3	2.5E-09	2.8	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			RCP----SEAL	RCP SEAL LOCA
			SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
4	2.5E-09	2.8	!19LOOP	LOSS OF OFFSITE POWER
			EPSCBFO52RAT-ACD	EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF)
			RCP----SEAL	RCP SEAL LOCA
			SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE

Table 19.1-29 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 2 of 5)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
5	2.5E-09	2.8	!19LOOP	LOSS OF OFFSITE POWER
			EPSCBFO52UAT-ACD	EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF)
			RCP----SEAL	RCP SEAL LOCA
			SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
6	1.5E-09	1.6	!19LOOP	LOSS OF OFFSITE POWER
			CWSTMRC001B	NCS-RHX-001B (B-CCW HX) TEST & MAINTENANCE
			EPSCF4DLLRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			RCP----SEAL	RCP SEAL LOCA
7	1.5E-09	1.6	!19LOOP	LOSS OF OFFSITE POWER
			CWSTMRC001B	NCS-RHX-001B (B-CCW HX) TEST & MAINTENANCE
			EPSCBFO52RAT-ACD	EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF)
			RCP----SEAL	RCP SEAL LOCA
8	1.5E-09	1.6	!19LOOP	LOSS OF OFFSITE POWER
			CWSTMRC001B	NCS-RHX-001B (B-CCW HX) TEST & MAINTENANCE
			EPSCBFO52UAT-ACD	EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF)
			RCP----SEAL	RCP SEAL LOCA

Table 19.1-29 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 3 of 5)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
9	1.3E-09	1.4	!19LOOP CWSTMPC001B EPSCF4DLLRDG-234 EPSOO02RDG RCP----SEAL	LOSS OF OFFSITE POWER NCS-RPP-001B (B-CCW PUMP) TEST & MAINTENANCE EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS RCP SEAL LOCA
10	1.2E-09	1.4	!19LOOP CWSTMPC001B EPSCBFO52UAT-ACD RCP----SEAL	LOSS OF OFFSITE POWER NCS-RPP-001B (B-CCW PUMP) TEST & MAINTENANCE EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF) RCP SEAL LOCA
11	1.2E-09	1.4	!19LOOP CWSTMPC001B EPSCBFO52RAT-ACD RCP----SEAL	LOSS OF OFFSITE POWER NCS-RPP-001B (B-CCW PUMP) TEST & MAINTENANCE EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF) RCP SEAL LOCA
12	5.3E-10	0.59	!19LOOP EPSCF4DLADDG-134 EPSOO02RDG RCP----SEAL SWSTMPE001B	LOSS OF OFFSITE POWER EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS RCP SEAL LOCA EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE

Table 19.1-29 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 4 of 5)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
13	4.0E-10	0.44	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLSRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			RCP----SEAL	RCP SEAL LOCA
			SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE
14	3.9E-10	0.44	!19LOOP	LOSS OF OFFSITE POWER
			CHICF2PMBD001-ALL	CVS-RPP-001A,B (CHI PUMP) FAIL TO START (CCF)
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)
15	3.8E-10	0.42	!19LOOP	LOSS OF OFFSITE POWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			RCP----SEAL	RCP SEAL LOCA
			SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)
16	3.5E-10	0.39	!19LOOP	LOSS OF OFFSITE POWER
			EPSCF4DLLRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			RCP----SEAL	RCP SEAL LOCA
			SWSPMBD001B-R	EWS-OPP-001B (B-ESW PUMP) FAIL TO RE-START

Table 19.1-29 LOOP with Reactor Trip Resulting LOCCW Sequence Dominant Cutsets (Sheet 5 of 5)

Rank	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
17	3.5E-10	0.39	!19LOOP EPSCF4DLLRDG-134 EPSOO02RDG RCP----SEAL SWSPMBD001C-R	LOSS OF OFFSITE POWER EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF) (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS RCP SEAL LOCA EWS-OPP-001C (C-ESW PUMP) FAIL TO RE-START
18	3.5E-10	0.39	!19LOOP EPSCBFO52UAT-ACD RCP----SEAL SWSPMBD001B-R	LOSS OF OFFSITE POWER EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF) RCP SEAL LOCA EWS-OPP-001B (B-ESW PUMP) FAIL TO RE-START
19	3.5E-10	0.39	!19LOOP EPSCBFO52RAT-ACD RCP----SEAL SWSPMBD001B-R	LOSS OF OFFSITE POWER EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF) RCP SEAL LOCA EWS-OPP-001B (B-ESW PUMP) FAIL TO RE-START
20	3.5E-10	0.39	!19LOOP EPSCBFO52UAT-ABD RCP----SEAL SWSPMBD001C-R	LOSS OF OFFSITE POWER EPS 52/UATA,B,D (BREAKER) FAIL TO OPEN (CCF) RCP SEAL LOCA EWS-OPP-001C (C-ESW PUMP) FAIL TO RE-START

Table 19.1-30 Basic Events (Hardware Failure, Human Error) FV Importance (Sheet 1 of 4)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	OPS----PRBF	POWER RECOVERY (1H)	5.3E-01	3.4E-01	1.3E+00
2	OPS----PRCF	POWER RECOVERY (3H)	4.1E-01	3.3E-01	1.5E+00
3	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	2.9E-01	1.5E+01
4	EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	9.9E-04	2.2E-01	2.2E+02
5	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	1.8E-01	1.7E+01
6	ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER	5.1E-01	1.7E-01	1.2E+00
7	EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT	1.7E-02	5.2E-02	4.0E+00
8	EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	2.1E-04	4.6E-02	2.2E+02
9	HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP	3.8E-03	4.2E-02	1.2E+01
10	RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	9.7E-06	3.9E-02	4.0E+03
11	SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF	1.0E-05	3.7E-02	3.7E+03
12	EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.6E-04	3.4E-02	2.2E+02
13	RTPDASF	DAS FAILURE	1.0E-02	3.0E-02	3.9E+00
14	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.1E-06	2.9E-02	1.4E+04
15	EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START	6.5E-03	2.2E-02	4.3E+00
16	EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.5E-03	2.1E-02	1.5E+01
17	HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	2.6E-03	2.1E-02	9.0E+00

Table 19.1-30 Basic Events (Hardware Failure, Human Error) FV Importance (Sheet 2 of 4)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
18	SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE	1.2E-02	1.9E-02	2.6E+00
19	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	1.9E-02	1.7E+05
20	EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	1.6E-02	1.9E+00
21	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	1.6E-02	4.1E+00
22	SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	4.8E-05	1.6E-02	3.3E+02
23	EFWCF2PTAD001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO START (CCF)	4.5E-04	1.5E-02	3.5E+01
24	SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS	5.7E-02	1.5E-02	1.3E+00
25	EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE	5.0E-03	1.5E-02	4.0E+00
26	EFWPTAD001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO START	6.5E-03	1.3E-02	2.9E+00
27	EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	1.3E-02	1.7E+00
28	RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	8.4E-05	1.2E-02	1.4E+02
29	MFWHARD	MFW SYSTEM FAILURE	1.0E-01	1.1E-02	1.1E+00
30	EPSCF4DLLRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	1.0E-02	4.2E+01
31	NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN	2.0E-02	9.4E-03	1.5E+00
32	EPSTMDGP1	EPS A-AAC GTG TEST & MAINTENANCE	1.2E-02	9.3E-03	1.8E+00
33	HPICF4PMAD001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	1.1E-04	8.9E-03	8.1E+01
34	HPIOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS	5.7E-02	8.9E-03	1.1E+00

Table 19.1-30 Basic Events (Hardware Failure, Human Error) FV Importance (Sheet 3 of 4)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
35	CWSCF4PCBD001-R-ALL	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	2.6E-05	8.8E-03	3.3E+02
36	EPSCBFO52RAT-ACD	EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.4E-03	1.6E+03
37	EPSCBFO52UAT-ACD	EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.4E-03	1.6E+03
38	EPSCF4SEFFDG-ALL	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	3.8E-05	8.2E-03	2.2E+02
39	EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	2.4E-03	8.1E-03	4.3E+00
40	EPSDLLRDGC	EPS C-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	7.7E-03	1.5E+00
41	EFWTMTA001D	EFS-RPP-001D (D-EFW PUMP) TEST & MAINTENANCE	5.0E-03	7.7E-03	2.5E+00
42	EPSTMDGP2	EPS B-AAC GTG TEST & MAINTENANCE	1.2E-02	6.8E-03	1.6E+00
43	CWSTMRC001B	NCS-RHX-001B (B-CCW HX) TEST & MAINTENANCE	7.0E-03	6.5E-03	1.9E+00
44	VCWCHBD001B	VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START	1.0E-02	6.4E-03	1.6E+00
45	CHICF2PMBD001-ALL	CVS-RPP-001A,B (CHI PUMP) FAIL TO START (CCF)	2.0E-04	6.2E-03	3.2E+01
46	RTPMTCF	UNFAVORABLE MODERATOR TEMPERATURE	5.0E-02	6.0E-03	1.1E+00
47	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.0E-03	3.3E+00
48	OPS----PRBS	POWER RECOVERY SUCCESS (1H)	4.7E-01	5.7E-03	1.0E+00
49	HPIOO02FWBD-DP2	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP	5.4E-02	5.6E-03	1.1E+00
50	MFWOO02R	(HE) FAIL TO RECOVER MFWS	3.8E-03	5.6E-03	2.5E+00
51	CWSTMPC001B	NCS-RPP-001B (B-CCW PUMP) TEST & MAINTENANCE	6.0E-03	5.5E-03	1.9E+00

Table 19.1-30 Basic Events (Hardware Failure, Human Error) FV Importance (Sheet 4 of 4)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
52	EPSOO01UATRAT	(HE) FAIL TO SEPARATE 52/UATA,D,52/RATA,D (BREAKER) AT LOCAL	1.6E-02	5.5E-03	1.3E+00
53	EPSDLLRDGB	EPS B-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	5.4E-03	1.3E+00
54	EFWPTLR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION	1.5E-03	5.2E-03	4.3E+00
55	VCWTMPZ001B	VWS-PPP-001B (B-ESSENTIAL CHILLED WATER PUMP) TEST & MAINTENANCE	8.0E-03	5.1E-03	1.6E+00
56	RSSOO02LNUP	(HE) FAIL TO OPERATE ALTERNATE CORE COOLING	7.4E-03	5.0E-03	1.7E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 1 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	1.9E-02	1.7E+05
2	RTPBTSWCCF	BASIC SOFTWARE CCF	1.0E-07	4.7E-03	4.6E+04
3	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.1E-06	2.9E-02	1.4E+04
4	EPSCF4CBSC52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	1.3E-03	8.5E+03
5	EPSCF4CBSC52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	1.3E-03	8.5E+03
6	SWSCF4PMYR-FF	EWS-OPP-001A,B,C,D (A,B,C,D-ESW PUMP) FAIL TO RUN (CCF)	1.2E-08	7.5E-05	6.2E+03
7	EPSCF4CBSO52STH-ALL	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	9.6E-04	6.1E+03
8	EPSCF4CBSO52STL-ALL	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	9.6E-04	6.1E+03
9	CWSCF4RHPR-FF	NCS-RHX-001A,B,C,D (A,B,C,D-CCW HX) PLUG / FOUL (CCF)	3.6E-08	2.1E-04	5.8E+03
10	CWSCF4PCYR-FF	NCS-RPP-001A,B,C,D (A,B,C,D-CCW PUMP) FAIL TO RUN (CCF)	6.7E-09	3.9E-05	5.8E+03
11	EPSCF4CBSO52LC-ALL	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	7.3E-04	4.6E+03
12	RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	9.7E-06	3.9E-02	4.0E+03
13	RWSXVEL001	RWS-VLV-001 EXTERNAL LEAK LARGE	7.2E-08	2.9E-04	4.0E+03
14	RWSXVEL024	RWS-VLV-024 EXTERNAL LEAK LARGE	7.2E-08	2.9E-04	4.0E+03
15	RWSCVEL023	RWS-VLV-023 EXTERNAL LEAK LARGE	4.8E-08	1.9E-04	4.0E+03
16	RWSMVEL002	RWS-MOV-002 EXTERNAL LEAK LARGE	2.4E-08	9.7E-05	4.0E+03

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 2 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
17	RWSPNELPIPE1	RWS PIPING BETWEEN RWSP AND RWS-VLV-023 EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
18	RWSPNELPIPE2	RWS PIPING BETWEEN RWSP AND RWS-VLV-002 EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
19	RWSTNEL001	RWS-CPT-001 (RWSP) EXTERNAL LEAK LARGE	4.8E-08	1.9E-04	4.0E+03
20	HPIMVEL001B	SIS-MOV-001B EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
21	HPIMVEL001A	SIS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
22	HPIMVEL001D	SIS-MOV-001D EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
23	HPIMVEL001C	SIS-MOV-001C EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
24	RSSMVELCSS001B	CSS-MOV-001B EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
25	RSSMVELCSS001A	CSS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
26	RSSMVELCSS001D	CSS-MOV-001D EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
27	RSSMVELCSS001C	CSS-MOV-001C EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
28	EPSCF4CBSO52LC-123	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.2E-04	4.0E+03
29	EPSCF4CBSO52STH-234	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.2E-04	4.0E+03
30	EPSCF4CBSO52STL-234	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.2E-04	4.0E+03
31	HPIPNELSUCTSA	SIS PIPING A BETWEEN RWSP AND SIS-MOV-001A EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
32	RSSPNEL01C	CSS PIPING BETWEEN RWSP AND CSS-MOV-001C EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
33	RSSPNEL01A	CSS PIPING BETWEEN RWSP AND CSS-MOV-001A EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 3 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
34	RSSPNEL01D	CSS PIPING BETWEEN RWSP AND CSS-MOV-001D EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
35	RSSPNEL01B	CSS PIPING BETWEEN RWSP AND CSS-MOV-001B EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
36	HPIPNELSUCTSD	SIS PIPING D BETWEEN RWSP AND SIS-MOV-001D EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
37	HPIPNELSUCTSB	SIS PIPING B BETWEEN RWSP AND SIS-MOV-001B EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
38	HPIPNELSUCTSC	SIS PIPING C BETWEEN RWSP AND SIS-MOV-001C EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
39	SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF	1.0E-05	3.7E-02	3.7E+03
40	RTPCF4AXFFRT-ALL	REACTOR TRIP BREAKER A1,A2,B1,B2,C1,C2,D1,D2 (CCF)	2.3E-06	4.6E-03	1.9E+03
41	EPSCBFO52RAT-ACD	EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.4E-03	1.6E+03
42	EPSCBFO52UAT-ACD	EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.4E-03	1.6E+03
43	EPSCF4CBSC52RAT-134	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	4.7E-05	1.6E+03
44	EPSCF4CBSC52UAT-134	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	4.7E-05	1.6E+03
45	RTPCF4ICYRRT7001-ALL	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	1.4E-06	2.1E-03	1.5E+03
46	EFWCF2CVOD008-ALL	EFS-VLV-008A,B FAIL TO OPEN (CCF)	2.4E-06	3.6E-03	1.5E+03
47	EFWCF4CVOD012-ALL	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	1.7E-06	2.5E-03	1.5E+03
48	EFWCF4CVOD018-ALL	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	1.7E-06	2.5E-03	1.5E+03
49	EFWCF4MVFC017-ALL	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	8.5E-07	1.3E-03	1.5E+03
50	EFWCF4MVFC017-134	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	4.2E-04	1.5E+03

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 4 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
51	EFWCF4MVFC017-234	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	4.2E-04	1.5E+03
52	EFWCF4MVFC017-124	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	4.2E-04	1.5E+03
53	EFWCF4MVFC017-123	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	4.2E-04	1.5E+03
54	EFWXVEL006A	EFS-VLV-006A EXTERNAL LEAK LARGE	7.2E-08	1.1E-04	1.5E+03
55	EFWXVEL006B	EFS-VLV-006B EXTERNAL LEAK LARGE	7.2E-08	1.1E-04	1.5E+03
56	EFWCF4CVOD018-123	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	9.2E-05	1.5E+03
57	EFWCF4CVOD018-124	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	9.2E-05	1.5E+03
58	EFWCF4CVOD018-134	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	9.2E-05	1.5E+03
59	EFWCF4CVOD018-234	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	9.2E-05	1.5E+03
60	EPSCF4CBSO72DB-124	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.9E-05	1.0E+03
61	EPSCF4CBSO72DB-234	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.9E-05	1.0E+03
62	EPSCF4BYFF-134	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	1.2E-05	1.0E+03
63	EPSCF4BYFF-123	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	1.2E-05	1.0E+03
64	EPSCF4CBSO72DB-ALL	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.5E-04	9.3E+02
65	EPSCF4BYFF-ALL	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	5.0E-08	4.7E-05	9.3E+02
66	EPSCBFO52UAT-ABD	EPS 52/UATA,B,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.2E-03	6.2E+02
67	EPSCBFO52RAT-ABD	EPS 52/RATA,B,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.2E-03	6.2E+02
68	EPSCF4CBSC52RAT-124	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.8E-05	6.2E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 5 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
69	EPSCF4CBSC52UAT-124	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.8E-05	6.2E+02
70	RWSCF4SUPR001-123	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	2.2E-03	6.1E+02
71	ACCCF4CVOD103-ALL	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	4.9E-04	4.9E+02
72	ACCCF4CVOD102-ALL	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	4.9E-04	4.9E+02
73	ACCCF4CVOD102-134	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
74	ACCCF4CVOD102-234	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
75	ACCCF4CVOD103-123	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
76	ACCCF4CVOD103-124	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
77	ACCCF4CVOD102-124	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
78	ACCCF4CVOD103-234	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
79	ACCCF4CVOD103-134	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
80	ACCCF4CVOD102-123	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.3E-04	4.9E+02
81	ACCCF4CVOD102-23	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.8E-05	4.9E+02
82	ACCCF4CVOD103-24	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.8E-05	4.9E+02
83	ACCCF4CVOD102-34	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.8E-05	4.9E+02
84	ACCCF4CVOD103-12	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.8E-05	4.9E+02
85	ACCCF4CVOD102-24	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.8E-05	4.9E+02
86	ACCCF4CVOD103-14	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.8E-05	4.9E+02
87	EPSCF4CBSO72DB-123	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.3E-05	4.4E+02
88	EPSCF4BYFF-234	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	5.4E-06	4.4E+02
89	SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	4.8E-05	1.6E-02	3.3E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 6 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
90	CWSCF4PCBD001-R-ALL	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	2.6E-05	8.8E-03	3.3E+02
91	EPSCF4CBSO72DB-134	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	9.6E-06	3.3E+02
92	EPSCF4BYFF-124	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	4.1E-06	3.3E+02
93	SWSCF4CVOD602-R-ALL	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	1.5E-07	4.9E-05	3.2E+02
94	SWSCF4CVOD502-R-ALL	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	1.5E-07	4.9E-05	3.2E+02
95	CWSCF4CVOD016-R-ALL	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	1.5E-07	4.9E-05	3.2E+02
96	EPSCF4CBSO52STH-124	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.7E-06	3.0E+02
97	EPSCF4CBSO52STL-134	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.7E-06	3.0E+02
98	EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	9.9E-04	2.2E-01	2.2E+02
99	EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	2.1E-04	4.6E-02	2.2E+02
100	EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.6E-04	3.4E-02	2.2E+02
101	EPSCF4SEFFDG-ALL	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	3.8E-05	8.2E-03	2.2E+02
102	EPSCF4CBFC52EPS-ALL	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	2.0E-05	4.4E-03	2.2E+02
103	EPSCF4CBSO52EPS-ALL	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	3.4E-05	2.2E+02
104	EPSCF4IVFF001-ALL	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.5E-06	3.2E-04	2.2E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 7 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
105	EPSCF4CBSO52UA-ALL	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	3.3E-05	2.1E+02
106	EPSCF4CBSO72AU-ALL	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	3.3E-05	2.1E+02
107	EPSCF4CBSO52LC-234	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.0E-06	2.1E+02
108	HPIPMEL001B	SIS-RPP-001B (B-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
109	RSSPMEL001B	RHS-RPP-001B (B-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
110	HPIPMEL001C	SIS-RPP-001C (C-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
111	RSSRIEL001C	RHS-RHX-001C (C-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.2E-04	1.6E+02
112	RSSRIEL001D	RHS-RHX-001D (D-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.2E-04	1.6E+02
113	RSSRIEL001A	RHS-RHX-001A (A-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.2E-04	1.6E+02
114	RSSRIEL001B	RHS-RHX-001B (B-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.2E-04	1.6E+02
115	RSSPMEL001C	RHS-RPP-001C (C-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
116	RSSXVEL013D	RHS-VLV-013D EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
117	RSSXVEL013C	RHS-VLV-013C EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
118	RSSXVEL013A	RHS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
119	RSSXVEL013B	RHS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
120	RSSCVEL004D	RHS-VLV-004D EXTERNAL LEAK LARGE	4.8E-08	7.8E-06	1.6E+02
121	RSSCVEL004C	RHS-VLV-004C EXTERNAL LEAK LARGE	4.8E-08	7.8E-06	1.6E+02
122	RSSCVEL004A	RHS-VLV-004A EXTERNAL LEAK LARGE	4.8E-08	7.8E-06	1.6E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 8 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
123	CFACVEL012	CSS-VLV-012 EXTERNAL LEAK LARGE	4.8E-08	7.8E-06	1.6E+02
124	RSSCVEL004B	RHS-VLV-004B EXTERNAL LEAK LARGE	4.8E-08	7.8E-06	1.6E+02
125	HPIPMEL001A	SIS-RPP-001A (A-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
126	RSSPMEL001A	RHS-RPP-001A (A-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
127	HPIPMEL001D	SIS-RPP-001D (D-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
128	RSSPMEL001D	RHS-RPP-001D (D-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E-05	1.6E+02
129	RSSXVEL034A	RHS-VLV-034A EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
130	RSSXVEL034D	RHS-VLV-034D EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
131	RSSXVEL031D	RHS-VLV-031D EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
132	RSSXVEL031A	RHS-VLV-031A EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
133	RSSXVEL002B	CSS-VLV-002B EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
134	RSSXVEL002D	CSS-VLV-002D EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
135	RSSXVEL002A	CSS-VLV-002A EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
136	RSSXVEL002C	CSS-VLV-002C EXTERNAL LEAK LARGE	7.2E-08	1.2E-05	1.6E+02
137	RSSMVEL004C	CSS-MOV-004C EXTERNAL LEAK LARGE	2.4E-08	3.9E-06	1.6E+02
138	RSSMVEL004B	CSS-MOV-004B EXTERNAL LEAK LARGE	2.4E-08	3.9E-06	1.6E+02
139	RSSMVEL004D	CSS-MOV-004D EXTERNAL LEAK LARGE	2.4E-08	3.9E-06	1.6E+02
140	RSSMVEL004A	CSS-MOV-004A EXTERNAL LEAK LARGE	2.4E-08	3.9E-06	1.6E+02
141	HPICVEL004A	SIS-VLV-004A EXTERNAL LEAK LARGE	4.8E-08	7.7E-06	1.6E+02
142	HPICVEL004B	SIS-VLV-004B EXTERNAL LEAK LARGE	4.8E-08	7.7E-06	1.6E+02
143	HPICVEL004D	SIS-VLV-004D EXTERNAL LEAK LARGE	4.8E-08	7.7E-06	1.6E+02
144	HPICVEL004C	SIS-VLV-004C EXTERNAL LEAK LARGE	4.8E-08	7.7E-06	1.6E+02
145	RWSMVEL004	RWS-MOV-004 EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
146	HPIMVEL009A	SIS-MOV-009A EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 9 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
147	HPIMVEL009D	SIS-MOV-009D EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
148	HPIMVEL009C	SIS-MOV-009C EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
149	HPIMVEL009B	SIS-MOV-009B EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
150	RWSPNELPIPE3	RWS PIPING BETWEEN RWS-VLV-002 AND RWS-VLV-004 EXTERNAL LEAK LARGE	6.0E-10	9.6E-08	1.6E+02
151	HPIPNELINJSC	SIS C-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	9.6E-08	1.6E+02
152	HPIPNELINJSA	SIS A-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	9.6E-08	1.6E+02
153	HPIPNELINJSB	SIS B-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	9.6E-08	1.6E+02
154	HPIPNELINJSD	SIS D-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	9.6E-08	1.6E+02
155	RSSMVEL021C	RHS-MOV-021C EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
156	RSSMVEL021D	RHS-MOV-021D EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
157	RSSMVEL021A	RHS-MOV-021A EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
158	RSSMVEL021B	RHS-MOV-021B EXTERNAL LEAK LARGE	2.4E-08	3.8E-06	1.6E+02
159	RSSAVEL611	RHS-FCV-611 EXTERNAL LEAK LARGE	2.2E-08	3.5E-06	1.6E+02
160	RSSAVEL613	RHS-HCV-613 EXTERNAL LEAK LARGE	2.2E-08	3.5E-06	1.6E+02
161	RSSAVEL623	RHS-HCV-623 EXTERNAL LEAK LARGE	2.2E-08	3.5E-06	1.6E+02
162	RSSAVEL621	RHS-FCV-621 EXTERNAL LEAK LARGE	2.2E-08	3.5E-06	1.6E+02
163	RWSPMEL001A	RWS-RPP-001A (A-RWR PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.0E-05	1.6E+02
164	RWSPMEL001B	RWS-RPP-001B (B-RWR PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.0E-05	1.6E+02
165	RWSXVEL103A	SFS-VLV-103A EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 10 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
166	RWSXVEL066A	NCS-VLV-066A EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
167	RWSXVEL103B	SFS-VLV-103B EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
168	RWSXVEL066B	NCS-VLV-066B EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
169	RWSXVEL006B	RWS-VLV-006B EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
170	RWSXVEL013B	RWS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
171	RWSXVEL021	RWS-VLV-021 EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
172	RWSXVEL028	SFS-VLV-028 EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
173	RWSXVEL013A	RWS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
174	RWSXVEL006A	RWS-VLV-006A EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
175	RWSXVEL005	RWS-VLV-005 EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
176	RWSXVEL014	RWS-VLV-014 EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
177	RWSXVEL101	RWS-VLV-101 EXTERNAL LEAK LARGE	7.2E-08	1.1E-05	1.6E+02
178	RWSCVEL037	LMS-VLV-037 EXTERNAL LEAK LARGE	4.8E-08	7.6E-06	1.6E+02
179	RWSCVEL012B	RWS-VLV-012B EXTERNAL LEAK LARGE	4.8E-08	7.6E-06	1.6E+02
180	RWSCVEL027	SFS-VLV-027 EXTERNAL LEAK LARGE	4.8E-08	7.6E-06	1.6E+02
181	RWSCVEL065A	NCS-VLV-065A EXTERNAL LEAK LARGE	4.8E-08	7.6E-06	1.6E+02
182	RWSCVEL012A	RWS-VLV-012A EXTERNAL LEAK LARGE	4.8E-08	7.6E-06	1.6E+02
183	RWSCVEL065B	NCS-VLV-065B EXTERNAL LEAK LARGE	4.8E-08	7.6E-06	1.6E+02
184	RWSPNELPIPE4	RWS PIPING BETWEEN RWS-VLV-004 AND RWSAT EXTERNAL LEAK LARGE	6.0E-10	9.5E-08	1.6E+02
185	RWSCF4SUPR001-234	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	5.4E-04	1.5E+02
186	EPSCF4IVFF001-124	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	7.2E-05	1.5E+02
187	RSSCF4PMAD001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.9E-05	2.6E-03	1.4E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 11 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
188	EPSCF4CBSO52STH-134	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.1E-06	1.4E+02
189	EPSCF4CBSO52STL-124	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.1E-06	1.4E+02
190	RSSCF4PMSR001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	5.0E-06	7.0E-04	1.4E+02
191	RSSCF4RHPR001-ALL	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	4.8E-06	6.7E-04	1.4E+02
192	RSSCF4CVOD004-ALL	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	4.3E-07	6.0E-05	1.4E+02
193	RSSCF4PMLR001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.7E-06	2.4E-04	1.4E+02
194	EPSCBFO52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)	2.0E-05	2.8E-03	1.4E+02
195	EPSCBFO52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)	2.0E-05	2.8E-03	1.4E+02
196	RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	8.4E-05	1.2E-02	1.4E+02
197	RSSPNEL05A	RHS RHR OPERATION SUCTION LINE A (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
198	RSSPNEL07C	CSS C/V SPRAY LINE C (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
199	RSSPNEL05D	RHS RHR OPERATION SUCTION LINE D (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
200	RSSPNEL05B	RHS RHR OPERATION SUCTION LINE B (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
201	RSSPNEL05C	RHS RHR OPERATION SUCTION LINE C (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 12 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
202	RSSPNEL08D	RHS ALTERNATE CORE COOLING LINE D (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
203	RSSPNEL11D	RHS PIPING BETWEEN RHS-VLV-031D AND ALTERNATE CORE COOLING LINE EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
204	RSSPNEL08A	RHS ALTERNATE CORE COOLING LINE A (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
205	RSSPNEL10D	CSS PIPING BETWEEN RHS-VLV-034D AND D-CS/RHR PUMP SUCTION LINE EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
206	RSSPNEL07D	CSS C/V SPRAY LINE D (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
207	RSSPNEL04D	RHS D-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
208	RSSPNEL03D	CSS PIPING BETWEEN CSS-MOV-001D AND D-CS/RHR PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
209	RSSPNEL12C	RHS-FCV-621 LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
210	HPIPNELSUCTLA	SIS PIPING A BETWEEN SIS-MOV-001A AND A-SI PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
211	RSSPNEL08B	RHS ALTERNATE CORE COOLING LINE B (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
212	RSSPNEL08C	RHS ALTERNATE CORE COOLING LINE C (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
213	HPIPNELSUCTLB	SIS PIPING B BETWEEN SIS-MOV-001B AND B-SI PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
214	RSSPNEL03B	CSS PIPING BETWEEN CSS-MOV-001B AND B-CS/RHR PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 13 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
215	HPIPNELSUCTLC	SIS PIPING C BETWEEN SIS-MOV-001C AND C-SI PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
216	RSSPNEL04B	RHS B-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
217	HPIPNELSUCTLD	SIS PIPING D BETWEEN SIS-MOV-001D AND D-SI PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
218	RSSPNEL07A	CSS C/V SPRAY LINE A (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
219	RSSPNEL04A	RHS A-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
220	RSSPNEL10A	CSS PIPING BETWEEN RHS-VLV-034A AND A-CS/RHR PUMP SUCTION LINE EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
221	RSSPNEL03A	CSS PIPING BETWEEN CSS-MOV-001A AND A-CS/RHR PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
222	RSSPNEL11A	RHS PIPING BETWEEN RHS-VLV-031A AND ALTERNATE CORE COOLING LINE EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
223	RSSPNEL12B	RHS-FCV-611 LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
224	RSSPNEL03C	CSS PIPING BETWEEN CSS-MOV-001C AND C-CS/RHR PUMP EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
225	RSSPNEL04C	RHS C-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02
226	RSSPNEL07B	CSS C/V SPRAY LINE B (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	8.3E-08	1.4E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 14 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
227	RWSCF4SUPR001-124	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	4.7E-04	1.3E+02
228	EFWCF4CVOD012-234	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	7.9E-06	1.3E+02
229	EPSCF4IVFF001-123	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	6.1E-05	1.2E+02
230	EPSCF4CBSO72AU-124	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.5E-06	1.2E+02
231	EPSCF4CBSO52UA-124	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.5E-06	1.2E+02
232	EPSCBFO52UAT-AD	EPS 52/UATA,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	5.7E-04	1.2E+02
233	EPSCBFO52RAT-AD	EPS 52/RATA,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	5.7E-04	1.2E+02
234	EPSCF4CBSC52UAT-14	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	3.9E-06	1.2E+02
235	EPSCF4CBSC52RAT-14	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	3.9E-06	1.2E+02
236	EPSCF4CBSO52STH-123	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.3E-06	1.1E+02
237	EPSCF4CBSO52STL-123	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.3E-06	1.1E+02
238	EPSCF4CBSO52LC-124	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.3E-06	1.1E+02
239	MSPPNELPA1	NMS MAIN STEAM LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	6.2E-08	1.0E+02
240	EPSCF4CBSO52UA-123	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.9E-06	1.0E+02
241	EPSCF4CBSO72AU-123	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.9E-06	1.0E+02

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 15 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
242	EPSCF4CBSO52STH-24	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	2.8E-06	8.3E+01
243	EPSCF4CBSO52STL-34	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	2.8E-06	8.3E+01
244	EPSCF4CBSO52LC-23	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	2.8E-06	8.3E+01
245	HPICF4PMAD001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	1.1E-04	8.9E-03	8.1E+01
246	HPICF4PMSR001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	8.5E-06	6.6E-04	7.9E+01
247	HPICF4PMLR001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.9E-06	2.2E-04	7.6E+01
248	HPICF4CVOD013-ALL	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	7.4E-05	7.5E+01
249	HPICF4CVOD012-ALL	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	7.4E-05	7.5E+01
250	HPICF4CVOD010-ALL	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	7.4E-05	7.5E+01
251	HPICF4CVOD004-ALL	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	7.4E-05	7.5E+01
252	EPSCBFO52RAT-BCD	EPS 52/RATB,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.7E-04	7.3E+01
253	EPSCF4CBSC52RAT-234	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	2.1E-06	7.3E+01
254	EPSCBFO52UAT-BCD	EPS 52/UATB,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.7E-04	7.3E+01
255	EPSCF4CBSC52UAT-234	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	2.1E-06	7.3E+01
256	EFWCF4CVOD012-134	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	4.3E-06	7.0E+01
257	HPICF4PMAD001-123	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	9.5E-06	5.8E-04	6.2E+01
258	HPICF4PMSR001-123	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	2.0E-04	6.1E+01
259	EPSCBFO52UAT-ABC	EPS 52/UATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.1E-04	6.0E+01
260	EPSCBFO52RAT-ABC	EPS 52/RATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.1E-04	6.0E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 16 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
261	EPSCF4CBSC52UAT-123	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.7E-06	6.0E+01
262	EPSCF4CBSC52RAT-123	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.7E-06	6.0E+01
263	HPICF4PMLR001-123	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-06	6.6E-05	5.9E+01
264	HPICF4CVOD012-123	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.5E-05	5.8E+01
265	HPICF4CVOD010-123	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.5E-05	5.8E+01
266	HPICF4CVOD004-123	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.5E-05	5.8E+01
267	HPICF4CVOD013-123	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.5E-05	5.8E+01
268	EFWXVEL013A	EFS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	3.4E-06	4.9E+01
269	EFWXVEL013D	EFS-VLV-013D EXTERNAL LEAK LARGE	7.2E-08	3.4E-06	4.9E+01
270	EFWCVEL012A	EFS-VLV-012A EXTERNAL LEAK LARGE	4.8E-08	2.3E-06	4.9E+01
271	EFWCVEL012D	EFS-VLV-012D EXTERNAL LEAK LARGE	4.8E-08	2.3E-06	4.9E+01
272	EFWCF4CVOD012-124	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	2.9E-06	4.7E+01
273	EFWCF4CVOD012-123	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	2.9E-06	4.7E+01
274	EFWCVEL018D	EFS-VLV-018D EXTERNAL LEAK LARGE	4.8E-08	2.2E-06	4.6E+01
275	EFWCVEL018A	EFS-VLV-018A EXTERNAL LEAK LARGE	4.8E-08	2.2E-06	4.6E+01
276	EPSCF4CBSO52LC-134	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.3E-06	4.4E+01
277	EPSCF4DLLRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	1.0E-02	4.2E+01
278	EPSCF4DLADDG-134	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	2.2E-03	4.2E+01
279	EPSCF4DLSRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	1.6E-03	4.2E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 17 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
280	EPSCF4SEFFDG-234	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	5.1E-04	4.2E+01
281	EPSCF4CBFC52EPS-123	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	2.1E-04	4.2E+01
282	EPSCF4CBSO52EPS-234	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.2E-06	4.2E+01
283	EFWMVEL014D	EFS-MOV-014D EXTERNAL LEAK LARGE	2.4E-08	9.8E-07	4.2E+01
284	EFWMVEL017D	EFS-MOV-017D EXTERNAL LEAK LARGE	2.4E-08	9.8E-07	4.2E+01
285	EFWPNELSGD	EFS D-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	2.5E-08	4.2E+01
286	EFWMVEL019D	EFS-MOV-019D EXTERNAL LEAK LARGE	2.4E-08	9.4E-07	4.0E+01
287	EFWMVEL019A	EFS-MOV-019A EXTERNAL LEAK LARGE	2.4E-08	9.4E-07	4.0E+01
288	EFWMVEL017A	EFS-MOV-017A EXTERNAL LEAK LARGE	2.4E-08	9.4E-07	4.0E+01
289	EFWMVEL014A	EFS-MOV-014A EXTERNAL LEAK LARGE	2.4E-08	9.4E-07	4.0E+01
290	EFWPNELSGA	EFS A-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	2.4E-08	4.0E+01
291	RWSCF4SUPR001-23	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	1.1E-04	3.7E+01
292	EPSCF4CBSO52STL-14	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.1E-06	3.5E+01
293	EPSCF4CBSO52STH-14	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.1E-06	3.5E+01
294	EFWCF2PTAD001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO START (CCF)	4.5E-04	1.5E-02	3.5E+01
295	EFWCF2PTSR001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.1E-04	3.8E-03	3.5E+01
296	EFWCF2PTLR001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	7.2E-05	2.4E-03	3.5E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 18 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
297	EFWCVOD008B	EFS-VLV-008B FAIL TO OPEN	9.6E-06	3.2E-04	3.4E+01
298	EFWCVPR008B	EFS-VLV-008B PLUG	2.4E-06	7.9E-05	3.4E+01
299	EFWCVEL008B	EFS-VLV-008B EXTERNAL LEAK LARGE	4.8E-08	1.6E-06	3.4E+01
300	PZRSVCD121	RCS-VLV-121 FAIL TO RE-CLOSE	7.0E-05	2.3E-03	3.4E+01
301	PZRSVCD122	RCS-VLV-122 FAIL TO RE-CLOSE	7.0E-05	2.3E-03	3.4E+01
302	PZRSVCD123	RCS-VLV-123 FAIL TO RE-CLOSE	7.0E-05	2.3E-03	3.4E+01
303	PZRSVCD120	RCS-VLV-120 FAIL TO RE-CLOSE	7.0E-05	2.3E-03	3.4E+01
304	EFWCF2MVOD103-ALL	EFS-MOV-103A,D FAIL TO OPEN (CCF)	4.2E-05	1.4E-03	3.4E+01
305	SGNBTSWCCF3	NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF	1.0E-04	3.2E-03	3.3E+01
306	EFWXVPR007B	EFS-VLV-007B PLUG	2.4E-06	7.6E-05	3.3E+01
307	EFWXVEL009D	EFS-VLV-009D EXTERNAL LEAK LARGE	7.2E-08	2.3E-06	3.3E+01
308	EFWXVEL007B	EFS-VLV-007B EXTERNAL LEAK LARGE	7.2E-08	2.3E-06	3.3E+01
309	EFWXVEL009C	EFS-VLV-009C EXTERNAL LEAK LARGE	7.2E-08	2.3E-06	3.3E+01
310	EFWTNEL001B	EFS-RPT-001B (B-EFW PIT) EXTERNAL LEAK LARGE	4.8E-08	1.5E-06	3.3E+01
311	EFWPNELCSTB	EFS B-EFW PIT OUTLET PIPING EXTERNAL LEAK LARGE	6.0E-10	1.9E-08	3.3E+01
312	CHICF2PMBD001-ALL	CVS-RPP-001A,B (CHI PUMP) FAIL TO START (CCF)	2.0E-04	6.2E-03	3.2E+01
313	CHIORPR170	CVS-FE-170 (ORIFICE) PLUG	2.4E-05	7.3E-04	3.1E+01
314	CHIORPR150	CVS-FE-150 (ORIFICE) PLUG	2.4E-05	7.3E-04	3.1E+01
315	CHIORPR180	CVS-FE-180 (ORIFICE) PLUG	2.4E-05	7.3E-04	3.1E+01
316	CHIORPR160	CVS-FE-160 (ORIFICE) PLUG	2.4E-05	7.3E-04	3.1E+01
317	CHICVOD179C	CVS-VLV-179C FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
318	CHICVOD179A	CVS-VLV-179A FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
319	CHICVOD179B	CVS-VLV-179B FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
320	CHICVOD182A	CVS-VLV-182A FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 19 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
321	CHICVOD181D	CVS-VLV-181D FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
322	CHICVOD182B	CVS-VLV-182B FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
323	CHICVOD182D	CVS-VLV-182D FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
324	CHICVOD182C	CVS-VLV-182C FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
325	CHICVOD181B	CVS-VLV-181B FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
326	CHICVOD181C	CVS-VLV-181C FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
327	CHICVOD179D	CVS-VLV-179D FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
328	CHICVOD181A	CVS-VLV-181A FAIL TO OPEN	1.2E-05	3.6E-04	3.1E+01
329	CHIAVCM165	CVS-AOV-165 SPURIOUS CLOSE	4.8E-06	1.5E-04	3.1E+01
330	CHIAVCM140	CVS-FCV-140 SPURIOUS CLOSE	4.8E-06	1.5E-04	3.1E+01
331	CHIXVPR177C	CVS-VLV-177C PLUG	2.4E-06	7.3E-05	3.1E+01
332	CHICVPR179B	CVS-VLV-179B PLUG	2.4E-06	7.3E-05	3.1E+01
333	CHIXVPR173	CVS-VLV-173 PLUG	2.4E-06	7.3E-05	3.1E+01
334	CHIXVPR168	CVS-VLV-168 PLUG	2.4E-06	7.3E-05	3.1E+01
335	CHICVPR182D	CVS-VLV-182D PLUG	2.4E-06	7.3E-05	3.1E+01
336	CHICVPR179C	CVS-VLV-179C PLUG	2.4E-06	7.3E-05	3.1E+01
337	CHICVPR182C	CVS-VLV-182C PLUG	2.4E-06	7.3E-05	3.1E+01
338	CHIFLPR003B	CVS-KFT-003B (SEAL WATER INJECTION FILTER) PLUG	2.4E-06	7.3E-05	3.1E+01
339	CHIAVPR140	CVS-FCV-140 PLUG	2.4E-06	7.3E-05	3.1E+01
340	CHIXVPR177B	CVS-VLV-177B PLUG	2.4E-06	7.3E-05	3.1E+01
341	CHIMVPR178B	CVS-MOV-178B PLUG	2.4E-06	7.3E-05	3.1E+01
342	CHIXVPR180D	CVS-VLV-180D PLUG	2.4E-06	7.3E-05	3.1E+01
343	CHIXVPR180C	CVS-VLV-180C PLUG	2.4E-06	7.3E-05	3.1E+01
344	CHIXVPR177A	CVS-VLV-177A PLUG	2.4E-06	7.3E-05	3.1E+01
345	CHIXVPR180A	CVS-VLV-180A PLUG	2.4E-06	7.3E-05	3.1E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 20 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
346	CHIXVPR177D	CVS-VLV-177D PLUG	2.4E-06	7.3E-05	3.1E+01
347	CHIXVPR180B	CVS-VLV-180B PLUG	2.4E-06	7.3E-05	3.1E+01
348	CHIAVPR165	CVS-AOV-165 PLUG	2.4E-06	7.3E-05	3.1E+01
349	CHICVPR179A	CVS-VLV-179A PLUG	2.4E-06	7.3E-05	3.1E+01
350	CHIMVPR178C	CVS-MOV-178C PLUG	2.4E-06	7.3E-05	3.1E+01
351	CHICVPR181D	CVS-VLV-181D PLUG	2.4E-06	7.3E-05	3.1E+01
352	CHIMVPR178A	CVS-MOV-178A PLUG	2.4E-06	7.3E-05	3.1E+01
353	CHICVPR181A	CVS-VLV-181A PLUG	2.4E-06	7.3E-05	3.1E+01
354	CHIMVPR178D	CVS-MOV-178D PLUG	2.4E-06	7.3E-05	3.1E+01
355	CHICVPR181B	CVS-VLV-181B PLUG	2.4E-06	7.3E-05	3.1E+01
356	CHICVPR182A	CVS-VLV-182A PLUG	2.4E-06	7.3E-05	3.1E+01
357	CHIXVPR164	CVS-VLV-164 PLUG	2.4E-06	7.3E-05	3.1E+01
358	CHICVPR181C	CVS-VLV-181C PLUG	2.4E-06	7.3E-05	3.1E+01
359	CHIXVPR170B	CVS-VLV-170B PLUG	2.4E-06	7.3E-05	3.1E+01
360	CHICVPR179D	CVS-VLV-179D PLUG	2.4E-06	7.3E-05	3.1E+01
361	CHIXVPR171B	CVS-VLV-171B PLUG	2.4E-06	7.3E-05	3.1E+01
362	CHIXVPR166	CVS-VLV-166 PLUG	2.4E-06	7.3E-05	3.1E+01
363	CHICVPR182B	CVS-VLV-182B PLUG	2.4E-06	7.3E-05	3.1E+01
364	CHIMVCM178A	CVS-MOV-178A SPURIOUS CLOSE	9.6E-07	2.9E-05	3.1E+01
365	CHIMVCM178B	CVS-MOV-178B SPURIOUS CLOSE	9.6E-07	2.9E-05	3.1E+01
366	CHIMVCM178C	CVS-MOV-178C SPURIOUS CLOSE	9.6E-07	2.9E-05	3.1E+01
367	CHIMVCM178D	CVS-MOV-178D SPURIOUS CLOSE	9.6E-07	2.9E-05	3.1E+01
368	ACWCF2MVCD316-ALL	NCS-MOV-316A,B FAIL TO CLOSE (CCF)	4.7E-05	1.4E-03	3.1E+01
369	ACWCF2MVOD322-ALL	NCS-MOV-322A,B FAIL TO OPEN (CCF)	4.7E-05	1.4E-03	3.1E+01
370	ACWCF2MVOD324-ALL	NCS-MOV-324A,B FAIL TO OPEN (CCF)	4.7E-05	1.4E-03	3.1E+01
371	CHIMVPR121B	CVS-LCV-121B PLUG	2.4E-06	7.2E-05	3.1E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 21 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
372	CHIMVPR121C	CVS-LCV-121C PLUG	2.4E-06	7.2E-05	3.1E+01
373	CHICVPR125	CVS-VLV-125 PLUG	2.4E-06	7.2E-05	3.1E+01
374	CHIMVCM121C	CVS-LCV-121C SPURIOUS CLOSE	9.6E-07	2.9E-05	3.1E+01
375	CHIMVCM121B	CVS-LCV-121B SPURIOUS CLOSE	9.6E-07	2.9E-05	3.1E+01
376	CHITNEL001	CVS-RTK-001 (VCT) EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
377	EFWCVOD008A	EFS-VLV-008A FAIL TO OPEN	9.6E-06	2.9E-04	3.1E+01
378	EFWCVPR008A	EFS-VLV-008A PLUG	2.4E-06	7.2E-05	3.1E+01
379	EFWCVEL008A	EFS-VLV-008A EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
380	ACWCF2CVCD306-ALL	NCS-VLV-306A,B FAIL TO CLOSE (CCF)	4.7E-06	1.4E-04	3.1E+01
381	CHIRIEL001	CVS-CHX-001 (REGENERATIVE HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	2.1E-05	3.1E+01
382	CHIPMEL001B	CVS-RPP-001B (B-CHI PUMP) EXTERNAL LEAK LARGE	1.9E-07	5.7E-06	3.1E+01
383	CHIPMEL001A	CVS-RPP-001A (A-CHI PUMP) EXTERNAL LEAK LARGE	1.9E-07	5.7E-06	3.1E+01
384	CHIXVEL167	CVS-VLV-167 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
385	CHIXVEL147	CVS-VLV-147 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
386	CHIXVEL144	CVS-VLV-144 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
387	CHIXVEL132A	CVS-VLV-132A EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
388	CHIXVEL126A	CVS-VLV-126A EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
389	CHIXVEL170B	CVS-VLV-170B EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
390	CHIXVEL130B	CVS-VLV-130B EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
391	CHIXVEL132B	CVS-VLV-132B EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
392	CHIXVEL171B	CVS-VLV-171B EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
393	CHIXVEL166	CVS-VLV-166 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
394	CHIXVEL145	CVS-VLV-145 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 22 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
395	CHIXVEL163	CVS-VLV-163 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
396	CHIXVEL126B	CVS-VLV-126B EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
397	CHIXVEL164	CVS-VLV-164 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
398	CHIXVEL173	CVS-VLV-173 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
399	CHIXVEL168	CVS-VLV-168 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
400	CHIXVEL130A	CVS-VLV-130A EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
401	CHIXVEL133	CVS-VLV-133 EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.1E+01
402	CHICVEL131B	CVS-VLV-131B EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
403	CHICVEL160	CVS-VLV-160 EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
404	CHICVEL129B	CVS-VLV-129B EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
405	CHICVEL153	CVS-VLV-153 EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
406	CHICVEL125	CVS-VLV-125 EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
407	CHICVEL161	CVS-VLV-161 EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
408	CHICVEL131A	CVS-VLV-131A EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
409	CHICVEL129A	CVS-VLV-129A EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.1E+01
410	CHIMVEL151	CVS-MOV-151 EXTERNAL LEAK LARGE	2.4E-08	7.1E-07	3.1E+01
411	CHIMVEL121C	CVS-LCV-121C EXTERNAL LEAK LARGE	2.4E-08	7.1E-07	3.1E+01
412	CHIMVEL152	CVS-MOV-152 EXTERNAL LEAK LARGE	2.4E-08	7.1E-07	3.1E+01
413	CHIMVEL121B	CVS-LCV-121B EXTERNAL LEAK LARGE	2.4E-08	7.1E-07	3.1E+01
414	CHIAVEL138	CVS-FCV-138 EXTERNAL LEAK LARGE	2.2E-08	6.4E-07	3.1E+01
415	CHIAVEL146	CVS-AOV-146 EXTERNAL LEAK LARGE	2.2E-08	6.4E-07	3.1E+01
416	CHIAVEL140	CVS-FCV-140 EXTERNAL LEAK LARGE	2.2E-08	6.4E-07	3.1E+01
417	CHIAVEL159	CVS-AOV-159 EXTERNAL LEAK LARGE	2.2E-08	6.4E-07	3.1E+01
418	CHIAVEL165	CVS-AOV-165 EXTERNAL LEAK LARGE	2.2E-08	6.4E-07	3.1E+01
419	CHIAVEL155	CVS-AOV-155 EXTERNAL LEAK LARGE	2.2E-08	6.4E-07	3.1E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 23 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
420	CHIPNELPIPE1	CVS CHARGING INJECTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.8E-08	3.1E+01
421	CHICF2PMYR001-R-ALL	CVS-RPP-001A,B (CHI PUMP) FAIL TO RUN (CCF)	5.0E-06	1.5E-04	3.0E+01
422	EFWXVPR007A	EFS-VLV-007A PLUG	2.4E-06	7.1E-05	3.0E+01
423	EFWXVEL009B	EFS-VLV-009B EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.0E+01
424	EFWXVEL007A	EFS-VLV-007A EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.0E+01
425	EFWXVEL009A	EFS-VLV-009A EXTERNAL LEAK LARGE	7.2E-08	2.1E-06	3.0E+01
426	EFWTNEL001A	EFS-RPT-001A (A-EFW PIT) EXTERNAL LEAK LARGE	4.8E-08	1.4E-06	3.0E+01
427	EFWPNELCSTA	EFS A-EFW PIT OUTLET PIPING EXTERNAL LEAK LARGE	6.0E-10	1.8E-08	3.0E+01
428	EPSCF4CBSO52LC-34	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	9.5E-07	2.9E+01
429	MSRCF4AVCD515-ALL	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	1.8E-04	4.9E-03	2.9E+01
430	MSRCF4AVCD515-13	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	1.5E-03	2.9E+01
431	MSRCF4AVCD515-23	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	1.5E-03	2.9E+01
432	MSRCF4AVCD515-34	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	1.5E-03	2.9E+01
433	MSRCF4AVCD515-123	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	7.2E-04	2.9E+01
434	MSRCF4AVCD515-134	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	7.2E-04	2.9E+01
435	MSRCF4AVCD515-234	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	7.2E-04	2.9E+01
436	MSRCF4AVCD515-24	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	1.4E-03	2.9E+01
437	MSRCF4AVCD515-14	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	1.4E-03	2.9E+01
438	MSRCF4AVCD515-12	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	1.4E-03	2.9E+01
439	MSRCF4AVCD515-124	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	7.2E-04	2.9E+01
440	EFWCF4CVOD012-24	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	6.2E-06	2.8E+01
441	EPSCF4CBSO72DD1-ALL	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	4.3E-06	2.8E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 24 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
442	EPSCF4CBSO72DD2-ALL	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	4.3E-06	2.8E+01
443	EPSCF4CBSO72DD1-12	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	9.2E-07	2.8E+01
444	EPSCF4CBSO72DD2-14	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	9.2E-07	2.8E+01
445	EPSCF4CBSO72DD2-124	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.0E-07	2.8E+01
446	EPSCF4CBSO72DD1-124	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.0E-07	2.8E+01
447	EPSCF4CBSO72DD1-123	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.0E-07	2.8E+01
448	EPSCF4CBSO72DD2-134	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.0E-07	2.8E+01
449	CHIXVEL180B	CVS-VLV-180B EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
450	CHIXVEL180A	CVS-VLV-180A EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
451	CHIXVEL177A	CVS-VLV-177A EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
452	CHIXVEL177C	CVS-VLV-177C EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
453	CHIXVEL177B	CVS-VLV-177B EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
454	CHIXVEL180D	CVS-VLV-180D EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
455	CHIXVEL180C	CVS-VLV-180C EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
456	CHIXVEL177D	CVS-VLV-177D EXTERNAL LEAK LARGE	7.2E-08	1.9E-06	2.8E+01
457	CHICVEL179A	CVS-VLV-179A EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
458	CHICVEL179D	CVS-VLV-179D EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
459	CHICVEL179C	CVS-VLV-179C EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
460	CHICVEL179B	CVS-VLV-179B EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 25 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
461	CHICVEL182C	CVS-VLV-182C EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
462	CHICVEL182B	CVS-VLV-182B EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
463	CHICVEL181A	CVS-VLV-181A EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
464	CHICVEL182D	CVS-VLV-182D EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
465	CHICVEL181C	CVS-VLV-181C EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
466	CHICVEL181B	CVS-VLV-181B EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
467	CHICVEL182A	CVS-VLV-182A EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
468	CHICVEL181D	CVS-VLV-181D EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
469	CHIMVEL178D	CVS-MOV-178D EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
470	CHIMVEL178C	CVS-MOV-178C EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
471	CHIMVEL178B	CVS-MOV-178B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
472	CHIMVEL178A	CVS-MOV-178A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
473	CHICVEL595	CVS-VLV-595 EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
474	ACWCVEL306A	NCS-VLV-306A EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
475	ACWCVEL306B	NCS-VLV-306B EXTERNAL LEAK LARGE	4.8E-08	1.3E-06	2.8E+01
476	ACWMVEL316A	NCS-MOV-316A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
477	ACWMVEL316B	NCS-MOV-316B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
478	ACWMVEL326B	NCS-MOV-326B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
479	ACWMVEL322B	NCS-MOV-322B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
480	ACWMVEL321B	NCS-MOV-321B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
481	ACWMVEL326A	NCS-MOV-326A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
482	ACWMVEL323B	NCS-MOV-323B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
483	ACWMVEL325B	NCS-MOV-325B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
484	ACWMVEL324A	NCS-MOV-324A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
485	ACWMVEL321A	NCS-MOV-321A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
486	ACWMVEL322A	NCS-MOV-322A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 26 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
487	ACWMVEL325A	NCS-MOV-325A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
488	ACWMVEL324B	NCS-MOV-324B EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
489	ACWMVEL323A	NCS-MOV-323A EXTERNAL LEAK LARGE	2.4E-08	6.4E-07	2.8E+01
490	ACWPNELPIPEB2	ALTERNATIVE CCW B-CHI PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.6E-08	2.8E+01
491	ACWPNELPIPEA2	ALTERNATIVE CCW A-CHI PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.6E-08	2.8E+01
492	ACWPNELPIPEA1	ALTERNATIVE CCW A-CHI PUMP SUCTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.6E-08	2.8E+01
493	ACWPNELPIPEB1	ALTERNATIVE CCW B-CHI PUMP SUCTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.6E-08	2.8E+01
494	EFWCF4CVOD012-13	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	6.0E-06	2.7E+01
495	EFWCF4CVOD012-34	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	5.9E-06	2.7E+01
496	SWSCF4PMBD001-R-124	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	4.0E-04	2.7E+01
497	CWSCF4PCBD001-R-123	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	2.1E-04	2.7E+01
498	EFWCF4MVFC017-14	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	1.4E-05	2.6E+01
499	EFWXVEL026B	EFS-VLV-026B EXTERNAL LEAK LARGE	7.2E-08	1.7E-06	2.5E+01
500	EFWPNELTESTB	EFS C,D-EFW PUMP TEST LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.4E-08	2.5E+01
501	EFWCF4CVOD018-23	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	5.4E-06	2.5E+01
502	EPSCBFO52RAT-CD	EPS 52/RATC,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.2E-04	2.5E+01
503	EPSCF4CBSC52RAT-34	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	8.0E-07	2.5E+01
504	EPSCBFO52UAT-CD	EPS 52/UATC,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.2E-04	2.5E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 27 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
505	EPSCF4CBSC52UAT-34	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	8.0E-07	2.5E+01
506	EFWXVEL013B	EFS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	1.7E-06	2.4E+01
507	EFWXVEL013C	EFS-VLV-013C EXTERNAL LEAK LARGE	7.2E-08	1.7E-06	2.4E+01
508	EFWCVEL012B	EFS-VLV-012B EXTERNAL LEAK LARGE	4.8E-08	1.1E-06	2.4E+01
509	EFWCVEL012C	EFS-VLV-012C EXTERNAL LEAK LARGE	4.8E-08	1.1E-06	2.4E+01
510	EFWCF4MVFC017-13	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	1.3E-05	2.4E+01
511	EFWCF4MVFC017-34	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	1.3E-05	2.4E+01
512	EFWXVEL026A	EFS-VLV-026A EXTERNAL LEAK LARGE	7.2E-08	1.7E-06	2.4E+01
513	EFWPNELTESTA	EFS A,B-EFW PUMP TEST LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.4E-08	2.4E+01
514	EFWCF4CVOD018-13	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	5.2E-06	2.4E+01
515	EFWCF4CVOD018-12	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	5.2E-06	2.4E+01
516	EFWCVEL018C	EFS-VLV-018C EXTERNAL LEAK LARGE	4.8E-08	1.0E-06	2.2E+01
517	EFWCVEL018B	EFS-VLV-018B EXTERNAL LEAK LARGE	4.8E-08	1.0E-06	2.2E+01
518	PZRCF2MVOD117-ALL	RCS-MOV-117A,B FAIL TO OPEN (CCF)	1.3E-04	2.4E-03	2.0E+01
519	SGNBTSWCCF1	GROUP-1 APPLICATION SOFTWARE CCF	1.0E-05	1.8E-04	1.9E+01
520	RWSCF4SUPR001-12	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	5.4E-05	1.9E+01
521	SWSCF4PMBD001-R-134	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	2.7E-04	1.9E+01
522	CWSCF4PCBD001-R-124	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	1.5E-04	1.9E+01
523	EFWMVEL017B	EFS-MOV-017B EXTERNAL LEAK LARGE	2.4E-08	4.1E-07	1.8E+01
524	EFWMVEL014B	EFS-MOV-014B EXTERNAL LEAK LARGE	2.4E-08	4.1E-07	1.8E+01
525	EFWMVEL017C	EFS-MOV-017C EXTERNAL LEAK LARGE	2.4E-08	4.1E-07	1.8E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 28 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
526	EFWMVEL014C	EFS-MOV-014C EXTERNAL LEAK LARGE	2.4E-08	4.1E-07	1.8E+01
527	EFWPNELSGC	EFS C-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.0E-08	1.8E+01
528	EFWPNELSGB	EFS B-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.0E-08	1.8E+01
529	EPSCF4IVFF001-134	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	8.2E-06	1.7E+01
530	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	1.8E-01	1.7E+01
531	EFWMVEL019B	EFS-MOV-019B EXTERNAL LEAK LARGE	2.4E-08	3.7E-07	1.7E+01
532	EFWMVEL019C	EFS-MOV-019C EXTERNAL LEAK LARGE	2.4E-08	3.7E-07	1.7E+01
533	EPSCF4DLLRDG-134	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	3.9E-03	1.7E+01
534	EPSCF4DLADDG-124	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	8.1E-04	1.7E+01
535	EPSCF4DLSRDG-134	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	6.1E-04	1.7E+01
536	EPSCF4SEFFDG-134	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	1.9E-04	1.7E+01
537	EPSCF4CBFC52EPS-124	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	8.1E-05	1.7E+01
538	EPSCF4CBSO52EPS-134	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.5E-07	1.7E+01
539	SWSCF4PMBD001-R-234	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	2.4E-04	1.7E+01
540	CWSCF4PCBD001-R-134	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	1.3E-04	1.6E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 29 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
541	EPSCF4IVFF002-ALL	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	1.5E-06	2.2E-05	1.6E+01
542	EPSCF2CBSO52LL2-ALL	EPS 52/LLDA,LLDD (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	4.1E-06	1.5E+01
543	EPSCF2CBSO52LC1-ALL	EPS 52/LCA1,D1 (BREAKER) SPURIOUS CLOSE (CCF)	2.8E-07	4.1E-06	1.5E+01
544	EPSCF2CBSO52LL1-ALL	EPS 52/LLAA,LLAD (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	4.1E-06	1.5E+01
545	RTPCF4ICYRRT7001-235	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.3E-06	1.5E+01
546	RTPCF4ICYRRT7001-245	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.3E-06	1.5E+01
547	RTPCF4ICYRRT7001-345	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.3E-06	1.5E+01
548	RTPCF4ICYRRT7001-234	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.3E-06	1.5E+01
549	CWSCF4CVOD016-R-134	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	7.1E-07	1.5E+01
550	SWSCF4CVOD602-R-234	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	7.1E-07	1.5E+01
551	SWSCF4CVOD502-R-234	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	7.1E-07	1.5E+01
552	EPSCF4DLLRDG-124	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	3.5E-03	1.5E+01
553	EPSCF4DLADDG-123	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	7.3E-04	1.5E+01
554	EPSCF4DLSRDG-124	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	5.5E-04	1.5E+01
555	EPSCF4SEFFDG-124	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	1.8E-04	1.5E+01
556	EPSCF4CBFC52EPS-234	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	7.2E-05	1.5E+01
557	EPSCF4CBSO52EPS-124	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.1E-07	1.5E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 30 of 34)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
558	EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.5E-03	2.1E-02	1.5E+01
559	EPSCF2DLADDGP-ALL	EPS AAC GTG A,B FAIL TO START (CCF)	3.1E-04	4.3E-03	1.5E+01
560	EPSCF2DLSRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	2.3E-04	3.3E-03	1.5E+01
561	EPSCF2SEFFDGP-ALL	EPS AAC GTG A,B SEQUENCER FAIL TO OPERATE (CCF)	1.4E-04	2.0E-03	1.5E+01
562	EPSCF2CBFC52AAC2-ALL	EPS 52/AACAP,52/AACBP (BREAKER) FAIL TO CLOSE (CCF)	2.8E-05	4.0E-04	1.5E+01
563	EPSCF2CBSO5AAC2-ALL	EPS 52/AACAP,52/AACBP (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	4.0E-06	1.5E+01
564	EPPBTSWCCF	BO-SIGNAL (TRAIN P1,2) SOFTWARE CCF	1.0E-04	1.4E-03	1.5E+01
565	EPPBTHWCCF	BO-SIGNAL (TRAIN P1,2) HARDWARE CCF	2.1E-06	3.0E-05	1.5E+01
566	EPSCF2CBFC52AAC-ALL	EPS 52/AACA,D (BREAKER) FAIL TO CLOSE (CCF)	2.8E-05	3.9E-04	1.5E+01
567	EPSCF2CBFC89AAC-ALL	EPS 89/AACA,D (SELECTER CIRCUIT) FAIL TO CLOSE (CCF)	2.8E-05	3.9E-04	1.5E+01
568	EPSCF2CBFO52EPS-ALL	EPS 52/EPSA,D (BREAKER) FAIL TO OPEN (CCF)	2.8E-05	3.9E-04	1.5E+01
569	EPSCF2CBSO52AAC-ALL	EPS 52/AACA,D (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	3.9E-06	1.5E+01
570	EPSCF2CBSC52EPS-ALL	EPS 52/EPSA,D (BREAKER) SPURIOUS CLOSE (CCF)	2.8E-07	3.9E-06	1.5E+01
571	EPSCF2CBSO89AAC-ALL	EPS 89/AACA,D (SELECTER CIRCUIT) SPURIOUS OPEN (CCF)	2.8E-07	3.9E-06	1.5E+01
572	EPSCF4DLLRDG-123	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	3.4E-03	1.5E+01
573	EPSCF4DLADDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	7.1E-04	1.5E+01
574	EPSCF4DLSRDG-123	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	5.3E-04	1.5E+01

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 31 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
575	EPSCF4SEFFDG-123	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	1.7E-04	1.5E+01
576	EPSCF4CBFC52EPS-134	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	7.1E-05	1.5E+01
577	EPSCF4CBSO52EPS-123	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.0E-07	1.5E+01
578	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	2.9E-01	1.5E+01
579	EPSBSFFAM001D	ESS-AM-001D (D CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	7.8E-05	1.4E+01
580	EPSCF4IVFF001-234	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	6.6E-06	1.4E+01
581	HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP	3.8E-03	4.2E-02	1.2E+01
582	HPICF4PMAD001-234	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	9.5E-06	1.0E-04	1.2E+01
583	EPSBSFFDD001D	ESS-DD-001D (D DC SWITCHBOARD BUS) FAILURE	5.8E-06	6.0E-05	1.1E+01
584	SWSCF4PMBD001-R-123	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	1.5E-04	1.1E+01
585	HPICF4PMSR001-234	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	3.2E-05	1.1E+01
586	CWSCF4PCBD001-R-234	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	8.2E-05	1.1E+01
587	HPICF4PMLR001-234	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-06	1.0E-05	9.8E+00
588	SWSCF4CVOD602-R-134	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	4.3E-07	9.7E+00
589	CWSCF4CVOD016-R-124	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	4.3E-07	9.7E+00
590	SWSCF4CVOD502-R-134	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	4.3E-07	9.7E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 32 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
591	RWSCF4SUPR001-134	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	3.1E-05	9.5E+00
592	HPICF4CVOD010-234	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	2.1E-06	9.0E+00
593	HPICF4CVOD012-234	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	2.1E-06	9.0E+00
594	HPICF4CVOD004-234	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	2.1E-06	9.0E+00
595	HPICF4CVOD013-234	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	2.1E-06	9.0E+00
596	HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	2.6E-03	2.1E-02	9.0E+00
597	SWSCF2PMYR001AC-ALL	EWS-OPP-001A,C (ESW PUMP) FAIL TO RUN (CCF)	8.9E-06	6.7E-05	8.5E+00
598	HPICF4PMAD001-23	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	2.2E-05	1.6E-04	8.4E+00
599	EPSCF4CBSO72AU-134	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.0E-07	7.8E+00
600	EPSCF4CBSO72AU-234	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.0E-07	7.8E+00
601	EPSCF4CBSO52UA-234	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.0E-07	7.8E+00
602	EPSCF4CBSO52UA-134	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.0E-07	7.8E+00
603	EPSCBFO52RAT-AC	EPS 52/RATA,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	3.4E-05	7.8E+00
604	EPSCBFO52UAT-AC	EPS 52/UATA,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	3.4E-05	7.8E+00
605	EPSCF4CBSC52UAT-13	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	2.3E-07	7.8E+00
606	EPSCF4CBSC52RAT-13	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	2.3E-07	7.8E+00
607	HPICF4PMSR001-23	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.6E-06	2.4E-05	7.6E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 33 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
608	RSSCF4PMAD001-123	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	4.0E-05	7.5E+00
609	EPSCF4IVFF001-13	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	6.0E-06	7.0E+00
610	HPICF4PMLR001-23	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.2E-06	7.4E-06	7.0E+00
611	RSSCF4PMAD001-134	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	3.6E-05	6.8E+00
612	SWSCF2PMYR001BD-ALL	EWS-OPP-001B,D (ESW PUMP) FAIL TO RUN (CCF)	8.9E-06	5.1E-05	6.7E+00
613	CWSCF2PCYR001AC-ALL	NCS-RPP-001A,C (CCW PUMP) FAIL TO RUN (CCF)	5.0E-06	2.8E-05	6.7E+00
614	SWSCF4CVOD602-R-124	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	2.8E-07	6.6E+00
615	CWSCF4CVOD016-R-123	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	2.8E-07	6.6E+00
616	SWSCF4CVOD502-R-124	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	2.8E-07	6.6E+00
617	RSSCF4PMSR001-234	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	9.0E-06	6.4E+00
618	SGNOO04ICVR12	(HE) MISCALIBRATION OF C/V PRESSURE SENSORS A,B,C,D	6.7E-05	3.5E-04	6.3E+00
619	SGNCF4ICVR0012-ALL	CONTAINMENT PRESSURE SENSOR CCF	1.3E-06	6.7E-06	6.3E+00
620	SWSCF2PMBD001BD-ALL	EWS-OPP-001B,D (ESW PUMP) FAIL TO START (CCF)	1.4E-04	7.0E-04	6.1E+00
621	RSSCF4MVOD145-234	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	7.3E-06	6.0E+00
622	EPSCF4IVFF001-12	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	5.0E-06	6.0E+00
623	EPSCF4IVFF001-24	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	5.0E-06	6.0E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 34 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
624	RSSCF4PMSR001-124	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	8.2E-06	5.9E+00
625	SWSSTPRST05	EWS-ST05 (STRAINER) PLUG	1.7E-04	8.1E-04	5.8E+00
626	SWSXVPR506C	EWS-VLV-506C PLUG	2.4E-06	1.2E-05	5.8E+00
627	SWSXVPR508C	EWS-VLV-508C PLUG	2.4E-06	1.2E-05	5.8E+00
628	SWSMVPR503C	EWS-MOV-503C PLUG	2.4E-06	1.2E-05	5.8E+00
629	SWSCVPR502C	EWS-VLV-502C PLUG	2.4E-06	1.2E-05	5.8E+00
630	SWSMVCM503C	EWS-MOV-503C SPURIOUS CLOSE	9.6E-07	4.6E-06	5.8E+00
631	SWSXVEL507C	EWS-VLV-507C EXTERNAL LEAK LARGE	7.2E-08	3.5E-07	5.8E+00
632	SWSXVEL508C	EWS-VLV-508C EXTERNAL LEAK LARGE	7.2E-08	3.5E-07	5.8E+00
633	SWSXVEL701C	EWS-VLV-701C EXTERNAL LEAK LARGE	7.2E-08	3.5E-07	5.8E+00
634	SWSXVEL509C	EWS-VLV-509C EXTERNAL LEAK LARGE	7.2E-08	3.5E-07	5.8E+00
635	SWSXVEL506C	EWS-VLV-506C EXTERNAL LEAK LARGE	7.2E-08	3.5E-07	5.8E+00
636	SWSCVEL502C	EWS-VLV-502C EXTERNAL LEAK LARGE	4.8E-08	2.3E-07	5.8E+00
637	SWSMVEL503C	EWS-MOV-503C EXTERNAL LEAK LARGE	2.4E-08	1.2E-07	5.8E+00
638	SWSPEELSWPC1	EWS C-ESW PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	1.7E-08	5.8E+00
639	SWSPMYR001C	EWS-OPP-001C (C-ESW PUMP) FAIL TO RUN	1.1E-04	5.2E-04	5.7E+00
640	HPICF4CVOD013-23	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.5E-07	5.7E+00
641	HPICF4CVOD004-23	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.5E-07	5.7E+00
642	HPICF4CVOD010-23	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.5E-07	5.7E+00
643	HPICF4CVOD012-23	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	7.5E-07	5.7E+00
644	RSSCF4MVOD004-ALL	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	8.4E-05	3.8E-04	5.6E+00
645	SWSORPRESS0003C	EWS-ESS0003C (ORIFICE) PLUG	2.4E-05	1.1E-04	5.5E+00
646	SWSFMPR2062	EWS-FT-2062 (FLOW METER) PLUG	2.4E-05	1.1E-04	5.5E+00
647	SWSXVPR601C	EWS-VLV-601C PLUG	2.4E-06	1.1E-05	5.5E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 35 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
648	SWSCVPR602C	EWS-VLV-602C PLUG	2.4E-06	1.1E-05	5.5E+00
649	SWSXVEL601C	EWS-VLV-601C EXTERNAL LEAK LARGE	7.2E-08	3.3E-07	5.5E+00
650	SWSCVEL602C	EWS-VLV-602C EXTERNAL LEAK LARGE	4.8E-08	2.2E-07	5.5E+00
651	SWSPEELSWSC2	EWS C-ESW PUMP COOLING LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	1.6E-08	5.5E+00
652	MSPSVCD510A	NMS-VLV-510A FAIL TO RE-CLOSE	7.0E-05	3.1E-04	5.5E+00
653	MSPSVCD509A	NMS-VLV-509A FAIL TO RE-CLOSE	7.0E-05	3.1E-04	5.5E+00
654	MSPSVOM509A	NMS-VLV-509A SPURIOUS OPEN	4.8E-06	2.2E-05	5.5E+00
655	MSPSVOM510A	NMS-VLV-510A SPURIOUS OPEN	4.8E-06	2.2E-05	5.5E+00
656	RSSCF4MVOD145-124	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	6.5E-06	5.5E+00
657	EPSTRFF001D	ESS-AT-001D (6.9KV-480V D CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	3.6E-05	5.5E+00
658	EPSBSFFAL001D	ESS-AL-001D (D CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	2.6E-05	5.5E+00
659	EPSCBFO52RAT-BD	EPS 52/RATB,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	2.2E-05	5.5E+00
660	EPSCBFO52UAT-BD	EPS 52/UATB,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	2.2E-05	5.5E+00
661	EPSCF4CBSC52RAT-24	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.5E-07	5.5E+00
662	EPSCF4CBSC52UAT-24	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.5E-07	5.5E+00
663	SGNCF4ICVR0012-134	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	1.8E-06	5.3E+00
664	SGNCF4ICVR0012-234	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	1.8E-06	5.3E+00
665	SGNCF4ICVR0012-124	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	1.8E-06	5.3E+00
666	SGNCF4ICVR0012-123	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	1.8E-06	5.3E+00
667	EPSBSFFAC001D	ESS-AC-001D (D CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	2.4E-05	5.2E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 36 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
668	SWSCF4PMBD001-R-23	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	2.9E-04	5.0E+00
669	EPSBSFFDD001A	ESS-DD-001A (A DC SWITCHBOARD BUS) FAILURE	5.8E-06	2.3E-05	5.0E+00
670	CWSCF4PCBD001-R-34	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	1.6E-04	5.0E+00
671	EPSCBSO52STHD	EPS 52/STHD (BREAKER) SPURIOUS OPEN	3.0E-06	1.2E-05	5.0E+00
672	EPSCBSO52LCD	EPS 52/LCD (BREAKER) SPURIOUS OPEN	3.0E-06	1.2E-05	5.0E+00
673	EPSCBSO52STLD	EPS 52/STLD (BREAKER) SPURIOUS OPEN	3.0E-06	1.2E-05	5.0E+00
674	ACCORPRACC02B	SIS-ACC02B (ORIFICE) PLUG	2.4E-05	9.5E-05	5.0E+00
675	ACCORPRACC02D	SIS-ACC02D (ORIFICE) PLUG	2.4E-05	9.5E-05	5.0E+00
676	ACCORPRACC02C	SIS-ACC02C (ORIFICE) PLUG	2.4E-05	9.5E-05	5.0E+00
677	ACCCVOD102C	SIS-VLV-102C FAIL TO OPEN	9.7E-06	3.8E-05	5.0E+00
678	ACCCVOD103C	SIS-VLV-103C FAIL TO OPEN	9.7E-06	3.8E-05	5.0E+00
679	ACCCVOD103B	SIS-VLV-103B FAIL TO OPEN	9.7E-06	3.8E-05	5.0E+00
680	ACCCVOD103D	SIS-VLV-103D FAIL TO OPEN	9.7E-06	3.8E-05	5.0E+00
681	ACCCVOD102B	SIS-VLV-102B FAIL TO OPEN	9.7E-06	3.8E-05	5.0E+00
682	ACCCVOD102D	SIS-VLV-102D FAIL TO OPEN	9.7E-06	3.8E-05	5.0E+00
683	ACCMVPR101C	SIS-MOV-101C PLUG	2.4E-06	9.5E-06	5.0E+00
684	ACCCVPR102D	SIS-VLV-102D PLUG	2.4E-06	9.5E-06	5.0E+00
685	ACCCVPR102B	SIS-VLV-102B PLUG	2.4E-06	9.5E-06	5.0E+00
686	ACCCVPR103D	SIS-VLV-103D PLUG	2.4E-06	9.5E-06	5.0E+00
687	ACCMVPR101D	SIS-MOV-101D PLUG	2.4E-06	9.5E-06	5.0E+00
688	ACCCVPR102C	SIS-VLV-102C PLUG	2.4E-06	9.5E-06	5.0E+00
689	ACCMVPR101B	SIS-MOV-101B PLUG	2.4E-06	9.5E-06	5.0E+00
690	ACCCVPR103C	SIS-VLV-103C PLUG	2.4E-06	9.5E-06	5.0E+00
691	ACCCVPR103B	SIS-VLV-103B PLUG	2.4E-06	9.5E-06	5.0E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 37 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
692	ACCCVEL102C	SIS-VLV-102C EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	5.0E+00
693	ACCCVEL102D	SIS-VLV-102D EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	5.0E+00
694	ACCCVEL102B	SIS-VLV-102B EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	5.0E+00
695	ACCMVEL101C	SIS-MOV-101C EXTERNAL LEAK LARGE	2.4E-08	9.5E-08	5.0E+00
696	ACCMVEL101D	SIS-MOV-101D EXTERNAL LEAK LARGE	2.4E-08	9.5E-08	5.0E+00
697	ACCMVEL101B	SIS-MOV-101B EXTERNAL LEAK LARGE	2.4E-08	9.5E-08	5.0E+00
698	ACCPNELINJB	SIS B-ACC INJECTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	2.4E-09	5.0E+00
699	ACCPNELINJC	SIS C-ACC INJECTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	2.4E-09	5.0E+00
700	ACCPNELINJD	SIS D-ACC INJECTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	2.4E-09	5.0E+00
701	RSSCF4PMLR001-234	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.8E-07	2.3E-06	4.9E+00
702	ACCCF4CVOD103-13	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	6.2E-07	4.9E+00
703	ACCCF4CVOD102-12	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	6.2E-07	4.9E+00
704	ACCCF4CVOD103-34	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	6.2E-07	4.9E+00
705	ACCCF4CVOD102-13	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	6.2E-07	4.9E+00
706	ACCCF4CVOD103-23	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	6.2E-07	4.9E+00
707	ACCCF4CVOD102-14	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	6.2E-07	4.9E+00
708	ACCCVEL103D	SIS-VLV-103D EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	4.9E+00
709	ACCCVEL103B	SIS-VLV-103B EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	4.9E+00
710	ACCCVEL103C	SIS-VLV-103C EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	4.9E+00
711	RSSCVEL028D	RHS-VLV-028D EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	4.9E+00
712	RSSCVEL028C	RHS-VLV-028C EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	4.9E+00
713	RSSCVEL028B	RHS-VLV-028B EXTERNAL LEAK LARGE	4.8E-08	1.9E-07	4.9E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 38 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
714	EPSBSFFAC003A	ESS-AC-003A (A MOV 480V MCC1 BUS) FAILURE	5.8E-06	2.1E-05	4.6E+00
715	EPSCBFO52RAT-AB	EPS 52/RATA,B (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.8E-05	4.6E+00
716	EPSCBFO52UAT-AB	EPS 52/UATA,B (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.8E-05	4.6E+00
717	EPSCF4CBSC52RAT-12	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.2E-07	4.6E+00
718	EPSCF4CBSC52UAT-12	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.2E-07	4.6E+00
719	EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START	6.5E-03	2.2E-02	4.3E+00
720	EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	2.4E-03	8.1E-03	4.3E+00
721	EFWPTLR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION	1.5E-03	5.2E-03	4.3E+00
722	EFWPTEL001A	EFS-RPP-001A (A-EFW PUMP) EXTERNAL LEAK LARGE	2.2E-07	7.3E-07	4.3E+00
723	EFWMVOD103A	EFS-MOV-103A FAIL TO OPEN	9.6E-04	3.1E-03	4.3E+00
724	EPSCF4DLLRDG-23	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	8.2E-04	4.2E+00
725	EPSCF4DLADDG-34	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	1.4E-04	4.2E+00
726	EPSCF4DLSRDG-23	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	1.3E-04	4.2E+00
727	EPSCF4SEFFDG-23	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	8.1E-05	4.2E+00
728	EPSCF4CBFC52EPS-13	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	1.6E-05	4.2E+00
729	EPSCF4CBSO52EPS-23	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.1E-07	4.2E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 39 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
730	RSSCF4PMLR001-124	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.8E-07	1.8E-06	4.2E+00
731	EFWCF2PMAD001BC-ALL	EFS-RPP-001B,C (EFW PUMP) FAIL TO START (CCF)	2.2E-04	7.0E-04	4.2E+00
732	HVACF2AHSR401-ALL	VRS-RAH-401B,C (EFW PUMP AIR HANDLING UNIT) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.2E-04	3.7E-04	4.2E+00
733	VCWCF2CHYR001-ALL	VWS-PEQ-001B,C (ESSENTIAL CHILLER UNIT) FAIL TO RUN (CCF)	1.0E-04	3.2E-04	4.1E+00
734	SWSCF2CVOD502BD-ALL	EWS-VLV-502B,D FAIL TO OPEN (CCF)	5.6E-07	1.8E-06	4.1E+00
735	SWSCF2CVOD602BD-ALL	EWS-VLV-602B,D FAIL TO OPEN (CCF)	5.6E-07	1.8E-06	4.1E+00
736	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	1.6E-02	4.1E+00
737	RTPCF4ICVRRT6001-ALL	PRESSURIZER PRESSURE SENSOR CCF	1.1E-06	3.4E-06	4.1E+00
738	HVACF2AHAD401-ALL	VRS-RAH-401B,C (EFW PUMP AIR HANDLING UNIT) FAIL TO START (CCF)	3.8E-05	1.2E-04	4.1E+00
739	HPICF4PMAD001-124	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	9.5E-06	2.9E-05	4.1E+00
740	EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT	1.7E-02	5.2E-02	4.0E+00
741	RSSCF4CVOD004-234	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	6.7E-07	4.0E+00
742	RSSCF4RHPR001-234	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	6.4E-08	1.9E-07	4.0E+00
743	EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE	5.0E-03	1.5E-02	4.0E+00
744	EPSBSFFAM001C	ESS-AM-001C (C CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	1.7E-05	4.0E+00
745	EFWCF2PMSR001BC-ALL	EFS-RPP-001B,C (EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-05	5.1E-05	4.0E+00
746	RTPDASF	DAS FAILURE	1.0E-02	3.0E-02	3.9E+00
747	RSSCF4CVOD005-ALL	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	4.3E-07	1.2E-06	3.9E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 40 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
748	EPSBSFFDD001C	ESS-DD-001C (C DC SWITCHBOARD BUS) FAILURE	5.8E-06	1.7E-05	3.9E+00
749	CWSCF4MVCD007-ALL	NCS-MOV-007A,B,C,D FAIL TO CLOSE (CCF)	1.3E-05	3.5E-05	3.8E+00
750	CWSCF4MVCD020-ALL	NCS-MOV-020A,B,C,D FAIL TO CLOSE (CCF)	1.3E-05	3.5E-05	3.8E+00
751	EFWCVOD012A	EFS-VLV-012A FAIL TO OPEN	9.5E-06	2.6E-05	3.8E+00
752	EFWCVPR012A	EFS-VLV-012A PLUG	2.4E-06	6.6E-06	3.8E+00
753	EFWXVPR013A	EFS-VLV-013A PLUG	2.4E-06	6.6E-06	3.8E+00
754	EFWXVIL023A	EFS-VLV-023A INTERNAL LEAK LARGE	1.1E-05	2.9E-05	3.8E+00
755	EFWXVEL021A	EFS-VLV-021A EXTERNAL LEAK LARGE	7.2E-08	2.0E-07	3.8E+00
756	EFWXVEL023A	EFS-VLV-023A EXTERNAL LEAK LARGE	7.2E-08	2.0E-07	3.8E+00
757	EFWCVEL022A	EFS-VLV-022A EXTERNAL LEAK LARGE	4.8E-08	1.3E-07	3.8E+00
758	EFWCVEL020A	EFS-VLV-020A EXTERNAL LEAK LARGE	4.8E-08	1.3E-07	3.8E+00
759	HPICF4PMSR001-124	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	9.0E-06	3.7E+00
760	EFWCF2PMLR001BC-ALL	EFS-RPP-001B,C (EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.9E-06	1.6E-05	3.7E+00
761	VCWCF2PMYR001-ALL	VWS-PPP-001B,C (ESSENTIAL CHILLED WATER PUMP) FAIL TO RUN (CCF)	5.6E-06	1.5E-05	3.7E+00
762	HVACF2AHLR401-ALL	VRS-RAH-401B,C (EFW PUMP AIR HANDLING UNIT) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	4.3E-06	1.2E-05	3.7E+00
763	RSSCF4PMAD001-124	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	1.6E-05	3.6E+00
764	EPSCF4DLLRDG-34	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	6.5E-04	3.6E+00
765	EPSCF4DLADDG-14	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	1.1E-04	3.6E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 41 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
766	EPSCF4DLSRDG-34	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	1.0E-04	3.6E+00
767	EPSCF4SEFFDG-34	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	6.4E-05	3.6E+00
768	EPSCF4CBFC52EPS-12	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	1.3E-05	3.6E+00
769	EPSCF4CBSO52EPS-34	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	8.6E-08	3.6E+00
770	SWSCF4PMBD001-R-14	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	1.8E-04	3.5E+00
771	HPICF4PMLR001-124	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-06	2.8E-06	3.5E+00
772	CWSCF4PCBD001-R-12	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	9.6E-05	3.5E+00
773	SWSRIEL001C	NCS-RHX-001C (C-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.7E-06	3.4E+00
774	SWSXVEL514C	EWS-VLV-514C EXTERNAL LEAK LARGE	7.2E-08	1.7E-07	3.4E+00
775	SWSXVEL511C	EWS-VLV-511C EXTERNAL LEAK LARGE	7.2E-08	1.7E-07	3.4E+00
776	SWSPEELSWSC3	EWS C-CCW HX COOLING LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	8.7E-09	3.4E+00
777	EPSCF4IVFF001-14	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	2.4E-06	3.4E+00
778	EFWMVPR103A	EFS-MOV-103A PLUG	2.4E-06	5.8E-06	3.4E+00
779	EFWMVCM103A	EFS-MOV-103A SPURIOUS CLOSE	9.6E-07	2.3E-06	3.4E+00
780	EFWMVEL103A	EFS-MOV-103A EXTERNAL LEAK LARGE	2.4E-08	5.8E-08	3.4E+00
781	EFWPNELSTA	EFS A-T/D EFW PUMP STEAM SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.4E-09	3.4E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 42 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
782	EFWXVPR009A	EFS-VLV-009A PLUG	2.4E-06	5.7E-06	3.4E+00
783	RSSCF4CVOD004-124	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	5.2E-07	3.4E+00
784	RSSCF4RHPR001-124	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	6.4E-08	1.5E-07	3.4E+00
785	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.0E-03	3.3E+00
786	HPICF4CVOD004-124	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	6.2E-07	3.3E+00
787	HPICF4CVOD012-124	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	6.2E-07	3.3E+00
788	HPICF4CVOD010-124	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	6.2E-07	3.3E+00
789	HPICF4CVOD013-124	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	6.2E-07	3.3E+00
790	EPSCF4DLLRDG-12	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	5.8E-04	3.3E+00
791	EPSCF4DLADDG-23	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	9.8E-05	3.3E+00
792	EPSCF4DLSRDG-12	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	9.2E-05	3.3E+00
793	EPSCF4SEFFDG-12	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	5.7E-05	3.3E+00
794	EPSCF4CBFC52EPS-34	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	1.1E-05	3.3E+00
795	EPSCBFO52UAT-BC	EPS 52/UATB,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.1E-05	3.3E+00
796	EPSCF4CBSO52EPS-12	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.7E-08	3.3E+00
797	EPSCF4CBSC52UAT-23	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	7.7E-08	3.3E+00
798	RWSCF4SUPR001-24	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	6.8E-06	3.3E+00
799	HPICF4PMAD001-134	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	9.5E-06	2.1E-05	3.3E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 43 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
800	EPSCF4DLLRDG-24	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	5.6E-04	3.2E+00
801	EPSCF4DLADDG-13	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	9.5E-05	3.2E+00
802	EPSCF4DLSRDG-24	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	8.9E-05	3.2E+00
803	EPSCF4SEFFDG-24	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	5.6E-05	3.2E+00
804	EPSCF4CBFC52EPS-23	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	1.1E-05	3.2E+00
805	EPSCF4CBSO52EPS-24	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.5E-08	3.2E+00
806	EPSBSFFAC003D	ESS-AC-003D (D MOV 480V MCC1 BUS) FAILURE	5.8E-06	1.3E-05	3.2E+00
807	EPSCF4IVFF001-34	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	2.2E-06	3.2E+00
808	EPSCBFO52RAT-D	EPS 52/RATD (BREAKER) FAIL TO OPEN	3.5E-04	7.4E-04	3.1E+00
809	EPSCBFO52UAT-D	EPS 52/UATD (BREAKER) FAIL TO OPEN	3.5E-04	7.4E-04	3.1E+00
810	EPSCBSC52UATD	EPS 52/UATD (BREAKER) SPURIOUS CLOSE	3.0E-06	6.4E-06	3.1E+00
811	EPSCBSC52RATD	EPS 52/RATD (BREAKER) SPURIOUS CLOSE	3.0E-06	6.4E-06	3.1E+00
812	EFWXVOD006B	EFS-VLV-006B FAIL TO OPEN	7.0E-04	1.5E-03	3.1E+00
813	EFWXVPR006B	EFS-VLV-006B PLUG	2.4E-06	5.0E-06	3.1E+00
814	EFWXVCD007B	EFS-VLV-007B FAIL TO CLOSE	7.0E-04	1.5E-03	3.1E+00
815	EFWCF4CVOD012-23	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	4.7E-07	3.1E+00
816	CWSCF2PCYR001BD-ALL	NCS-RPP-001B,D (CCW PUMP) FAIL TO RUN (CCF)	5.0E-06	1.0E-05	3.0E+00
817	EFWCF4MVFC017-12	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	1.1E-06	3.0E+00
818	EFWCF4MVFC017-24	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	1.1E-06	3.0E+00
819	EFWPTAD001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO START	6.5E-03	1.3E-02	2.9E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 44 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
820	EFWPTSR001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	2.4E-03	4.7E-03	2.9E+00
821	EFWPTLR001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION	1.5E-03	3.0E-03	2.9E+00
822	EFWPTEL001D	EFS-RPP-001D (D-EFW PUMP) EXTERNAL LEAK LARGE	2.2E-07	4.2E-07	2.9E+00
823	HPICF4PMSR001-134	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	6.3E-06	2.9E+00
824	EFWMVOD103D	EFS-MOV-103D FAIL TO OPEN	9.6E-04	1.8E-03	2.9E+00
825	SWSORPROR04C	EWS-OR04C (ORIFICE) PLUG	2.4E-05	4.6E-05	2.9E+00
826	SWSORPR2026	EWS-FE-2026 (ORIFICE) PLUG	2.4E-05	4.6E-05	2.9E+00
827	CWSORPR1232	NCS-FE-1232 (ORIFICE) PLUG	2.4E-05	4.6E-05	2.9E+00
828	CWSCVPR016C	NCS-VLV-016C PLUG	2.4E-06	4.6E-06	2.9E+00
829	CWSXVPR101C	NCS-VLV-101C PLUG	2.4E-06	4.6E-06	2.9E+00
830	CWSXVPR005C	NCS-VLV-005C PLUG	2.4E-06	4.6E-06	2.9E+00
831	SWSXVPR520C	EWS-VLV-520C PLUG	2.4E-06	4.6E-06	2.9E+00
832	SWSXVPR517C	EWS-VLV-517C PLUG	2.4E-06	4.6E-06	2.9E+00
833	CWSXVPR018C	NCS-VLV-018C PLUG	2.4E-06	4.6E-06	2.9E+00
834	CWSXVPR008C	NCS-VLV-008C PLUG	2.4E-06	4.6E-06	2.9E+00
835	CWSXVPR104C	NCS-VLV-104C PLUG	2.4E-06	4.6E-06	2.9E+00
836	CWSPCYR001C	NCS-RPP-001C (C-CCW PUMP) FAIL TO RUN	6.2E-05	1.2E-04	2.9E+00
837	HPICF4PMAD001-12	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	2.2E-05	4.0E-05	2.8E+00
838	RSSCF4PMSR001-123	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	3.1E-06	2.8E+00
839	CWSORPR1227	NCS-FE-1227 (ORIFICE) PLUG	2.4E-05	4.3E-05	2.8E+00
840	HPICF4PMLR001-134	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-06	2.0E-06	2.8E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 45 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
841	EPSCBFO52RAT-BC	EPS 52/RATB,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	8.7E-06	2.7E+00
842	EPSCF4CBSC52RAT-23	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	5.9E-08	2.7E+00
843	EPSCF4CBSO72DB-24	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.7E-08	2.7E+00
844	EPSCF4BYFF-13	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.9E-08	3.2E-08	2.7E+00
845	SWSMVOD503B	EWS-MOV-503B FAIL TO OPEN	1.0E-03	1.7E-03	2.7E+00
846	SWSMVPR503B	EWS-MOV-503B PLUG	2.4E-06	4.0E-06	2.7E+00
847	RSSCF4MVOD145-123	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	2.4E-06	2.7E+00
848	SWSMVCM503B	EWS-MOV-503B SPURIOUS CLOSE	9.6E-07	1.6E-06	2.7E+00
849	SWSMVEL503B	EWS-MOV-503B EXTERNAL LEAK LARGE	2.4E-08	4.0E-08	2.7E+00
850	HPICF4CVOD012-134	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	4.5E-07	2.7E+00
851	HPICF4CVOD013-134	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	4.5E-07	2.7E+00
852	HPICF4CVOD004-134	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	4.5E-07	2.7E+00
853	HPICF4CVOD010-134	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	4.5E-07	2.7E+00
854	NCCOO04PI1254	(HE) NCC MISCALIBRATION OF PI-1254	8.0E-04	1.3E-03	2.6E+00
855	NCCIPFF1254	PI-1254 FAIL TO OPERATE	2.7E-05	4.4E-05	2.6E+00
856	SGNPIFD4001B	SLS-B POWER I/F B (DIGITAL PART) FAILURE	2.7E-04	4.4E-04	2.6E+00
857	EPSCF4IVFF001-23	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	1.6E-06	2.6E+00
858	SWSSTPRST03	EWS-ST03 (STRAINER) PLUG	1.7E-04	2.7E-04	2.6E+00
859	SWSXVPR508B	EWS-VLV-508B PLUG	2.4E-06	3.9E-06	2.6E+00
860	SWSXVPR506B	EWS-VLV-506B PLUG	2.4E-06	3.9E-06	2.6E+00
861	SWSXVEL509B	EWS-VLV-509B EXTERNAL LEAK LARGE	7.2E-08	1.2E-07	2.6E+00
862	SWSXVEL507B	EWS-VLV-507B EXTERNAL LEAK LARGE	7.2E-08	1.2E-07	2.6E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 46 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
863	SWSXVEL506B	EWS-VLV-506B EXTERNAL LEAK LARGE	7.2E-08	1.2E-07	2.6E+00
864	SWSXVEL701B	EWS-VLV-701B EXTERNAL LEAK LARGE	7.2E-08	1.2E-07	2.6E+00
865	SWSXVEL508B	EWS-VLV-508B EXTERNAL LEAK LARGE	7.2E-08	1.2E-07	2.6E+00
866	SWSPEELSWPB1	EWS B-ESW PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	5.8E-09	2.6E+00
867	SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE	1.2E-02	1.9E-02	2.6E+00
868	SWSPMYR001B	EWS-OPP-001B (B-ESW PUMP) FAIL TO RUN	1.1E-04	1.8E-04	2.6E+00
869	EPSCF4IVFF002-134	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	5.0E-07	7.9E-07	2.6E+00
870	RSSCF4PMLR001-123	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.8E-07	9.0E-07	2.6E+00
871	EFWCVOD012D	EFS-VLV-012D FAIL TO OPEN	9.5E-06	1.5E-05	2.6E+00
872	EFWCVPR012D	EFS-VLV-012D PLUG	2.4E-06	3.8E-06	2.6E+00
873	EFWXVPR013D	EFS-VLV-013D PLUG	2.4E-06	3.8E-06	2.6E+00
874	EFWXVIL023D	EFS-VLV-023D INTERNAL LEAK LARGE	1.1E-05	1.7E-05	2.6E+00
875	EFWXVEL021D	EFS-VLV-021D EXTERNAL LEAK LARGE	7.2E-08	1.1E-07	2.6E+00
876	EFWXVEL023D	EFS-VLV-023D EXTERNAL LEAK LARGE	7.2E-08	1.1E-07	2.6E+00
877	EFWCVEL022D	EFS-VLV-022D EXTERNAL LEAK LARGE	4.8E-08	7.5E-08	2.6E+00
878	EFWCVEL020D	EFS-VLV-020D EXTERNAL LEAK LARGE	4.8E-08	7.5E-08	2.6E+00
879	SWSCF4PMBD001-R-24	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	1.1E-04	2.5E+00
880	RSSCF4PMAD001-234	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	9.6E-06	2.5E+00
881	EPSCF4CBSO52STH-34	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.2E-08	2.5E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 47 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
882	EPSCF4CBSO52STL-24	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.2E-08	2.5E+00
883	EPSCF4CBSO52LC-13	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.2E-08	2.5E+00
884	EFWTMTA001D	EFS-RPP-001D (D-EFW PUMP) TEST & MAINTENANCE	5.0E-03	7.7E-03	2.5E+00
885	SWSORPRESS0003B	EWS-ESS0003B (ORIFICE) PLUG	2.4E-05	3.7E-05	2.5E+00
886	SWSFMPR2061	EWS-FT-2061 (FLOW METER) PLUG	2.4E-05	3.7E-05	2.5E+00
887	SWSCVPR602B	EWS-VLV-602B PLUG	2.4E-06	3.7E-06	2.5E+00
888	SWSXVPR601B	EWS-VLV-601B PLUG	2.4E-06	3.7E-06	2.5E+00
889	SWSXVEL601B	EWS-VLV-601B EXTERNAL LEAK LARGE	7.2E-08	1.1E-07	2.5E+00
890	SWSCVEL602B	EWS-VLV-602B EXTERNAL LEAK LARGE	4.8E-08	7.4E-08	2.5E+00
891	SWSPEELSWSB2	EWS B-ESW PUMP COOLING LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	5.5E-09	2.5E+00
892	CWSCF2PCBD001BD-ALL	NCS-RPP-001B,D (CCW PUMP) FAIL TO START (CCF)	7.5E-05	1.1E-04	2.5E+00
893	HPICF4PMSR001-12	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.6E-06	5.3E-06	2.5E+00
894	SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE	1.2E-03	1.8E-03	2.5E+00
895	CWSCF4PCBD001-R-13	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	5.8E-05	2.5E+00
896	MFWOO02R	(HE) FAIL TO RECOVER MFWS	3.8E-03	5.6E-03	2.5E+00
897	SWSCF4PMBD001-R-12	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	1.0E-04	2.4E+00
898	SWSCF4PMBD001-R-34	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	1.0E-04	2.4E+00
899	RTPCF4ICVRRT6001-134	PRESSURIZER PRESSURE SENSOR CCF	3.7E-07	5.2E-07	2.4E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 48 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
900	RTPCF4ICVRRT6001-123	PRESSURIZER PRESSURE SENSOR CCF	3.7E-07	5.2E-07	2.4E+00
901	RTPCF4ICVRRT6001-124	PRESSURIZER PRESSURE SENSOR CCF	3.7E-07	5.2E-07	2.4E+00
902	RTPCF4ICVRRT6001-234	PRESSURIZER PRESSURE SENSOR CCF	3.7E-07	5.2E-07	2.4E+00
903	SWSXVPR511C	EWS-VLV-511C PLUG	2.4E-06	3.4E-06	2.4E+00
904	SWSXVPR514C	EWS-VLV-514C PLUG	2.4E-06	3.4E-06	2.4E+00
905	EPSTRFF001B	ESS-AT-001B (6.9KV-480V B CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	1.1E-05	2.4E+00
906	EPSBSFFAL001B	ESS-AL-001B (B CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	8.0E-06	2.4E+00
907	EPSCBFO52RAT-A	EPS 52/RATA (BREAKER) FAIL TO OPEN	3.5E-04	4.8E-04	2.4E+00
908	EPSCBFO52UAT-A	EPS 52/UATA (BREAKER) FAIL TO OPEN	3.5E-04	4.8E-04	2.4E+00
909	EPSCBSC52UATA	EPS 52/UATA (BREAKER) SPURIOUS CLOSE	3.0E-06	4.2E-06	2.4E+00
910	EPSCBSC52RATA	EPS 52/RATA (BREAKER) SPURIOUS CLOSE	3.0E-06	4.2E-06	2.4E+00
911	EPSCF4IVFF002-124	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	5.0E-07	6.9E-07	2.4E+00
912	CWSCF4PCBD001-R-23	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	5.4E-05	2.4E+00
913	CWSCF4PCBD001-R-14	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	5.3E-05	2.4E+00
914	EFWMVPR103D	EFS-MOV-103D PLUG	2.4E-06	3.3E-06	2.4E+00
915	EFWMVCM103D	EFS-MOV-103D SPURIOUS CLOSE	9.6E-07	1.3E-06	2.4E+00
916	EFWMVEL103D	EFS-MOV-103D EXTERNAL LEAK LARGE	2.4E-08	3.3E-08	2.4E+00
917	EFWPNELSTB	EFS D-T/D EFW PUMP STEAM SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.1E-10	2.4E+00
918	SWSPMEL001C	EWS-OPP-001C (C-ESW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.6E-07	2.3E+00
919	EFWXVPR009D	EFS-VLV-009D PLUG	2.4E-06	3.2E-06	2.3E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 49 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
920	EPSBSFFAM001A	ESS-AM-001A (A CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	7.6E-06	2.3E+00
921	EPSBSFFAC001B	ESS-AC-001B (B CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	7.5E-06	2.3E+00
922	HPICF4PMLR001-12	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.2E-06	1.6E-06	2.3E+00
923	EFWCF4CVOD018-34	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	2.9E-07	2.3E+00
924	EFWCF4CVOD018-24	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	2.9E-07	2.3E+00
925	SWSCF4PMBD001-R-13	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	9.2E-05	2.3E+00
926	RSSCF4CVOD004-123	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	2.8E-07	2.3E+00
927	RSSCF4RHPR001-123	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	6.4E-08	8.2E-08	2.3E+00
928	EPSCBSO52STHB	EPS 52/STHB (BREAKER) SPURIOUS OPEN	3.0E-06	3.7E-06	2.2E+00
929	EPSCBSO52LCB	EPS 52/LCB (BREAKER) SPURIOUS OPEN	3.0E-06	3.7E-06	2.2E+00
930	EPSCBSO52STLB	EPS 52/STLB (BREAKER) SPURIOUS OPEN	3.0E-06	3.7E-06	2.2E+00
931	CWSRHPF001C	NCS-RHX-001C (C-CCW HX) PLUG / FOUL	1.4E-06	1.7E-06	2.2E+00
932	CWSCF4PCBD001-R-24	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	4.9E-05	2.2E+00
933	EPSBSFFAM007	ENS-AM-007 (P1 NON-CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	7.0E-06	2.2E+00
934	SWSCVPR502B	EWS-VLV-502B PLUG	2.4E-06	2.9E-06	2.2E+00
935	SWSCVEL502B	EWS-VLV-502B EXTERNAL LEAK LARGE	4.8E-08	5.8E-08	2.2E+00
936	EPSTRFF001C	ESS-AT-001C (6.9KV-480V C CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	9.6E-06	2.2E+00
937	EPSBSFFAL001C	ESS-AL-001C (C CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	6.8E-06	2.2E+00
938	CWSRIEL001C	NCS-RHX-001C (C-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	8.2E-07	2.1E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 50 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
939	CWSPMEL001C	NCS-RPP-001C (C-CCW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.2E-07	2.1E+00
940	CWSXVEL018C	NCS-VLV-018C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
941	CWSXVEL104C	NCS-VLV-104C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
942	CWSXVEL101C	NCS-VLV-101C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
943	CWSXVEL008C	NCS-VLV-008C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
944	HPIXVEL115C	NCS-VLV-115C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
945	HPIXVEL111C	NCS-VLV-111C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
946	HPIXVEL116C	NCS-VLV-116C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
947	HPIXVEL114C	NCS-VLV-114C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
948	HPIXVEL119C	NCS-VLV-119C EXTERNAL LEAK LARGE	7.2E-08	8.2E-08	2.1E+00
949	CWSCVEL016C	NCS-VLV-016C EXTERNAL LEAK LARGE	4.8E-08	5.4E-08	2.1E+00
950	CWSPNELCWC	NCS CWS TRAIN C PIPING EXTERNAL LEAK LARGE	6.0E-10	6.8E-10	2.1E+00
951	EPSCF4DLLRDG-13	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	2.8E-04	2.1E+00
952	EPSCF4DLLRDG-14	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	2.8E-04	2.1E+00
953	EPSCF4DLADDG-24	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	4.8E-05	2.1E+00
954	EPSCF4DLADDG-12	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	4.8E-05	2.1E+00
955	EPSCF4DLSRDG-13	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	4.4E-05	2.1E+00
956	EPSCF4DLSRDG-14	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	4.4E-05	2.1E+00
957	EPSCF4SEFFDG-13	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	2.8E-05	2.1E+00
958	EPSCF4SEFFDG-14	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	2.8E-05	2.1E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 51 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
959	EPSCF4CBFC52EPS-14	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	5.5E-06	2.1E+00
960	EPSCF4CBFC52EPS-24	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	5.5E-06	2.1E+00
961	EPSCF4CBSO52EPS-13	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.7E-08	2.1E+00
962	EPSCF4CBSO52EPS-14	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.7E-08	2.1E+00
963	SWSSTPRST02C	EWS-ST02C (STRAINER) PLUG	1.7E-04	1.8E-04	2.1E+00
964	RWSSUPR001C	SIS-CSR-001C (C-ESS/CS STRAINER) PLUG DURING OPERATION	2.1E-04	2.3E-04	2.1E+00
965	EPSBSFFAC001C	ESS-AC-001C (C CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	6.1E-06	2.1E+00
966	EFWCF4CVOD012-14	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	2.3E-07	2.0E+00
967	RSSCF4PMAD001-12	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.3E-05	1.3E-05	2.0E+00
968	ACWCF2MVOD325-ALL	NCS-MOV-325A,B FAIL TO OPEN (CCF)	4.7E-05	4.7E-05	2.0E+00
969	ACWCF2MVOD321-ALL	NCS-MOV-321A,B FAIL TO OPEN (CCF)	4.7E-05	4.7E-05	2.0E+00
970	SWSRIEL001B	NCS-RHX-001B (B-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	7.0E-07	2.0E+00
971	SWSXVEL514B	EWS-VLV-514B EXTERNAL LEAK LARGE	7.2E-08	7.0E-08	2.0E+00
972	SWSXVEL511B	EWS-VLV-511B EXTERNAL LEAK LARGE	7.2E-08	7.0E-08	2.0E+00
973	SWSPEELSWSB3	EWS B-CCW HX COOLING LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	3.5E-09	2.0E+00
974	EPSCBSO52STHC	EPS 52/STHC (BREAKER) SPURIOUS OPEN	3.0E-06	2.9E-06	2.0E+00
975	EPSCBSO52STLC	EPS 52/STLC (BREAKER) SPURIOUS OPEN	3.0E-06	2.9E-06	2.0E+00
976	EPSCBSO52LCC	EPS 52/LCC (BREAKER) SPURIOUS OPEN	3.0E-06	2.9E-06	2.0E+00

Table 19.1-31 Basic Events (Hardware Failure, Human Error) RAW (Sheet 52 of 52)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
977	RSSCF4PMSR001-134	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	1.6E-06	2.0E+00
978	RSSCF4MVOD145-134	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	1.4E-06	2.0E+00
979	SWSPMBD001C-R	EWS-OPP-001C (C-ESW PUMP) FAIL TO RE-START	1.7E-03	1.6E-03	2.0E+00

Table 19.1-32 Common Cause Failure FV Importance

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	9.9E-04	2.2E-01	2.2E+02
2	EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	2.1E-04	4.6E-02	2.2E+02
3	RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	9.7E-06	3.9E-02	4.0E+03
4	SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF	1.0E-05	3.7E-02	3.7E+03
5	EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.6E-04	3.4E-02	2.2E+02
6	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.1E-06	2.9E-02	1.4E+04
7	EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.5E-03	2.1E-02	1.5E+01
8	SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	4.8E-05	1.6E-02	3.3E+02
9	EFWCF2PTAD001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO START (CCF)	4.5E-04	1.5E-02	3.5E+01
10	RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	8.4E-05	1.2E-02	1.4E+02

Table 19.1-33 Common Cause Failure RAW

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPBTSWCCF	BASIC SOFTWARE CCF	1.0E-07	4.7E-03	4.6E+04
2	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.1E-06	2.9E-02	1.4E+04
3	EPSCF4CBSC52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	1.3E-03	8.5E+03
4	EPSCF4CBSC52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	1.3E-03	8.5E+03
5	SWSCF4PMYR-FF	EWS-OPP-001A,B,C,D (A,B,C,D-ESW PUMP) FAIL TO RUN (CCF)	1.2E-08	7.5E-05	6.2E+03
6	EPSCF4CBSO52STH-ALL	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	9.6E-04	6.1E+03
7	EPSCF4CBSO52STL-ALL	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	9.6E-04	6.1E+03
8	CWSCF4RHPR-FF	NCS-RHX-001A,B,C,D (A,B,C,D-CCW HX) PLUG / FOUL (CCF)	3.6E-08	2.1E-04	5.8E+03
9	CWSCF4PCYR-FF	NCS-RPP-001A,B,C,D (A,B,C,D-CCW PUMP) FAIL TO RUN (CCF)	6.7E-09	3.9E-05	5.8E+03
10	EPSCF4CBSO52LC-ALL	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	7.3E-04	4.6E+03

Table 19.1-34 Human Error FV Importance

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	2.9E-01	1.5E+01
2	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	1.8E-01	1.7E+01
3	ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER	5.1E-01	1.7E-01	1.2E+00
4	EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT	1.7E-02	5.2E-02	4.0E+00
5	HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP	3.8E-03	4.2E-02	1.2E+01
6	HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	2.6E-03	2.1E-02	9.0E+00
7	SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS	5.7E-02	1.5E-02	1.3E+00
8	NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN	2.0E-02	9.4E-03	1.5E+00
9	HPIOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS	5.7E-02	8.9E-03	1.1E+00
10	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.0E-03	3.3E+00

Table 19.1-35 Human Error RAW

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	1.8E-01	1.7E+01
2	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	2.9E-01	1.5E+01
3	HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP	3.8E-03	4.2E-02	1.2E+01
4	HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	2.6E-03	2.1E-02	9.0E+00
5	SGNOO04ICVR12	(HE) MISCALIBRATION OF C/V PRESSURE SENSORS A,B,C,D	6.7E-05	3.5E-04	6.3E+00
6	EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT	1.7E-02	5.2E-02	4.0E+00
7	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.0E-03	3.3E+00
8	NCCOO04PI1254	(HE) NCC MISCALIBRATION OF PI-1254	8.0E-04	1.3E-03	2.6E+00
9	MFWOO02R	(HE) FAIL TO RECOVER MFWS	3.8E-03	5.6E-03	2.5E+00
10	RSSOO02LNUP	(HE) FAIL TO OPERATE ALTERNATE CORE COOLING	7.4E-03	5.0E-03	1.7E+00

Table 19.1-36 Hardware Single Failure FV Importance

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPDASF	DAS FAILURE	1.0E-02	3.0E-02	3.9E+00
2	EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START	6.5E-03	2.2E-02	4.3E+00
3	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	1.9E-02	1.7E+05
4	EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	1.6E-02	1.9E+00
5	EFWPTAD001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO START	6.5E-03	1.3E-02	2.9E+00
6	EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	1.3E-02	1.7E+00
7	MFWHARD	MFW SYSTEM FAILURE	1.0E-01	1.1E-02	1.1E+00
8	EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	2.4E-03	8.1E-03	4.3E+00
9	EPSDLLRDGC	EPS C-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	7.7E-03	1.5E+00
10	VCWCHBD001B	VWS-PEQ-001B (B-ESSENTIAL CHILLER UNIT) FAIL TO START	1.0E-02	6.4E-03	1.6E+00

Table 19.1-37 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	1.9E-02	1.7E+05
2	RWSXVEL001	RWS-VLV-001 EXTERNAL LEAK LARGE	7.2E-08	2.9E-04	4.0E+03
3	RWSXVEL024	RWS-VLV-024 EXTERNAL LEAK LARGE	7.2E-08	2.9E-04	4.0E+03
4	RWSCVEL023	RWS-VLV-023 EXTERNAL LEAK LARGE	4.8E-08	1.9E-04	4.0E+03
5	RWSMVEL002	RWS-MOV-002 EXTERNAL LEAK LARGE	2.4E-08	9.7E-05	4.0E+03
6	RWSPNELPIPE1	RWS PIPING BETWEEN RWSP AND RWS-VLV-023 EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
7	RWSPNELPIPE2	RWS PIPING BETWEEN RWSP AND RWS-VLV-002 EXTERNAL LEAK LARGE	6.0E-10	2.4E-06	4.0E+03
8	RWSTNEL001	RWS-CPT-001 (RWSP) EXTERNAL LEAK LARGE	4.8E-08	1.9E-04	4.0E+03
9	HPIMVEL001B	SIS-MOV-001B EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03
10	HPIMVEL001A	SIS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	9.6E-05	4.0E+03

Table 19.1-38 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 1 of 5)

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 9)
	Digital I&C	M	Sensitivity analysis of failure probabilities were performed.	Sensitivity Analysis (Case 10)
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 19.1-38 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 2 of 5)

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 due to maintenance	M	US generic data is considered appropriate at design stage. However, Sensitivity analyses were performed.	Sensitivity Analysis (Case 01, Case 02, Case 03, Case 04)

Table 19.1-38 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 3 of 5)

Key Sources of Uncertainty and Key Assumptions		Type (Note)	Summary Results of Qualitative Assessments	Quantitative Approach
System Analysis	Class 1E electrical room HVAC are reliable and do not impact risk	M	Even if losses of HVAC occur, actuation signals of all trains will actually complete within a short time after the occurrence of an initiating event, and therefore, losses of HVAC may not affect the signal actuation. Even if HVAC function were to have impact on signals they will be limited to those that are required to operate hours after the initiating event. It is unlikely for losses of HVAC to actuate spurious signal and lead to functional failure of system so HVAC failure are likely to cause plant trip or malfunction of operating mitigation systems. To relax room heat up after losses of Class 1E electrical room HVAC, the operator will be open the room door and utilize available portable fans.	If Class 1E electrical room heat up were to occur and impact components in the most undesirable way, conditional core damage frequency will be 1.0 and the consequences will be severe.
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 19.1-38 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 4 of 5)

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 09)
	Statistical uncertainty of failure rate	P	(Statistical uncertainty is considerable)	Uncertainty Analysis
	Failure probability of digital I&C software	M	Sensitivity analysis of failure probability was performed.	Sensitivity Analysis (Case 10)
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 08)
	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 19.1-38 Key Sources of Uncertainty and Key Assumptions (Level 1 PRA for Internal Events at Power)

(Sheet 5 of 5)

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, and change lower bound HEPs to mean value.	Sensitivity Analysis (Case 05, Case 06, Case 07)
	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 19.1-39 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- 40 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 (3)When DAS is not available, manual closing operation at local.

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. or 1 of 2 safety depressurization valves open successfully.
Thermal/Hydraulic Computer Code	MAAP
Operation	(1) Detect core damage with core outlet thermometer (2) Manual opening operation from central control room (3) When manual opening operation is not available due to software CCF, manual opening operation from DAS.

Table19.1- 40 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 (2) When automatic control is not available, manual activating operation.

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 (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- 40 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)

Table19.1-41 Dependencies between Frontline Systems and Supporting Systems of the CSET

Supporting Systems (SSs) / Frontline Systems (FSs)		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			
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Firewater Injection to Reactor Cavity																	
Firewater Injection to Spray Header																	
Depressurization Valves for Severe Accident																	
Containment Isolation																	
Hydrogen Condtrol	A																
	B																

Supporting Systems (SSs) / Frontline Systems (FSs)		Emergency Station Power Supply System (Safety-related)												Emergency Station Power Supply System (Non-safety)			
		AC480V				DC125V (Switchboard)				AC120V (I&C Panelboard)				AC6.9 kV		AC480 V	
		A	B	C	D	A	B	C	D	A	B	C	D	P1	P2	P1	P2
Firewater Injection to Reactor Cavity		X												X		X	
Firewater Injection to Spray Header			X											X		X	
Depressurization Valves for Severe Accident		X			X												
Containment Isolation		X			X	X			X	X			X				
Hydrogen Condtrol	A									X						X	
	B										X						X

Supporting Systems (SSs) / Frontline Systems (FSs)		Heating, Ventilating & Air Conditioning System																		Instrument Air		Engineered Safety Features Actuation Signal							
		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 Actuation Signal				Containment Spray Actuation Signal			
		A	B	C	D	A	B	C	D	A	B	C	D	B	C	A	D	A	B	A	B	A	B	C	D	A	B	C	D
Firewater Injection to Reactor Cavity																													
Firewater Injection to Spray Header																													
Depressurization Valves for Severe Accident																													
Containment Isolation																				NA	NA					X			X
Hydrogen Condtrol	A																					X							
	B																						X						

Table19.1- 42 Dominant Cutsets of LRF (Sheet 1 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
1	6.0E-09	6.2	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN
			RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)
2	4.0E-09	4.1	!19LOOP	LOSS OF OFFSITE POWER
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBS	POWER RECOVERY SUCCESS (1H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
3	2.6E-09	2.7	!19LOOP	LOSS OF OFFSITE POWER
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCS	POWER RECOVERY SUCCESS (3H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
4	2.4E-09	2.5	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF3	NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF

Table19.1- 42 Dominant Cutsets of LR (Sheet 2 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
5	2.2E-09	2.2	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			CCWRSA	CCW RECOVERY (AFTER CORE MELT)
			RCP----SEAL	RCP SEAL LOCA
6	1.8E-09	1.9	!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
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF

Table19.1- 42 Dominant Cutsets of LR (Sheet 3 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
7	1.7E-09	1.8	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			LR-3A	CCFP FOR SPECIFIC PDS
			RCP----SEAL	RCP SEAL LOCA
8	1.3E-09	1.4	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN
			RSSCF4PMAD001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)
9	1.3E-09	1.3	!05SGTR	STEAM GENERATOR TUBE RUPTURE
			HITOO02	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW
			MSPMLWTH	WATER HUMMER IN STEAM LINE
			SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE
10	1.2E-09	1.3	!07RVR	REACTOR VESSEL RUPTURE
			LR-3A	CCFP FOR SPECIFIC PDS
11	1.2E-09	1.2	!15LOCCW	LOSS OF COMPONENT COOLING WATER
			ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER
			ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM
			RCP----SEAL	RCP SEAL LOCA
			RSAOO02FWP	(HE) FAIL TO OPERATE FIRE SUPRESSION PUMP

Table19.1- 42 Dominant Cutsets of LRF (Sheet 4 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
12	1.0E-09	1.1	!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
			EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			OPSRSB	OFFSITE POWER RECOVERY(AFTER CORE MELT)
			RCP----SEAL	RCP SEAL LOCA

Table19.1- 42 Dominant Cutsets of LRF (Sheet 5 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
13	1.0E-09	1.1	!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	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			OPSRSB	OFFSITE POWER RECOVERY(AFTER CORE MELT)
			RCP----SEAL	RCP SEAL LOCA
			RSBOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS(AFTER CORE MELT)
14	1.0E-09	1.0	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			RTPBTSWCCF	BASIC SOFTWARE CCF
15	8.4E-10	0.9	!19LOOP	LOSS OF OFFSITE POWER
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBS	POWER RECOVERY SUCCESS (1H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTHWCCF	DIGITAL I&C HARDWARE CCF

Table19.1- 42 Dominant Cutsets of LRF (Sheet 6 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
16	8.3E-10	0.9	!02MLOCA NCCOO02CCW RSSCF4MVOD145-ALL	MEDIUM PIPE BREAK LOCA (HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)
17	6.9E-10	0.7	!03SLOCA NCCOO02CCW RWSCF4SUPR001-ALL	SMALL PIPE BREAK LOCA (HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
18	6.7E-10	0.7	!10SLBO LR-8A RTPDASF SGNBTSWCCF2	STEAM LINE BREAK DOWNSTREAM MSIV CCFP FOR SPECIFIC PDS DAS FAILURE GROUP-2 APPLICATION SOFTWARE CCF

Table19.1- 42 Dominant Cutsets of LRF (Sheet 7 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
19	5.7E-10	0.6	!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	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			LR-5A	CCFP FOR SPECIFIC PDS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
20	5.7E-10	0.6	!19LOOP	LOSS OF OFFSITE POWER
			LR-8A	CCFP FOR SPECIFIC PDS
			RTPDASF	DAS FAILURE
			SGNBTHWCCF	DIGITAL I&C HARDWARE CCF
21	5.7E-10	0.6	!03SLOCA	SMALL PIPE BREAK LOCA
			EPSCF4CBSO52LC-ALL	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)
22	5.7E-10	0.6	!03SLOCA	SMALL PIPE BREAK LOCA
			EPSCF4CBSO52STH-ALL	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)
23	5.7E-10	0.6	!03SLOCA	SMALL PIPE BREAK LOCA
			EPSCF4CBSO52STL-ALL	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)

Table19.1- 42 Dominant Cutsets of LRF (Sheet 8 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
24	5.6E-10	0.6	!19LOOP EPSOO02RDG OPS----PRBF OPS----PRCS RCP----SEAL SGNBTHWCCF	LOSS OF OFFSITE POWER (HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS POWER RECOVERY (1H) POWER RECOVERY SUCCESS (3H) RCP SEAL LOCA DIGITAL I&C HARDWARE CCF
25	5.2E-10	0.5	!13TRANS EFWPTAD001A RTPBTSWCCF	GENERAL TRANSIENT EFS-RPP-001A (A-EFW PUMP) FAIL TO START BASIC SOFTWARE CCF
26	5.0E-10	0.5	!10SLBO RSSOO01CSP SGNBTSWCCF2	STEAM LINE BREAK DOWNSTREAM MSIV (HE) FAIL TO START CV SPRAY SYSTEM GROUP-2 APPLICATION SOFTWARE CCF
27	4.4E-10	0.5	!03SLOCA LR-3C RWSCF4SUPR001-ALL	SMALL PIPE BREAK LOCA CCFP FOR SPECIFIC PDS SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)
28	4.0E-10	0.4	!13TRANS EFWTMTA001A RTPBTSWCCF	GENERAL TRANSIENT EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE BASIC SOFTWARE CCF

Table19.1- 42 Dominant Cutsets of LRF (Sheet 9 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
29	4.0E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
30	3.9E-10	0.4	!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
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPS----PRBF	POWER RECOVERY (1H)
			OPS----PRCF	POWER RECOVERY (3H)
			RCP----SEAL	RCP SEAL LOCA
			SGNBTHWCCF	DIGITAL I&C HARDWARE CCF
31	3.8E-10	0.4	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			FDAOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS (AFTER CORE MELT)
			LR-8A	CCFP FOR SPECIFIC PDS
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
			SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS

Table19.1- 42 Dominant Cutsets of LRF (Sheet 10 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
32	3.8E-10	0.4	!10SLBO	STEAM LINE BREAK DOWNSTREAM MSIV
			FDAOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS (AFTER CORE MELT)
			HPIOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS
			LR-8A	CCFP FOR SPECIFIC PDS
			SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF
33	3.6E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCAVOD1212	NCS-PCV-1212 FAIL TO OPEN
			RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)
34	3.6E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			RTPBTSWCCF	BASIC SOFTWARE CCF
35	3.6E-10	0.4	!03SLOCA	SMALL PIPE BREAK LOCA
			NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN
			RSSCF4PMSR001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)
36	3.5E-10	0.4	!16PLOCW	PARTIAL LOSS OF COMPONENT COOLING WATER
			EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
			RCP----SEAL	RCP SEAL LOCA

Table19.1- 42 Dominant Cutsets of LRF (Sheet 11 of 11)

No.	Cutsets Freq. (/RY)	Percent (%)	Cutsets	Basic Event Name
37	3.4E-10	0.4	!03SLOCA NCCOO02CCW RSSCF4RHPR001-ALL	SMALL PIPE BREAK LOCA (HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)
38	3.2E-10	0.3	!16PLOCW RCP----SEAL RTPBTSWCCF	PARTIAL LOSS OF COMPONENT COOLING WATER RCP SEAL LOCA BASIC SOFTWARE CCF
39	3.0E-10	0.3	!05SGTR MSPMLWTH PZROO02PORV SGNST-EFWPA	STEAM GENERATOR TUBE RUPTURE WATER HUMMER IN STEAM LINE (HE) FAIL TO OPERATE RCS FORCED DEPRESSURIZATION A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE
40	3.0E-10	0.3	!03SLOCA NCCMVOD411D RSSCF4MVOD145-ALL	SMALL PIPE BREAK LOCA VWS-MOV-411D FAIL TO OPEN NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)

Table19.1-43 Contribution of Initiating Events to LRF

Initiating Event ID	Initiating Event Description	Percent Contribution
LOOP	Loss of Offsite Power	32.0%
SLOCA	Small Pipe Break LOCA	21.8%
LOCCW	Loss of Component Cooling Water	11.7%
SGTR	Steam Generator Tube Rupture	11.1%
PLOCW	Partial Loss of Component Cooling Water	9.3%
SLBO	Steam Line Break/Leak (Downstream MSIV: Turbine side)	4.3%
MLOCA	Medium Pipe Break LOCA	3.1%
TRANS	General Transient	2.4%
RVR	RV Rupture	1.3%
LOFF	Loss of Feedwater Flow	1.1%
VSLOCA	Very Small Pipe Break LOCA	1.0%
ATWS	Anticipated Transient Without Scram	0.7%
LOAC	Loss of Vital AC Bus	0.2%
FWLB	Feed-water Line Break	0.1%
LODC	Loss of Vital DC Bus	0.0%
SLBI	Steam Line Break/Leak (Upstream MSIV: CV side)	0.0%
LLOCA	Large Pipe Break LOCA	0.0%
	TOTALS=	100.0%

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 1 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF	1.0E-05	1.8E-01	1.8E+04
2	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	1.7E-01	9.1E+00
3	OPS----PRBF	POWER RECOVERY (1H)	5.3E-01	1.7E-01	1.1E+00
4	OPS----PRCF	POWER RECOVERY (3H)	4.1E-01	1.2E-01	1.2E+00
5	RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	8.4E-05	1.2E-01	1.5E+03
6	NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN	2.0E-02	1.1E-01	6.4E+00
7	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	9.9E-02	2.0E+01
8	EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	9.9E-04	7.9E-02	8.0E+01
9	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	7.8E-02	7.8E+00
10	OPSRSB	OFFSITE POWER RECOVERY(AFTER CORE MELT)	8.3E-02	7.7E-02	1.8E+00
11	ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER	5.1E-01	7.4E-02	1.1E+00
12	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.4E-02	2.6E+01
13	OPS----PRBS	POWER RECOVERY SUCCESS (1H)	4.7E-01	6.0E-02	1.1E+00
14	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.1E-06	5.0E-02	2.4E+04

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 2 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
15	CCWRSA	CCW RECOVERY (AFTER CORE MELT)	1.6E-02	4.8E-02	4.0E+00
16	OPS----PRCS	POWER RECOVERY SUCCESS (3H)	5.9E-01	4.0E-02	1.0E+00
17	RTPBTSWCCF	BASIC SOFTWARE CCF	1.0E-07	4.0E-02	3.9E+05
18	SGNBTSWCCF3	NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF	1.0E-04	3.5E-02	3.5E+02
19	EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	3.1E-02	2.7E+00
20	EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.5E-03	2.9E-02	2.1E+01
21	RSSCF4PMAD001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.9E-05	2.8E-02	1.5E+03
22	RTPDASF	DAS FAILURE	1.0E-02	2.8E-02	3.8E+00
23	EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	2.7E-02	2.5E+00
24	RSAOO02FWP	(HE) FAIL TO OPERATE FIRE SUPRESSION PUMP	8.5E-03	2.6E-02	4.0E+00
25	HITOO02	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW	2.7E-02	2.3E-02	1.8E+00
26	MSPMLWTH	WATER HUMMER IN STEAM LINE	1.0E-02	2.0E-02	3.0E+00
27	RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	9.7E-06	2.0E-02	2.0E+03
28	EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START	6.5E-03	1.9E-02	3.9E+00
29	EPSTMDGP2	EPS B-AAC GTG TEST & MAINTENANCE	1.2E-02	1.9E-02	2.5E+00

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 3 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
30	EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT	1.7E-02	1.9E-02	2.1E+00
31	SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE	1.2E-03	1.9E-02	1.6E+01
32	HITOO02-DP3	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW	1.7E-01	1.8E-02	1.1E+00
33	EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	2.1E-04	1.7E-02	8.0E+01
34	PZROO02PORV-DP3	(HE) FAIL TO OPERATE RCS FORCED DEPRESSURIZATION	1.5E-01	1.6E-02	1.1E+00
35	RSBOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS(AFTER CORE MELT)	7.0E-02	1.6E-02	1.2E+00
36	MSPOO02STRV-SG-DP3	(HE) FAIL TO DEPRESSURIZE RCS BY SECONDARY SIDE COOLING	1.5E-01	1.6E-02	1.1E+00
37	EPSTMDGP1	EPS A-AAC GTG TEST & MAINTENANCE	1.2E-02	1.6E-02	2.3E+00
38	NCCOO04PI1254	(HE) NCC MISCALIBRATION OF PI-1254	8.0E-04	1.5E-02	1.9E+01
39	RSSOO01CSP	(HE) FAIL TO START CV SPRAY SYSTEM	5.0E-03	1.4E-02	3.8E+00
40	EPSDLLRDGC	EPS C-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	1.4E-02	1.8E+00
41	FDAOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS (AFTER CORE MELT)	1.0E-01	1.4E-02	1.1E+00

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 4 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
42	EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE	5.0E-03	1.4E-02	3.7E+00
43	MSPOO0250C1-DP2	(HE) FAIL TO CLOSE NMS-50C1 (MANUAL VALVE)	5.8E-02	1.3E-02	1.2E+00
44	MSPOO0250B1-DP2	(HE) FAIL TO CLOSE NMS-50B1 (MANUAL VALVE)	5.8E-02	1.3E-02	1.2E+00
45	MSPOO0250A1-DP2	(HE) FAIL TO CLOSE NMS-50A1 (MANUAL VALVE)	5.8E-02	1.3E-02	1.2E+00
46	EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.6E-04	1.2E-02	8.0E+01
47	EPSDLLRDGD	EPS D-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	1.1E-02	1.7E+00
48	EFWPTAD001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO START	6.5E-03	1.1E-02	2.6E+00
49	SWSTMPE001D	EWS-OPP-001D (D-ESW PUMP) TEST & MAINTENANCE	1.2E-02	1.0E-02	1.8E+00
50	EPSCF4CBSO52STH-ALL	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.0E-02	6.5E+04
51	EPSCF4CBSO52STL-ALL	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.0E-02	6.5E+04
52	EFWCF2PTAD001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO START (CCF)	4.5E-04	9.8E-03	2.2E+01
53	SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	4.8E-05	9.3E-03	2.0E+02
54	SGNOO01S	(HE) FAIL TO START SAFETY INJECTION PUMP BY DAS	5.7E-02	8.5E-03	1.1E+00

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 5 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
55	MSPOO0250A2-DP2	(HE) FAIL TO CLOSE NMS-50A2 (MANUAL VALVE)	5.8E-02	8.5E-03	1.1E+00
56	MSPOO0250C2-DP2	(HE) FAIL TO CLOSE NMS-50C2 (MANUAL VALVE)	5.8E-02	8.5E-03	1.1E+00
57	MSPOO0250B2-DP2	(HE) FAIL TO CLOSE NMS-50B2 (MANUAL VALVE)	5.8E-02	8.5E-03	1.1E+00
58	RSSOO02LNUP-SG-DP3	(HE) FAIL TO TRANSFER TO RHR OPERATION MODE	1.5E-01	8.3E-03	1.0E+00
59	HPIOO02FWBD-S-DP4	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	5.0E-01	8.3E-03	1.0E+00
60	EPSDLADDGP2	EPS B-AAC GTG FAIL TO START	4.7E-03	8.4E-03	2.7E+00
61	EPSTMDGC	EPS C-CLASS 1E GTG TEST & MAINTENANCE	1.2E-02	8.2E-03	1.7E+00
62	HPIOO01SDVDAS	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE BY DAS	5.7E-02	8.1E-03	1.1E+00
63	CHIOO01CHIB	(HE) FAIL TO START THE STANDBY CHARGING INJECTION PUMP B	2.6E-03	8.1E-03	4.1E+00
64	EPSCF4CBSO52LC-ALL	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	7.8E-03	4.9E+04
65	HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	2.6E-03	7.6E-03	3.9E+00

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 6 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
66	RSSCF4PMSR001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	5.0E-06	7.5E-03	1.5E+03
67	NCCOO02CCW-DP2	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN	6.9E-02	7.3E-03	1.1E+00
68	RSSCF4RHPR001-ALL	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	4.8E-06	7.1E-03	1.5E+03
69	SWSTMPE001B	EWS-OPP-001B (B-ESW PUMP) TEST & MAINTENANCE	1.2E-02	7.1E-03	1.6E+00
70	EPSCF4DLLRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	7.1E-03	2.9E+01
71	EPSDLADDGP1	EPS A-AAC GTG FAIL TO START	4.7E-03	7.2E-03	2.5E+00
72	EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	2.4E-03	7.0E-03	3.9E+00
73	NCCAVOD1212	NCS-PCV-1212 FAIL TO OPEN	1.2E-03	6.7E-03	6.6E+00
74	EFWTMTA001D	EFS-RPP-001D (D-EFW PUMP) TEST & MAINTENANCE	5.0E-03	6.5E-03	2.3E+00
75	HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP	3.8E-03	6.4E-03	2.7E+00
76	EPSTMDGD	EPS D-CLASS 1E GTG TEST & MAINTENANCE	1.2E-02	6.3E-03	1.5E+00

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 7 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
77	OPS----PRDF	OFFSITE POWER RECOVERY FAILURE WITHIN 24 HOUR	1.8E-02	6.2E-03	1.3E+00
78	EPSCF2DLADDGP-ALL	EPS AAC GTG A,B FAIL TO START (CCF)	3.1E-04	6.1E-03	2.1E+01
79	CWSTMRC001D	NCS-RHX-001D (D-CCW HX) TEST & MAINTENANCE	7.0E-03	5.9E-03	1.8E+00
80	RSSTMRP001C	RHS-RHX-001C (C-CS/RHR HX) TEST & MAINTENANCE	5.0E-03	5.9E-03	2.2E+00
81	EPSCBFO52RAT-ACD	EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	5.6E-03	1.1E+03
82	EPSCBFO52UAT-ACD	EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	5.6E-03	1.1E+03
83	NCCMVCD414	VWS-MOV-414 FAIL TO CLOSE	1.0E-03	5.6E-03	6.6E+00
84	NCCMVOD407	VWS-MOV-407 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
85	NCCMVOD425	VWS-MOV-425 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
86	NCCMVOD424	VWS-MOV-424 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
87	NCCMVOD422	VWS-MOV-422 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
88	NCCMVOD403	VWS-MOV-403 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
89	NCCMVOD411C	VWS-MOV-411C FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00

Table19.1- 44 Basic Events (Hardware Failure, Human Error) FV Importance for LRF (Sheet 8 of 8)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
90	NCCMVOD411A	VWS-MOV-411A FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
91	NCCMVOD411B	VWS-MOV-411B FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
92	NCCMVOD411D	VWS-MOV-411D FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
93	EPSOO01UATRAT	(HE) FAIL TO SEPARATE 52/UATA,D,52/RATA,D (BREAKER) AT LOCAL	1.6E-02	5.4E-03	1.3E+00
94	PZROO02PORV	(HE) FAIL TO OPERATE RCS FORCED DEPRESSURIZATION	6.2E-03	5.3E-03	1.9E+00
95	CWSCF4PCBD001-R-ALL	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	2.6E-05	5.1E-03	2.0E+02
96	CWSTMPC001D	NCS-RPP-001D (D-CCW PUMP) TEST & MAINTENANCE	6.0E-03	5.1E-03	1.8E+00
97	EPSSEFFDGP2	EPS B-AAC GTG SEQUENCER FAIL TO OPERATE	2.9E-03	5.1E-03	2.7E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 1 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPBTSWCCF	BASIC SOFTWARE CCF	1.0E-07	4.0E-02	3.9E+05
2	EPSCF4CBSO52STH-ALL	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.0E-02	6.5E+04
3	EPSCF4CBSO52STL-ALL	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.0E-02	6.5E+04
4	SWSCF4PMYR-FF	EWS-OPP-001A,B,C,D (A,B,C,D-ESW PUMP) FAIL TO RUN (CCF)	1.2E-08	7.6E-04	6.3E+04
5	CWSCF4RHPR-FF	NCS-RHX-001A,B,C,D (A,B,C,D-CCW HX) PLUG / FOUL (CCF)	3.6E-08	2.1E-03	5.8E+04
6	CWSCF4PCYR-FF	NCS-RPP-001A,B,C,D (A,B,C,D-CCW PUMP) FAIL TO RUN (CCF)	6.7E-09	3.9E-04	5.8E+04
7	EPSCF4CBSO52LC-ALL	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	7.8E-03	4.9E+04
8	RTPCRDF	ROD INJECTION FAILURE (4< RODS)	1.0E-07	2.8E-03	2.8E+04
9	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.1E-06	5.0E-02	2.4E+04
10	SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF	1.0E-05	1.8E-01	1.8E+04
11	EPSCF4CBSO72DB-ALL	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.4E-03	9.0E+03
12	EPSCF4BYFF-ALL	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	5.0E-08	4.5E-04	9.0E+03
13	EPSCF4CBSC52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	1.3E-03	8.3E+03

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 2 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
14	EPSCF4CBSC52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	1.3E-03	8.3E+03
15	EPSCF4CBSO52STH-124	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.8E-05	3.0E+03
16	EPSCF4CBSO52STL-134	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.8E-05	3.0E+03
17	EPSCF4CBSO52LC-234	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.3E-05	2.1E+03
18	RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	9.7E-06	2.0E-02	2.0E+03
19	RWSXVEL024	RWS-VLV-024 EXTERNAL LEAK LARGE	7.2E-08	1.4E-04	2.0E+03
20	RWSXVEL001	RWS-VLV-001 EXTERNAL LEAK LARGE	7.2E-08	1.4E-04	2.0E+03
21	RWSCVEL023	RWS-VLV-023 EXTERNAL LEAK LARGE	4.8E-08	9.6E-05	2.0E+03
22	RWSMVEL002	RWS-MOV-002 EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03
23	RWSPNELPIPE2	RWS PIPING BETWEEN RWSP AND RWS-VLV-002 EXTERNAL LEAK LARGE	6.0E-10	1.2E-06	2.0E+03
24	RWSPNELPIPE1	RWS PIPING BETWEEN RWSP AND RWS-VLV-023 EXTERNAL LEAK LARGE	6.0E-10	1.2E-06	2.0E+03
25	RWSTNEL001	RWS-CPT-001 (RWSP) EXTERNAL LEAK LARGE	4.8E-08	9.5E-05	2.0E+03
26	HPIMVEL001A	SIS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 3 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
27	HPIMVEL001D	SIS-MOV-001D EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03
28	HPIMVEL001C	SIS-MOV-001C EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03
29	HPIMVEL001B	SIS-MOV-001B EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03
30	RSSMVELCSS001B	CSS-MOV-001B EXTERNAL LEAK LARGE	2.4E-08	4.7E-05	2.0E+03
31	RSSMVELCSS001C	CSS-MOV-001C EXTERNAL LEAK LARGE	2.4E-08	4.7E-05	2.0E+03
32	RSSMVELCSS001D	CSS-MOV-001D EXTERNAL LEAK LARGE	2.4E-08	4.7E-05	2.0E+03
33	RSSMVELCSS001A	CSS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	4.7E-05	2.0E+03
34	EPSCF4CBSO52STH-134	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.6E-05	1.6E+03
35	EPSCF4CBSO52STL-124	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.6E-05	1.6E+03
36	EPSCF4CBSO52LC-123	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.5E-05	1.5E+03
37	RSSCF4PMAD001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.9E-05	2.8E-02	1.5E+03
38	RSSCF4PMSR001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	5.0E-06	7.5E-03	1.5E+03
39	RSSCF4RHPR001-ALL	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	4.8E-06	7.1E-03	1.5E+03
40	RSSCF4PMLR001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.7E-06	2.6E-03	1.5E+03

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 4 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
41	RSSCF4CVOD004-ALL	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	4.3E-07	6.4E-04	1.5E+03
42	RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	8.4E-05	1.2E-01	1.5E+03
43	MSPPNELPA1	NMS MAIN STEAM LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	8.8E-07	1.5E+03
44	EPSCF4CBSO52STL-123	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.0E-05	1.4E+03
45	EPSCF4CBSO52STH-123	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.0E-05	1.4E+03
46	EPSCF4CBSO52LC-124	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.0E-05	1.4E+03
47	RSSPNEL01D	CSS PIPING BETWEEN RWSP AND CSS-MOV-001D EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03
48	RSSPNEL01C	CSS PIPING BETWEEN RWSP AND CSS-MOV-001C EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03
49	HPIPNELSUCTSC	SIS PIPING C BETWEEN RWSP AND SIS-MOV-001C EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03
50	HPIPNELSUCTSD	SIS PIPING D BETWEEN RWSP AND SIS-MOV-001D EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03
51	HPIPNELSUCTSA	SIS PIPING A BETWEEN RWSP AND SIS-MOV-001A EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03
52	RSSPNEL01B	CSS PIPING BETWEEN RWSP AND CSS-MOV-001B EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 5 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
53	HPIPNELSUCTSB	SIS PIPING B BETWEEN RWSP AND SIS-MOV-001B EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03
54	RSSPNEL01A	CSS PIPING BETWEEN RWSP AND CSS-MOV-001A EXTERNAL LEAK LARGE	6.0E-10	8.2E-07	1.4E+03
55	EPSCF4CBSO72DB-123	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.6E-05	1.3E+03
56	EPSCF4BYFF-234	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	1.5E-05	1.3E+03
57	EPSCF4CBSO72DB-234	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.6E-05	1.2E+03
58	EPSCF4BYFF-123	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	1.5E-05	1.2E+03
59	EPSCF4CBSO52STL-234	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.4E-05	1.2E+03
60	EPSCF4CBSO52STH-234	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.4E-05	1.2E+03
61	EPSCBFO52RAT-ACD	EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	5.6E-03	1.1E+03
62	EPSCF4CBSC52RAT-134	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	3.2E-05	1.1E+03
63	EPSCBFO52UAT-ACD	EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	5.6E-03	1.1E+03
64	EPSCF4CBSC52UAT-134	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	3.2E-05	1.1E+03

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 6 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
65	EPSCF4CBSO72DB-124	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.0E-05	1.0E+03
66	EPSCF4BYFF-134	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	1.3E-05	1.0E+03
67	RTPCF4ICYRRT7001-ALL	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	1.4E-06	1.1E-03	8.0E+02
68	EPSCF4CBSO52LC-134	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.8E-05	6.1E+02
69	EPSCF4CBSO72DB-134	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.6E-05	5.6E+02
70	EPSCF4BYFF-124	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	6.9E-06	5.6E+02
71	EPSCBFO52RAT-ABD	EPS 52/RATA,B,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	2.5E-03	4.9E+02
72	EPSCBFO52UAT-ABD	EPS 52/UATA,B,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	2.5E-03	4.9E+02
73	EPSCF4CBSC52RAT-124	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.4E-05	4.9E+02
74	EPSCF4CBSC52UAT-124	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.4E-05	4.9E+02
75	EFWCF2CVOD008-ALL	EFS-VLV-008A,B FAIL TO OPEN (CCF)	2.4E-06	9.3E-04	3.9E+02
76	EFWCF4CVOD012-ALL	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	1.7E-06	6.5E-04	3.9E+02
77	EFWCF4CVOD018-ALL	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	1.7E-06	6.5E-04	3.9E+02
78	EFWCF4MVFC017-ALL	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	8.5E-07	3.3E-04	3.9E+02

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 7 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
79	EFWCF4MVFC017-134	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	1.1E-04	3.8E+02
80	EFWCF4MVFC017-124	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	1.1E-04	3.8E+02
81	EFWCF4MVFC017-234	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	1.1E-04	3.8E+02
82	EFWCF4MVFC017-123	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	2.8E-07	1.1E-04	3.8E+02
83	EFWXVEL006B	EFS-VLV-006B EXTERNAL LEAK LARGE	7.2E-08	2.6E-05	3.6E+02
84	EFWXVEL006A	EFS-VLV-006A EXTERNAL LEAK LARGE	7.2E-08	2.6E-05	3.6E+02
85	EFWCF4CVOD018-134	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	2.2E-05	3.6E+02
86	EFWCF4CVOD018-234	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	2.2E-05	3.6E+02
87	EFWCF4CVOD018-123	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	2.2E-05	3.6E+02
88	EFWCF4CVOD018-124	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	2.2E-05	3.6E+02
89	SGNBTSWCCF3	NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF	1.0E-04	3.5E-02	3.5E+02
90	RTPCF4AXFFRT-ALL	REACTOR TRIP BREAKER A1,A2,B1,B2,C1,C2,D1,D2 (CCF)	2.3E-06	6.8E-04	2.9E+02
91	EPSCF4CBSO52LC-23	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.5E-06	2.3E+02
92	EPSCF4CBSO52STH-24	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.4E-06	2.2E+02

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 8 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
93	EPSCF4CBSO52STL-34	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.4E-06	2.2E+02
94	EPSCBFO52RAT-BCD	EPS 52/RATB,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	1.1E-03	2.2E+02
95	EPSCF4CBSC52RAT-234	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	6.3E-06	2.2E+02
96	EPSCBFO52UAT-BCD	EPS 52/UATB,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	1.1E-03	2.2E+02
97	EPSCF4CBSC52UAT-234	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	6.3E-06	2.2E+02
98	SWSCF4PMBD001-R-ALL	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	4.8E-05	9.3E-03	2.0E+02
99	CWSCF4PCBD001-R-ALL	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	2.6E-05	5.1E-03	2.0E+02
100	SWSCF4CVOD502-R-ALL	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	1.5E-07	2.7E-05	1.8E+02
101	CWSCF4CVOD016-R-ALL	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	1.5E-07	2.7E-05	1.8E+02
102	SWSCF4CVOD602-R-ALL	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	1.5E-07	2.7E-05	1.8E+02
103	EPSCBFO52RAT-CD	EPS 52/RATC,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	8.9E-04	1.8E+02

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 9 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
104	EPSCF4CBSC52RAT-34	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	6.0E-06	1.8E+02
105	EPSCBFO52UAT-CD	EPS 52/UATC,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	8.9E-04	1.8E+02
106	EPSCF4CBSC52UAT-34	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	6.0E-06	1.8E+02
107	EPSCF2CBSO52LL1-ALL	EPS 52/LLAA,LLAD (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	4.3E-05	1.5E+02
108	EPSCF2CBSO52LL2-ALL	EPS 52/LLDA,LLDD (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	4.3E-05	1.5E+02
109	EPSCF2CBSO52LC1-ALL	EPS 52/LCA1,D1 (BREAKER) SPURIOUS CLOSE (CCF)	2.8E-07	4.3E-05	1.5E+02
110	EPSCF4IVFF002-ALL	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	1.5E-06	2.3E-04	1.5E+02
111	HPIPMEL001C	SIS-RPP-001C (C-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.7E-05	1.4E+02
112	RSSPMEL001C	RHS-RPP-001C (C-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.7E-05	1.4E+02
113	EPSCBFO52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)	2.0E-05	2.8E-03	1.4E+02
114	EPSCBFO52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)	2.0E-05	2.8E-03	1.4E+02
115	EPSCF4CBSO52STL-14	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	4.2E-06	1.3E+02

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 10 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
116	EPSCF4CBSO52STH-14	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	4.2E-06	1.3E+02
117	EFWCF4MVFC017-14	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	6.9E-05	1.2E+02
118	EFWCF4CVOD018-23	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	2.7E-05	1.2E+02
119	EFWCF4MVFC017-13	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	6.7E-05	1.2E+02
120	EFWCF4MVFC017-34	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	6.7E-05	1.2E+02
121	EFWCF4CVOD018-13	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	2.7E-05	1.2E+02
122	EFWCF4CVOD018-12	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	2.7E-05	1.2E+02
123	EPSCF4CBSO52LC-13	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.7E-06	1.1E+02
124	EPSCF4CBSO52STL-24	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.7E-06	1.1E+02
125	EPSCF4CBSO52STH-34	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.7E-06	1.1E+02
126	RWSCF4SUPR001-123	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	4.0E-04	1.1E+02
127	RWSCF4SUPR001-234	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	3.5E-04	9.7E+01
128	HPIPMEL001D	SIS-RPP-001D (D-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.7E-05	9.0E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 11 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
129	RSSPMEL001D	RHS-RPP-001D (D-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.7E-05	9.0E+01
130	RWSCF4SUPR001-124	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	3.2E-04	8.7E+01
131	RSSRIEL001D	RHS-RHX-001D (D-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	6.2E-05	8.7E+01
132	RSSRIEL001A	RHS-RHX-001A (A-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	6.2E-05	8.7E+01
133	RSSXVEL013D	RHS-VLV-013D EXTERNAL LEAK LARGE	7.2E-08	6.2E-06	8.7E+01
134	RSSXVEL013A	RHS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	6.2E-06	8.7E+01
135	RSSCVEL004A	RHS-VLV-004A EXTERNAL LEAK LARGE	4.8E-08	4.1E-06	8.7E+01
136	RSSCVEL004D	RHS-VLV-004D EXTERNAL LEAK LARGE	4.8E-08	4.1E-06	8.7E+01
137	RSSRIEL001C	RHS-RHX-001C (C-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	6.2E-05	8.7E+01
138	RSSXVEL013C	RHS-VLV-013C EXTERNAL LEAK LARGE	7.2E-08	6.2E-06	8.7E+01
139	RSSCVEL004C	RHS-VLV-004C EXTERNAL LEAK LARGE	4.8E-08	4.1E-06	8.7E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 12 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
140	RSSRIEL001B	RHS-RHX-001B (B-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	6.1E-05	8.6E+01
141	RSSXVEL013B	RHS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	6.1E-06	8.6E+01
142	RSSCVEL004B	RHS-VLV-004B EXTERNAL LEAK LARGE	4.8E-08	4.1E-06	8.6E+01
143	CFACVEL012	CSS-VLV-012 EXTERNAL LEAK LARGE	4.8E-08	4.0E-06	8.5E+01
144	HPIPMEL001A	SIS-RPP-001A (A-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.6E-05	8.5E+01
145	RSSPMEL001A	RHS-RPP-001A (A-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.6E-05	8.5E+01
146	HPIPMEL001B	SIS-RPP-001B (B-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.6E-05	8.5E+01
147	RSSPMEL001B	RHS-RPP-001B (B-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.6E-05	8.4E+01
148	RSSXVEL002B	CSS-VLV-002B EXTERNAL LEAK LARGE	7.2E-08	6.0E-06	8.4E+01
149	RSSMVEL004B	CSS-MOV-004B EXTERNAL LEAK LARGE	2.4E-08	2.0E-06	8.4E+01
150	RWSPMEL001B	RWS-RPP-001B (B-RWR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.6E-05	8.4E+01
151	RWSPMEL001A	RWS-RPP-001A (A-RWR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.6E-05	8.4E+01
152	RWSXVEL101	RWS-VLV-101 EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
153	RWSXVEL103A	SFS-VLV-103A EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
154	RWSXVEL028	SFS-VLV-028 EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 13 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
155	RWSXVEL006B	RWS-VLV-006B EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
156	RWSXVEL013A	RWS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
157	RWSXVEL005	RWS-VLV-005 EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
158	RWSXVEL006A	RWS-VLV-006A EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
159	RWSXVEL103B	SFS-VLV-103B EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
160	RWSXVEL013B	RWS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
161	RWSXVEL066A	NCS-VLV-066A EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
162	RWSXVEL021	RWS-VLV-021 EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
163	RWSXVEL014	RWS-VLV-014 EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
164	RWSXVEL066B	NCS-VLV-066B EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.4E+01
165	RWSCVEL065A	NCS-VLV-065A EXTERNAL LEAK LARGE	4.8E-08	4.0E-06	8.4E+01
166	RWSCVEL037	LMS-VLV-037 EXTERNAL LEAK LARGE	4.8E-08	4.0E-06	8.4E+01
167	RWSCVEL065B	NCS-VLV-065B EXTERNAL LEAK LARGE	4.8E-08	4.0E-06	8.4E+01
168	RWSCVEL012B	RWS-VLV-012B EXTERNAL LEAK LARGE	4.8E-08	4.0E-06	8.4E+01
169	RWSCVEL027	SFS-VLV-027 EXTERNAL LEAK LARGE	4.8E-08	4.0E-06	8.4E+01
170	RWSCVEL012A	RWS-VLV-012A EXTERNAL LEAK LARGE	4.8E-08	4.0E-06	8.4E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 14 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
171	RWSPNELPIPE4	RWS PIPING BETWEEN RWS-VLV-004 AND RWSAT EXTERNAL LEAK LARGE	6.0E-10	5.0E-08	8.4E+01
172	RSSXVEL002D	CSS-VLV-002D EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.2E+01
173	RSSXVEL002A	CSS-VLV-002A EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.2E+01
174	RSSXVEL002C	CSS-VLV-002C EXTERNAL LEAK LARGE	7.2E-08	5.9E-06	8.2E+01
175	RSSMVEL004C	CSS-MOV-004C EXTERNAL LEAK LARGE	2.4E-08	2.0E-06	8.2E+01
176	RSSMVEL004A	CSS-MOV-004A EXTERNAL LEAK LARGE	2.4E-08	2.0E-06	8.2E+01
177	RSSMVEL004D	CSS-MOV-004D EXTERNAL LEAK LARGE	2.4E-08	2.0E-06	8.2E+01
178	EPSCF4IVFF001-ALL	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.5E-06	1.2E-04	8.2E+01
179	RSSXVEL034A	RHS-VLV-034A EXTERNAL LEAK LARGE	7.2E-08	5.8E-06	8.1E+01
180	RSSXVEL031A	RHS-VLV-031A EXTERNAL LEAK LARGE	7.2E-08	5.8E-06	8.1E+01
181	RSSXVEL031D	RHS-VLV-031D EXTERNAL LEAK LARGE	7.2E-08	5.8E-06	8.1E+01
182	RSSXVEL034D	RHS-VLV-034D EXTERNAL LEAK LARGE	7.2E-08	5.8E-06	8.1E+01
183	HPICVEL004D	SIS-VLV-004D EXTERNAL LEAK LARGE	4.8E-08	3.8E-06	8.1E+01
184	HPICVEL004C	SIS-VLV-004C EXTERNAL LEAK LARGE	4.8E-08	3.8E-06	8.1E+01
185	HPICVEL004A	SIS-VLV-004A EXTERNAL LEAK LARGE	4.8E-08	3.8E-06	8.1E+01
186	HPICVEL004B	SIS-VLV-004B EXTERNAL LEAK LARGE	4.8E-08	3.8E-06	8.1E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 15 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
187	HPIMVEL009B	SIS-MOV-009B EXTERNAL LEAK LARGE	2.4E-08	1.9E-06	8.1E+01
188	HPIMVEL009A	SIS-MOV-009A EXTERNAL LEAK LARGE	2.4E-08	1.9E-06	8.1E+01
189	HPIMVEL009C	SIS-MOV-009C EXTERNAL LEAK LARGE	2.4E-08	1.9E-06	8.1E+01
190	HPIMVEL009D	SIS-MOV-009D EXTERNAL LEAK LARGE	2.4E-08	1.9E-06	8.1E+01
191	HPIPNELINJSA	SIS A-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	4.8E-08	8.1E+01
192	HPIPNELINJSC	SIS C-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	4.8E-08	8.1E+01
193	HPIPNELINJSB	SIS B-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	4.8E-08	8.1E+01
194	HPIPNELINJSD	SIS D-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	6.0E-10	4.8E-08	8.1E+01
195	EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	9.9E-04	7.9E-02	8.0E+01
196	EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	2.1E-04	1.7E-02	8.0E+01
197	EPSCF4DLSRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.6E-04	1.2E-02	8.0E+01
198	EPSCF4SEFFDG-ALL	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	3.8E-05	3.0E-03	8.0E+01
199	EPSCF4CBFC52EPS-ALL	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	2.0E-05	1.6E-03	8.0E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 16 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
200	EPSCF4CBSO52EPS-ALL	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.3E-05	8.0E+01
201	RSSCF4PMAD001-123	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	4.9E-04	7.9E+01
202	EPSCBFO52UAT-AD	EPS 52/UATA,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	3.9E-04	7.9E+01
203	EPSCBFO52RAT-AD	EPS 52/RATA,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	3.9E-04	7.9E+01
204	EPSCF4CBSC52UAT-14	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	2.6E-06	7.9E+01
205	EPSCF4CBSC52RAT-14	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	2.6E-06	7.9E+01
206	RSSMVEL021C	RHS-MOV-021C EXTERNAL LEAK LARGE	2.4E-08	1.8E-06	7.6E+01
207	RSSMVEL021D	RHS-MOV-021D EXTERNAL LEAK LARGE	2.4E-08	1.8E-06	7.6E+01
208	RSSMVEL021A	RHS-MOV-021A EXTERNAL LEAK LARGE	2.4E-08	1.8E-06	7.6E+01
209	RSSMVEL021B	RHS-MOV-021B EXTERNAL LEAK LARGE	2.4E-08	1.8E-06	7.6E+01
210	RWSMVEL004	RWS-MOV-004 EXTERNAL LEAK LARGE	2.4E-08	1.8E-06	7.6E+01
211	RWSPNELPIPE3	RWS PIPING BETWEEN RWS-VLV-002 AND RWS-VLV-004 EXTERNAL LEAK LARGE	6.0E-10	4.5E-08	7.6E+01
212	RSSCF4PMSR001-234	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	1.2E-04	7.6E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 17 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
213	EPSCF4CBSO52UA-ALL	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.2E-05	7.5E+01
214	EPSCF4CBSO72AU-ALL	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.2E-05	7.5E+01
215	RSSCF4MVOD145-234	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	1.1E-04	7.5E+01
216	RSSCF4PMAD001-134	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	4.4E-04	7.2E+01
217	RSSCF4PMLR001-234	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.8E-07	3.9E-05	6.9E+01
218	RSSCF4PMSR001-124	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	1.1E-04	6.9E+01
219	SWSCF2PMYR001AC-ALL	EWS-OPP-001A,C (ESW PUMP) FAIL TO RUN (CCF)	8.9E-06	5.9E-04	6.8E+01
220	RSSCF4MVOD145-124	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	9.7E-05	6.8E+01
221	ACCCF4CVOD102-ALL	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	6.5E-05	6.6E+01
222	ACCCF4CVOD103-ALL	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	6.5E-05	6.6E+01
223	ACCCF4CVOD102-123	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01
224	ACCCF4CVOD103-123	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 18 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
225	ACCCF4CVOD102-134	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01
226	ACCCF4CVOD102-234	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01
227	ACCCF4CVOD103-234	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01
228	ACCCF4CVOD102-124	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01
229	ACCCF4CVOD103-124	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01
230	ACCCF4CVOD103-134	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.7E-05	6.6E+01
231	ACCCF4CVOD102-34	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	1.0E-05	6.6E+01
232	ACCCF4CVOD103-24	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	1.0E-05	6.6E+01
233	ACCCF4CVOD103-12	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	1.0E-05	6.6E+01
234	ACCCF4CVOD102-23	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	1.0E-05	6.6E+01
235	ACCCF4CVOD103-14	SIS-VLV-103A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	1.0E-05	6.6E+01
236	ACCCF4CVOD102-24	SIS-VLV-102A,B,C,D FAIL TO OPEN (CCF)	1.6E-07	1.0E-05	6.6E+01
237	EPSCF4IVFF001-124	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	3.2E-05	6.5E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 19 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
238	RSSCF4CVOD004-234	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	1.4E-05	6.3E+01
239	RSSCF4RHPR001-234	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	6.4E-08	4.0E-06	6.3E+01
240	RSSCF4PMLR001-124	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.8E-07	3.5E-05	6.2E+01
241	RSSAVEL621	RHS-FCV-621 EXTERNAL LEAK LARGE	2.2E-08	1.3E-06	6.2E+01
242	RSSAVEL623	RHS-HCV-623 EXTERNAL LEAK LARGE	2.2E-08	1.3E-06	6.2E+01
243	RSSAVEL611	RHS-FCV-611 EXTERNAL LEAK LARGE	2.2E-08	1.3E-06	6.2E+01
244	RSSAVEL613	RHS-HCV-613 EXTERNAL LEAK LARGE	2.2E-08	1.3E-06	6.2E+01
245	RSSCF4CVOD004-124	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	1.3E-05	5.8E+01
246	RSSCF4RHPR001-124	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	6.4E-08	3.7E-06	5.8E+01
247	RSSCF4MVOD004-ALL	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	8.4E-05	4.8E-03	5.8E+01
248	CWSCF2PCYR001AC-ALL	NCS-RPP-001A,C (CCW PUMP) FAIL TO RUN (CCF)	5.0E-06	2.8E-04	5.7E+01
249	SGNOO04ICVR12	(HE) MISCALIBRATION OF C/V PRESSURE SENSORS A,B,C,D	6.7E-05	3.6E-03	5.5E+01
250	SGNCF4ICVR0012-ALL	CONTAINMENT PRESSURE SENSOR CCF	1.3E-06	6.9E-05	5.5E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 20 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
251	SGNCF4ICVR0012-123	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	2.2E-05	5.3E+01
252	SGNCF4ICVR0012-124	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	2.2E-05	5.3E+01
253	SGNCF4ICVR0012-234	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	2.2E-05	5.3E+01
254	SGNCF4ICVR0012-134	CONTAINMENT PRESSURE SENSOR CCF	4.3E-07	2.2E-05	5.3E+01
255	EPSBSFFAM001D	ESS-AM-001D (D CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	2.9E-04	5.2E+01
256	EPSBSFFDD001D	ESS-DD-001D (D DC SWITCHBOARD BUS) FAILURE	5.8E-06	2.9E-04	5.2E+01
257	EPSCBFO52UAT-ABC	EPS 52/UATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	2.5E-04	5.0E+01
258	EPSCBFO52RAT-ABC	EPS 52/RATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	2.5E-04	5.0E+01
259	EPSCF4CBSC52UAT-123	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.4E-06	5.0E+01
260	EPSCF4CBSC52RAT-123	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.4E-06	5.0E+01
261	EPSCF4IVFF001-123	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	2.4E-05	4.9E+01
262	MSPSVCD509A	NMS-VLV-509A FAIL TO RE-CLOSE	7.0E-05	3.4E-03	4.9E+01
263	MSPSVCD510A	NMS-VLV-510A FAIL TO RE-CLOSE	7.0E-05	3.4E-03	4.9E+01
264	MSPSVOM509A	NMS-VLV-509A SPURIOUS OPEN	4.8E-06	2.3E-04	4.9E+01
265	MSPSVOM510A	NMS-VLV-510A SPURIOUS OPEN	4.8E-06	2.3E-04	4.9E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 21 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
266	EPSCF4CBSO72AU-124	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.3E-06	4.6E+01
267	EPSCF4CBSO52UA-124	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.3E-06	4.6E+01
268	RSSCF4CVOD005-ALL	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	4.3E-07	1.8E-05	4.2E+01
269	EPSCF4CBSO72DB-24	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.0E-06	3.2E+01
270	EPSCF4BYFF-13	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.9E-08	5.9E-07	3.2E+01
271	RSSCF4PMAD001-124	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	1.9E-04	3.1E+01
272	CWSCF2RHP001AC-ALL	NCS-RHX-001A,C (CCW HX) PLUG / FOUL (CCF)	6.8E-08	1.9E-06	3.0E+01
273	RSSCF4MVOD145-123	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	4.1E-05	2.9E+01
274	RSSCF4PMSR001-123	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	4.7E-05	2.9E+01
275	EPSCF4DLLRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	7.1E-03	2.9E+01
276	EPSCF4DLADDG-134	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	1.5E-03	2.9E+01
277	EPSCF4DLSRDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	1.1E-03	2.9E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 22 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
278	EPSCF4SEFFDG-234	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	3.6E-04	2.9E+01
279	EPSCF4CBFC52EPS-123	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	1.5E-04	2.9E+01
280	EPSCF4CBSO52EPS-234	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.3E-07	2.9E+01
281	EPSCF4CBSO52UA-123	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.0E-07	2.8E+01
282	EPSCF4CBSO72AU-123	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.0E-07	2.8E+01
283	RSSCF4PMLR001-123	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.8E-07	1.5E-05	2.7E+01
284	PZRSVCD122	RCS-VLV-122 FAIL TO RE-CLOSE	7.0E-05	1.8E-03	2.6E+01
285	PZRSVCD121	RCS-VLV-121 FAIL TO RE-CLOSE	7.0E-05	1.8E-03	2.6E+01
286	PZRSVCD123	RCS-VLV-123 FAIL TO RE-CLOSE	7.0E-05	1.8E-03	2.6E+01
287	PZRSVCD120	RCS-VLV-120 FAIL TO RE-CLOSE	7.0E-05	1.8E-03	2.6E+01
288	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.4E-02	2.6E+01
289	SGNBTSWCCF1	GROUP-1 APPLICATION SOFTWARE CCF	1.0E-05	2.3E-04	2.4E+01
290	RSSCF4CVOD004-123	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	5.0E-06	2.4E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 23 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
291	RSSCF4RHPR001-123	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	6.4E-08	1.4E-06	2.4E+01
292	EFWCF4CVOD012-234	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	1.4E-06	2.3E+01
293	RSSCF4PMAD001-234	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	6.3E-06	1.4E-04	2.3E+01
294	EFWCF2PTAD001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO START (CCF)	4.5E-04	9.8E-03	2.2E+01
295	EFWCF2PTSR001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.1E-04	2.4E-03	2.2E+01
296	EFWCF2PTLR001AD-ALL	EFS-RPP-001A,D (EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	7.2E-05	1.6E-03	2.2E+01
297	RWSCF4SUPR001-134	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	7.8E-05	2.2E+01
298	RTPCF4ICYRRT7001-245	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.9E-06	2.2E+01
299	RTPCF4ICYRRT7001-345	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.9E-06	2.2E+01
300	RTPCF4ICYRRT7001-234	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.9E-06	2.2E+01
301	RTPCF4ICYRRT7001-235	SG WATER LEVEL SENSOR (NARROW RANGE) CCF	9.1E-08	1.9E-06	2.2E+01
302	EPSCF4CBSO72DD2-ALL	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	3.2E-06	2.2E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 24 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
303	EPSCF4CBSO72DD1-ALL	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	3.2E-06	2.2E+01
304	EPSCF4CBSO72DD1-12	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.9E-07	2.2E+01
305	EPSCF4CBSO72DD2-14	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.9E-07	2.2E+01
306	EPSCF4CBSO72DD2-124	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.0E-07	2.2E+01
307	EPSCF4CBSO72DD2-134	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.0E-07	2.2E+01
308	EPSCF4CBSO72DD1-124	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.0E-07	2.2E+01
309	EPSCF4CBSO72DD1-123	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.0E-07	2.2E+01
310	EFWCF2MVOD103-ALL	EFS-MOV-103A,D FAIL TO OPEN (CCF)	4.2E-05	8.6E-04	2.1E+01
311	EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.5E-03	2.9E-02	2.1E+01
312	EPSCF2DLADDGP-ALL	EPS AAC GTG A,B FAIL TO START (CCF)	3.1E-04	6.1E-03	2.1E+01
313	EPSCF2DLSRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	2.3E-04	4.6E-03	2.1E+01
314	EPSCF2SEFFDGP-ALL	EPS AAC GTG A,B SEQUENCER FAIL TO OPERATE (CCF)	1.4E-04	2.8E-03	2.1E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 25 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
315	EPSCF2CBFC52AAC2-ALL	EPS 52/AACAP,52/AACBP (BREAKER) FAIL TO CLOSE (CCF)	2.8E-05	5.6E-04	2.1E+01
316	EPSCF2CBSO5AAC2-ALL	EPS 52/AACAP,52/AACBP (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	5.6E-06	2.1E+01
317	RSSCF4MVOD145-134	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	2.9E-05	2.1E+01
318	EPPBTSWCCF	BO-SIGNAL (TRAIN P1,2) SOFTWARE CCF	1.0E-04	2.0E-03	2.1E+01
319	EPPBTHWCCF	BO-SIGNAL (TRAIN P1,2) HARDWARE CCF	2.1E-06	4.2E-05	2.1E+01
320	SWSCF4PMBD001-R-124	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	3.0E-04	2.1E+01
321	EPSCF4CBSO52STH-12	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.5E-07	2.0E+01
322	EPSCF4CBSO52STL-13	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.5E-07	2.0E+01
323	CWSCF4PCBD001-R-123	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	1.6E-04	2.0E+01
324	RSSCF4PMSR001-134	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-06	3.2E-05	2.0E+01
325	EPSCF4IVFF002-134	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	5.0E-07	9.4E-06	2.0E+01
326	OPSLOOP	CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP	5.3E-03	9.9E-02	2.0E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 26 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
327	EPSCF4CBSO52LC-24	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.1E-07	1.9E+01
328	NCCOO04PI1254	(HE) NCC MISCALIBRATION OF PI-1254	8.0E-04	1.5E-02	1.9E+01
329	NCCIPFF1254	PI-1254 FAIL TO OPERATE	2.7E-05	5.0E-04	1.9E+01
330	EPSCF4CBSO52STH-23	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.1E-07	1.9E+01
331	EPSCF4CBSO52STL-23	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.1E-07	1.9E+01
332	EPSCF4CBSO52LC-12	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.1E-07	1.9E+01
333	EPSCF2CBFC89AAC-ALL	EPS 89/AACA,D (SELECTOR CIRCUIT) FAIL TO CLOSE (CCF)	2.8E-05	5.1E-04	1.9E+01
334	EPSCF2CBFO52EPS-ALL	EPS 52/EPSA,D (BREAKER) FAIL TO OPEN (CCF)	2.8E-05	5.1E-04	1.9E+01
335	EPSCF2CBFC52AAC-ALL	EPS 52/AACA,D (BREAKER) FAIL TO CLOSE (CCF)	2.8E-05	5.1E-04	1.9E+01
336	EPSCF2CBSO52AAC-ALL	EPS 52/AACA,D (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	5.2E-06	1.9E+01
337	EPSCF2CBSC52EPS-ALL	EPS 52/EPSA,D (BREAKER) SPURIOUS CLOSE (CCF)	2.8E-07	5.2E-06	1.9E+01
338	EPSCF2CBSO89AAC-ALL	EPS 89/AACA,D (SELECTOR CIRCUIT) SPURIOUS OPEN (CCF)	2.8E-07	5.2E-06	1.9E+01
339	EFWXVEL013D	EFS-VLV-013D EXTERNAL LEAK LARGE	7.2E-08	1.3E-06	1.9E+01
340	EFWCVEL012D	EFS-VLV-012D EXTERNAL LEAK LARGE	4.8E-08	8.6E-07	1.9E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 27 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
341	EPSBSFFAC003A	ESS-AC-003A (A MOV 480V MCC1 BUS) FAILURE	5.8E-06	1.0E-04	1.8E+01
342	EPSCF4DLLRDG-123	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	4.1E-03	1.8E+01
343	EPSCF4DLADDG-234	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	8.7E-04	1.8E+01
344	EPSCF4DLSRDG-123	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	6.5E-04	1.8E+01
345	EPSCF4SEFFDG-123	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	2.1E-04	1.8E+01
346	EPSCF4CBFC52EPS-134	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	8.6E-05	1.8E+01
347	EPSCF4CBSO52EPS-123	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.9E-07	1.8E+01
348	RSSCF4PMLR001-134	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.8E-07	9.3E-06	1.7E+01
349	RWSCF4SUPR001-23	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	4.6E-05	1.7E+01
350	SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE	1.2E-03	1.9E-02	1.6E+01
351	EFWXVEL013A	EFS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	1.1E-06	1.6E+01
352	EFWCVEL012A	EFS-VLV-012A EXTERNAL LEAK LARGE	4.8E-08	7.2E-07	1.6E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 28 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
353	EFWCF4CVOD012-134	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	9.2E-07	1.6E+01
354	CHICF2PMBD001-ALL	CVS-RPP-001A,B (CHI PUMP) FAIL TO START (CCF)	2.0E-04	3.0E-03	1.6E+01
355	EPSBSFFAM007	ENS-AM-007 (P1 NON-CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	8.3E-05	1.5E+01
356	RSSCF4CVOD004-134	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	3.1E-06	1.5E+01
357	RSSCF4RHPR001-134	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	6.4E-08	9.1E-07	1.5E+01
358	SWSCF4PMBD001-R-134	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	2.1E-04	1.5E+01
359	CWSCF4PCBD001-R-124	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	1.2E-04	1.5E+01
360	EFWCF4CVOD012-34	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	3.1E-06	1.5E+01
361	EPSCF4IVFF001-234	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	6.7E-06	1.4E+01
362	HPICF4PMAD001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	1.1E-04	1.5E-03	1.4E+01
363	EFWCVEL018D	EFS-VLV-018D EXTERNAL LEAK LARGE	4.8E-08	6.1E-07	1.4E+01
364	EFWMVEL017D	EFS-MOV-017D EXTERNAL LEAK LARGE	2.4E-08	3.1E-07	1.4E+01
365	EFWMVEL014D	EFS-MOV-014D EXTERNAL LEAK LARGE	2.4E-08	3.1E-07	1.4E+01
366	EFWPNELSGD	EFS D-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	7.7E-09	1.4E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 29 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
367	EPSCF4DLLRDG-23	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	3.2E-03	1.4E+01
368	EPSCF4DLADDG-34	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	5.4E-04	1.4E+01
369	EPSCF4DLSRDG-23	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	5.0E-04	1.4E+01
370	EPSCF4SEFFDG-23	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	3.1E-04	1.4E+01
371	EPSCF4CBFC52EPS-13	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	6.2E-05	1.4E+01
372	EPSCF4CBSO52EPS-23	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	4.2E-07	1.4E+01
373	EPSCF4IVFF002-124	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	5.0E-07	6.2E-06	1.4E+01
374	ACWCF2MVOD322-ALL	NCS-MOV-322A,B FAIL TO OPEN (CCF)	4.7E-05	5.9E-04	1.3E+01
375	ACWCF2MVOD324-ALL	NCS-MOV-324A,B FAIL TO OPEN (CCF)	4.7E-05	5.9E-04	1.3E+01
376	ACWCF2MVCD316-ALL	NCS-MOV-316A,B FAIL TO CLOSE (CCF)	4.7E-05	5.9E-04	1.3E+01
377	CHIORPR160	CVS-FE-160 (ORIFICE) PLUG	2.4E-05	3.0E-04	1.3E+01
378	CHIORPR170	CVS-FE-170 (ORIFICE) PLUG	2.4E-05	3.0E-04	1.3E+01
379	CHIORPR180	CVS-FE-180 (ORIFICE) PLUG	2.4E-05	3.0E-04	1.3E+01
380	CHIORPR150	CVS-FE-150 (ORIFICE) PLUG	2.4E-05	3.0E-04	1.3E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 30 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
381	CHICVOD182A	CVS-VLV-182A FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
382	CHICVOD182D	CVS-VLV-182D FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
383	CHICVOD182C	CVS-VLV-182C FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
384	CHICVOD182B	CVS-VLV-182B FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
385	CHICVOD181D	CVS-VLV-181D FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
386	CHICVOD179C	CVS-VLV-179C FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
387	CHICVOD179B	CVS-VLV-179B FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
388	CHICVOD179A	CVS-VLV-179A FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
389	CHICVOD179D	CVS-VLV-179D FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
390	CHICVOD181C	CVS-VLV-181C FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
391	CHICVOD181B	CVS-VLV-181B FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
392	CHICVOD181A	CVS-VLV-181A FAIL TO OPEN	1.2E-05	1.5E-04	1.3E+01
393	CHIAVCM165	CVS-AOV-165 SPURIOUS CLOSE	4.8E-06	6.0E-05	1.3E+01
394	CHIAVCM140	CVS-FCV-140 SPURIOUS CLOSE	4.8E-06	6.0E-05	1.3E+01
395	CHIMVPR178A	CVS-MOV-178A PLUG	2.4E-06	3.0E-05	1.3E+01
396	CHIXVPR168	CVS-VLV-168 PLUG	2.4E-06	3.0E-05	1.3E+01
397	CHIAVPR165	CVS-AOV-165 PLUG	2.4E-06	3.0E-05	1.3E+01
398	CHIAVPR140	CVS-FCV-140 PLUG	2.4E-06	3.0E-05	1.3E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 31 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
399	CHIMVPR178B	CVS-MOV-178B PLUG	2.4E-06	3.0E-05	1.3E+01
400	CHIXVPR170B	CVS-VLV-170B PLUG	2.4E-06	3.0E-05	1.3E+01
401	CHIXVPR171B	CVS-VLV-171B PLUG	2.4E-06	3.0E-05	1.3E+01
402	CHIXVPR177A	CVS-VLV-177A PLUG	2.4E-06	3.0E-05	1.3E+01
403	CHIXVPR166	CVS-VLV-166 PLUG	2.4E-06	3.0E-05	1.3E+01
404	CHIMVPR178C	CVS-MOV-178C PLUG	2.4E-06	3.0E-05	1.3E+01
405	CHIMVPR178D	CVS-MOV-178D PLUG	2.4E-06	3.0E-05	1.3E+01
406	CHIXVPR164	CVS-VLV-164 PLUG	2.4E-06	3.0E-05	1.3E+01
407	CHICVPR182D	CVS-VLV-182D PLUG	2.4E-06	3.0E-05	1.3E+01
408	CHICVPR179D	CVS-VLV-179D PLUG	2.4E-06	3.0E-05	1.3E+01
409	CHICVPR181A	CVS-VLV-181A PLUG	2.4E-06	3.0E-05	1.3E+01
410	CHIXVPR173	CVS-VLV-173 PLUG	2.4E-06	3.0E-05	1.3E+01
411	CHICVPR179A	CVS-VLV-179A PLUG	2.4E-06	3.0E-05	1.3E+01
412	CHICVPR179B	CVS-VLV-179B PLUG	2.4E-06	3.0E-05	1.3E+01
413	CHICVPR179C	CVS-VLV-179C PLUG	2.4E-06	3.0E-05	1.3E+01
414	CHICVPR181B	CVS-VLV-181B PLUG	2.4E-06	3.0E-05	1.3E+01
415	CHICVPR182A	CVS-VLV-182A PLUG	2.4E-06	3.0E-05	1.3E+01
416	CHICVPR182B	CVS-VLV-182B PLUG	2.4E-06	3.0E-05	1.3E+01
417	CHICVPR182C	CVS-VLV-182C PLUG	2.4E-06	3.0E-05	1.3E+01
418	CHIFLPR003B	CVS-KFT-003B (SEAL WATER INJECTION FILTER) PLUG	2.4E-06	3.0E-05	1.3E+01
419	CHICVPR181C	CVS-VLV-181C PLUG	2.4E-06	3.0E-05	1.3E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 32 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
420	CHICVPR181D	CVS-VLV-181D PLUG	2.4E-06	3.0E-05	1.3E+01
421	CHIXVPR177B	CVS-VLV-177B PLUG	2.4E-06	3.0E-05	1.3E+01
422	CHIXVPR180C	CVS-VLV-180C PLUG	2.4E-06	3.0E-05	1.3E+01
423	CHIXVPR180A	CVS-VLV-180A PLUG	2.4E-06	3.0E-05	1.3E+01
424	CHIXVPR180D	CVS-VLV-180D PLUG	2.4E-06	3.0E-05	1.3E+01
425	CHIXVPR180B	CVS-VLV-180B PLUG	2.4E-06	3.0E-05	1.3E+01
426	CHIXVPR177D	CVS-VLV-177D PLUG	2.4E-06	3.0E-05	1.3E+01
427	CHIXVPR177C	CVS-VLV-177C PLUG	2.4E-06	3.0E-05	1.3E+01
428	CHIMVCM178A	CVS-MOV-178A SPURIOUS CLOSE	9.6E-07	1.2E-05	1.3E+01
429	CHIMVCM178B	CVS-MOV-178B SPURIOUS CLOSE	9.6E-07	1.2E-05	1.3E+01
430	CHIMVCM178D	CVS-MOV-178D SPURIOUS CLOSE	9.6E-07	1.2E-05	1.3E+01
431	CHIMVCM178C	CVS-MOV-178C SPURIOUS CLOSE	9.6E-07	1.2E-05	1.3E+01
432	EFWCVOD008B	EFS-VLV-008B FAIL TO OPEN	9.6E-06	1.2E-04	1.3E+01
433	EFWCVPR008B	EFS-VLV-008B PLUG	2.4E-06	2.9E-05	1.3E+01
434	EFWCVEL008B	EFS-VLV-008B EXTERNAL LEAK LARGE	4.8E-08	5.9E-07	1.3E+01
435	EPSCF4IVFF001-24	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	1.2E-05	1.3E+01
436	EPSCF4CBSO52STH-13	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	4.0E-07	1.3E+01
437	EPSCF4CBSO52STL-12	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	4.0E-07	1.3E+01
438	CHIRIEL001	CVS-CHX-001 (REGENERATIVE HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	8.6E-06	1.3E+01
439	CHIPMEL001A	CVS-RPP-001A (A-CHI PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.3E-06	1.3E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 33 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
440	CHIPMEL001B	CVS-RPP-001B (B-CHI PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.3E-06	1.3E+01
441	CHIXVEL163	CVS-VLV-163 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
442	CHIXVEL164	CVS-VLV-164 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
443	CHIXVEL132B	CVS-VLV-132B EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
444	CHIXVEL144	CVS-VLV-144 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
445	CHIXVEL147	CVS-VLV-147 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
446	CHIXVEL130A	CVS-VLV-130A EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
447	CHIXVEL168	CVS-VLV-168 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
448	CHIXVEL167	CVS-VLV-167 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
449	CHIXVEL130B	CVS-VLV-130B EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
450	CHIXVEL173	CVS-VLV-173 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
451	CHIXVEL166	CVS-VLV-166 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
452	CHIXVEL171B	CVS-VLV-171B EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
453	CHIXVEL132A	CVS-VLV-132A EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
454	CHIXVEL170B	CVS-VLV-170B EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
455	CHIXVEL126B	CVS-VLV-126B EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
456	CHIXVEL126A	CVS-VLV-126A EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
457	CHIXVEL145	CVS-VLV-145 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01
458	CHIXVEL133	CVS-VLV-133 EXTERNAL LEAK LARGE	7.2E-08	8.6E-07	1.3E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 34 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
459	CHICVEL125	CVS-VLV-125 EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
460	CHICVEL131B	CVS-VLV-131B EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
461	CHICVEL129B	CVS-VLV-129B EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
462	CHICVEL131A	CVS-VLV-131A EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
463	CHICVEL129A	CVS-VLV-129A EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
464	CHICVEL161	CVS-VLV-161 EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
465	CHICVEL160	CVS-VLV-160 EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
466	CHICVEL153	CVS-VLV-153 EXTERNAL LEAK LARGE	4.8E-08	5.7E-07	1.3E+01
467	CHIMVEL151	CVS-MOV-151 EXTERNAL LEAK LARGE	2.4E-08	2.9E-07	1.3E+01
468	CHIMVEL152	CVS-MOV-152 EXTERNAL LEAK LARGE	2.4E-08	2.9E-07	1.3E+01
469	CHIMVEL121C	CVS-LCV-121C EXTERNAL LEAK LARGE	2.4E-08	2.9E-07	1.3E+01
470	CHIMVEL121B	CVS-LCV-121B EXTERNAL LEAK LARGE	2.4E-08	2.9E-07	1.3E+01
471	CHIAVEL140	CVS-FCV-140 EXTERNAL LEAK LARGE	2.2E-08	2.6E-07	1.3E+01
472	CHIAVEL165	CVS-AOV-165 EXTERNAL LEAK LARGE	2.2E-08	2.6E-07	1.3E+01
473	CHIAVEL138	CVS-FCV-138 EXTERNAL LEAK LARGE	2.2E-08	2.6E-07	1.3E+01
474	CHIAVEL155	CVS-AOV-155 EXTERNAL LEAK LARGE	2.2E-08	2.6E-07	1.3E+01
475	CHIAVEL159	CVS-AOV-159 EXTERNAL LEAK LARGE	2.2E-08	2.6E-07	1.3E+01
476	CHIAVEL146	CVS-AOV-146 EXTERNAL LEAK LARGE	2.2E-08	2.6E-07	1.3E+01
477	CHIPNELPIPE1	CVS CHARGING INJECTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	7.2E-09	1.3E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 35 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
478	HPICF4PMSR001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	8.5E-06	1.0E-04	1.3E+01
479	EPSBSFFAC003D	ESS-AC-003D (D MOV 480V MCC1 BUS) FAILURE	5.8E-06	6.8E-05	1.3E+01
480	EPSTRFF001B	ESS-AT-001B (6.9KV-480V B CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	9.5E-05	1.3E+01
481	EPSBSFFAL001B	ESS-AL-001B (B CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	6.7E-05	1.3E+01
482	RSSCF4PMAD001-12	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.3E-05	1.5E-04	1.3E+01
483	EPSBSFFAC001B	ESS-AC-001B (B CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	6.6E-05	1.2E+01
484	CHIXVEL177C	CVS-VLV-177C EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
485	CHIXVEL177D	CVS-VLV-177D EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
486	CHIXVEL180A	CVS-VLV-180A EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
487	CHIXVEL180D	CVS-VLV-180D EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
488	CHIXVEL180C	CVS-VLV-180C EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
489	CHIXVEL180B	CVS-VLV-180B EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
490	CHIXVEL177B	CVS-VLV-177B EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
491	CHIXVEL177A	CVS-VLV-177A EXTERNAL LEAK LARGE	7.2E-08	8.2E-07	1.2E+01
492	CHICVEL181A	CVS-VLV-181A EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
493	CHICVEL181B	CVS-VLV-181B EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
494	CHICVEL181C	CVS-VLV-181C EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
495	CHICVEL179D	CVS-VLV-179D EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 36 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
496	CHICVEL179A	CVS-VLV-179A EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
497	CHICVEL179B	CVS-VLV-179B EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
498	CHICVEL179C	CVS-VLV-179C EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
499	CHICVEL182C	CVS-VLV-182C EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
500	CHICVEL182D	CVS-VLV-182D EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
501	CHICVEL182B	CVS-VLV-182B EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
502	CHICVEL181D	CVS-VLV-181D EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
503	CHICVEL182A	CVS-VLV-182A EXTERNAL LEAK LARGE	4.8E-08	5.5E-07	1.2E+01
504	CHIMVEL178C	CVS-MOV-178C EXTERNAL LEAK LARGE	2.4E-08	2.7E-07	1.2E+01
505	CHIMVEL178B	CVS-MOV-178B EXTERNAL LEAK LARGE	2.4E-08	2.7E-07	1.2E+01
506	CHIMVEL178D	CVS-MOV-178D EXTERNAL LEAK LARGE	2.4E-08	2.7E-07	1.2E+01
507	CHIMVEL178A	CVS-MOV-178A EXTERNAL LEAK LARGE	2.4E-08	2.7E-07	1.2E+01
508	EFWXVPR007B	EFS-VLV-007B PLUG	2.4E-06	2.7E-05	1.2E+01
509	EFWXVEL009C	EFS-VLV-009C EXTERNAL LEAK LARGE	7.2E-08	8.1E-07	1.2E+01
510	EFWXVEL009D	EFS-VLV-009D EXTERNAL LEAK LARGE	7.2E-08	8.1E-07	1.2E+01
511	EFWXVEL007B	EFS-VLV-007B EXTERNAL LEAK LARGE	7.2E-08	8.1E-07	1.2E+01
512	EFWTNEL001B	EFS-RPT-001B (B-EFW PIT) EXTERNAL LEAK LARGE	4.8E-08	5.4E-07	1.2E+01
513	EFWPNELCSTB	EFS B-EFW PIT OUTLET PIPING EXTERNAL LEAK LARGE	6.0E-10	6.8E-09	1.2E+01
514	CHIMVPR121B	CVS-LCV-121B PLUG	2.4E-06	2.7E-05	1.2E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 37 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
515	CHICVPR125	CVS-VLV-125 PLUG	2.4E-06	2.7E-05	1.2E+01
516	CHIMVPR121C	CVS-LCV-121C PLUG	2.4E-06	2.7E-05	1.2E+01
517	CHIMVCM121B	CVS-LCV-121B SPURIOUS CLOSE	9.6E-07	1.1E-05	1.2E+01
518	CHIMVCM121C	CVS-LCV-121C SPURIOUS CLOSE	9.6E-07	1.1E-05	1.2E+01
519	CHITNEL001	CVS-RTK-001 (VCT) EXTERNAL LEAK LARGE	4.8E-08	5.4E-07	1.2E+01
520	CHICF2PMYR001-R-ALL	CVS-RPP-001A,B (CHI PUMP) FAIL TO RUN (CCF)	5.0E-06	5.6E-05	1.2E+01
521	ACWCF2CVCD306-ALL	NCS-VLV-306A,B FAIL TO CLOSE (CCF)	4.7E-06	5.3E-05	1.2E+01
522	EPSCBSO52STHB	EPS 52/STHB (BREAKER) SPURIOUS OPEN	3.0E-06	3.4E-05	1.2E+01
523	EPSCBSO52STLB	EPS 52/STLB (BREAKER) SPURIOUS OPEN	3.0E-06	3.4E-05	1.2E+01
524	EPSCBSO52LCB	EPS 52/LCB (BREAKER) SPURIOUS OPEN	3.0E-06	3.4E-05	1.2E+01
525	RSSCF4PMSR001-23	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	3.7E-05	1.2E+01
526	RSSCF4PMLR001-23	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.2E-06	1.3E-05	1.2E+01
527	EPSCF4CBSO52LC-14	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.7E-07	1.2E+01
528	EPSCF4CBSO72AU-24	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.6E-07	1.2E+01
529	EPSCF4CBSO52UA-24	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.6E-07	1.2E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 38 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
530	EPSCF4CBSO72DB-34	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.6E-07	1.2E+01
531	EPSCF4CBSO72AU-234	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.1E-07	1.2E+01
532	EPSCF4CBSO52UA-234	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	3.1E-07	1.2E+01
533	EPSCF4BYFF-12	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.9E-08	2.0E-07	1.2E+01
534	HPICF4PMLR001-ALL	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.9E-06	3.1E-05	1.2E+01
535	RSSCF4MVOD145-23	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	5.9E-05	1.1E+01
536	EPSCBFO52RAT-BD	EPS 52/RATB,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	5.1E-05	1.1E+01
537	EPSCBFO52UAT-BD	EPS 52/UATB,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	5.1E-05	1.1E+01
538	EPSCF4CBSC52UAT-24	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	3.4E-07	1.1E+01
539	EPSCF4CBSC52RAT-24	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	3.4E-07	1.1E+01
540	HPICF4CVOD013-ALL	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	1.0E-05	1.1E+01
541	HPICF4CVOD012-ALL	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	1.0E-05	1.1E+01
542	HPICF4CVOD004-ALL	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	1.0E-05	1.1E+01
543	HPICF4CVOD010-ALL	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	1.0E-06	1.0E-05	1.1E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 39 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
544	EPSCF4IVFF002-14	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	1.0E-06	1.0E-05	1.1E+01
545	SWSCF4CVOD502-R-234	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	5.0E-07	1.1E+01
546	SWSCF4CVOD602-R-234	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	5.0E-07	1.1E+01
547	CWSCF4CVOD016-R-134	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	5.0E-07	1.1E+01
548	ACWCVEL306B	NCS-VLV-306B EXTERNAL LEAK LARGE	4.8E-08	4.8E-07	1.1E+01
549	ACWCVEL306A	NCS-VLV-306A EXTERNAL LEAK LARGE	4.8E-08	4.8E-07	1.1E+01
550	ACWMVEL316A	NCS-MOV-316A EXTERNAL LEAK LARGE	2.4E-08	2.4E-07	1.1E+01
551	ACWMVEL316B	NCS-MOV-316B EXTERNAL LEAK LARGE	2.4E-08	2.4E-07	1.1E+01
552	SWSSTPRST05	EWS-ST05 (STRAINER) PLUG	1.7E-04	1.6E-03	1.1E+01
553	SWSMVPR503C	EWS-MOV-503C PLUG	2.4E-06	2.3E-05	1.1E+01
554	SWSXVPR506C	EWS-VLV-506C PLUG	2.4E-06	2.3E-05	1.1E+01
555	SWSCVPR502C	EWS-VLV-502C PLUG	2.4E-06	2.3E-05	1.1E+01
556	SWSXVPR508C	EWS-VLV-508C PLUG	2.4E-06	2.3E-05	1.1E+01
557	SWSMVCM503C	EWS-MOV-503C SPURIOUS CLOSE	9.6E-07	9.4E-06	1.1E+01
558	SWSXVEL701C	EWS-VLV-701C EXTERNAL LEAK LARGE	7.2E-08	7.0E-07	1.1E+01
559	SWSXVEL506C	EWS-VLV-506C EXTERNAL LEAK LARGE	7.2E-08	7.0E-07	1.1E+01
560	SWSXVEL507C	EWS-VLV-507C EXTERNAL LEAK LARGE	7.2E-08	7.0E-07	1.1E+01
561	SWSXVEL509C	EWS-VLV-509C EXTERNAL LEAK LARGE	7.2E-08	7.0E-07	1.1E+01
562	SWSXVEL508C	EWS-VLV-508C EXTERNAL LEAK LARGE	7.2E-08	7.0E-07	1.1E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 40 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
563	SWSCVEL502C	EWS-VLV-502C EXTERNAL LEAK LARGE	4.8E-08	4.7E-07	1.1E+01
564	SWSMVEL503C	EWS-MOV-503C EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.1E+01
565	SWSPEELSWPC1	EWS C-ESW PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	3.5E-08	1.1E+01
566	SWSPMYR001C	EWS-OPP-001C (C-ESW PUMP) FAIL TO RUN	1.1E-04	1.1E-03	1.1E+01
567	EPSTRFF007	ESS-AT-007 (6.9KV-480V P1 NON-CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	7.8E-05	1.1E+01
568	EPSBSFFAL007	ENS-AL-007 (P1 NON-CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	5.5E-05	1.1E+01
569	EPSCBFO52RAT-D	EPS 52/RATD (BREAKER) FAIL TO OPEN	3.5E-04	3.3E-03	1.0E+01
570	EPSCBFO52UAT-D	EPS 52/UATD (BREAKER) FAIL TO OPEN	3.5E-04	3.3E-03	1.0E+01
571	EPSCBSC52RATD	EPS 52/RATD (BREAKER) SPURIOUS CLOSE	3.0E-06	2.9E-05	1.0E+01
572	EPSCBSC52UATD	EPS 52/UATD (BREAKER) SPURIOUS CLOSE	3.0E-06	2.9E-05	1.0E+01
573	CHICVEL595	CVS-VLV-595 EXTERNAL LEAK LARGE	4.8E-08	4.5E-07	1.0E+01
574	EFWCVEL018A	EFS-VLV-018A EXTERNAL LEAK LARGE	4.8E-08	4.5E-07	1.0E+01
575	EPSCF4CBSO52LC-34	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	3.2E-07	1.0E+01
576	EFWMVEL014A	EFS-MOV-014A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
577	EFWMVEL019D	EFS-MOV-019D EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
578	EFWMVEL019A	EFS-MOV-019A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 41 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
579	EFWMVEL017A	EFS-MOV-017A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
580	ACWMVEL323A	NCS-MOV-323A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
581	ACWMVEL324B	NCS-MOV-324B EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
582	ACWMVEL324A	NCS-MOV-324A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
583	ACWMVEL326B	NCS-MOV-326B EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
584	ACWMVEL326A	NCS-MOV-326A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
585	ACWMVEL323B	NCS-MOV-323B EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
586	ACWMVEL322A	NCS-MOV-322A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
587	ACWMVEL321B	NCS-MOV-321B EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
588	ACWMVEL321A	NCS-MOV-321A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
589	ACWMVEL325B	NCS-MOV-325B EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
590	ACWMVEL325A	NCS-MOV-325A EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
591	ACWMVEL322B	NCS-MOV-322B EXTERNAL LEAK LARGE	2.4E-08	2.3E-07	1.0E+01
592	EFWPNELSGA	EFS A-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.6E-09	1.0E+01
593	ACWPNELPIPEA1	ALTERNATIVE CCW A-CHI PUMP SUCTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.6E-09	1.0E+01
594	ACWPNELPIPEA2	ALTERNATIVE CCW A-CHI PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.6E-09	1.0E+01

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 42 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
595	ACWPNELPIPEB2	ALTERNATIVE CCW B-CHI PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.6E-09	1.0E+01
596	ACWPNELPIPEB1	ALTERNATIVE CCW B-CHI PUMP SUCTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.6E-09	1.0E+01
597	SWSFMPR2062	EWS-FT-2062 (FLOW METER) PLUG	2.4E-05	2.2E-04	1.0E+01
598	SWSORPRESS0003C	EWS-ESS0003C (ORIFICE) PLUG	2.4E-05	2.2E-04	1.0E+01
599	EPSCBSO52STLP1	EPS 52/STLP1 (BREAKER) SPURIOUS OPEN	3.1E-06	2.9E-05	1.0E+01
600	EPSCBSO52STHP1	EPS 52/STHP1 (BREAKER) SPURIOUS OPEN	3.1E-06	2.9E-05	1.0E+01
601	SWSXVPR601C	EWS-VLV-601C PLUG	2.4E-06	2.2E-05	1.0E+01
602	SWSCVPR602C	EWS-VLV-602C PLUG	2.4E-06	2.2E-05	1.0E+01
603	SWSXVEL601C	EWS-VLV-601C EXTERNAL LEAK LARGE	7.2E-08	6.7E-07	1.0E+01
604	SWSCVEL602C	EWS-VLV-602C EXTERNAL LEAK LARGE	4.8E-08	4.5E-07	1.0E+01
605	SWSPEELSWSC2	EWS C-ESW PUMP COOLING LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	3.4E-08	1.0E+01
606	EPSCF2CBSO72DU1-ALL	EPS 72/DUA1,D1 (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	2.6E-06	1.0E+01
607	SWSCF4CVOD602-R-134	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	4.6E-07	1.0E+01
608	CWSCF4CVOD016-R-124	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	4.6E-07	1.0E+01
609	SWSCF4CVOD502-R-134	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	5.0E-08	4.6E-07	1.0E+01
610	EFWCVOD008A	EFS-VLV-008A FAIL TO OPEN	9.6E-06	8.6E-05	9.9E+00
611	EFWCVPR008A	EFS-VLV-008A PLUG	2.4E-06	2.1E-05	9.9E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 43 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
612	EFWCVEL008A	EFS-VLV-008A EXTERNAL LEAK LARGE	4.8E-08	4.3E-07	9.9E+00
613	RSSCF4MVOD004-124	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	1.2E-05	9.5E+00
614	RSSCF4MVOD004-234	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	1.2E-05	9.4E+00
615	EPSCF2CBSO52STLP-ALL	EPS 52/STLP1,2 (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	2.4E-06	9.3E+00
616	EPSCF2CBSO52STHP-ALL	EPS 52/STHP1,2 (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	2.4E-06	9.3E+00
617	EFWXVPR007A	EFS-VLV-007A PLUG	2.4E-06	2.0E-05	9.2E+00
618	EFWXVEL007A	EFS-VLV-007A EXTERNAL LEAK LARGE	7.2E-08	5.9E-07	9.2E+00
619	EFWXVEL009B	EFS-VLV-009B EXTERNAL LEAK LARGE	7.2E-08	5.9E-07	9.2E+00
620	EFWXVEL009A	EFS-VLV-009A EXTERNAL LEAK LARGE	7.2E-08	5.9E-07	9.2E+00
621	EFWTNEL001A	EFS-RPT-001A (A-EFW PIT) EXTERNAL LEAK LARGE	4.8E-08	4.0E-07	9.2E+00
622	EFWPNELCSTA	EFS A-EFW PIT OUTLET PIPING EXTERNAL LEAK LARGE	6.0E-10	4.9E-09	9.2E+00
623	RSSCF4CVOD004-23	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.0E-07	1.6E-06	9.1E+00
624	RSSCF4RHPR001-23	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	1.7E-07	1.4E-06	9.1E+00
625	EFWXVEL013C	EFS-VLV-013C EXTERNAL LEAK LARGE	7.2E-08	5.8E-07	9.1E+00
626	EFWCVEL012C	EFS-VLV-012C EXTERNAL LEAK LARGE	4.8E-08	3.9E-07	9.1E+00
627	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	1.7E-01	9.1E+00
628	EPSBSFFAM001C	ESS-AM-001C (C CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	4.6E-05	9.1E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 44 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
629	EFWCF4CVOD012-124	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	5.0E-07	9.0E+00
630	EFWCF4CVOD012-123	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	6.2E-08	5.0E-07	9.0E+00
631	SWSCF4PMBD001-R-234	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	1.2E-04	9.0E+00
632	EPSTRFF001C	ESS-AT-001C (6.9KV-480V C CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	6.5E-05	9.0E+00
633	EPSBSFFAL001C	ESS-AL-001C (C CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	4.6E-05	9.0E+00
634	EFWCF4CVOD012-24	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	1.8E-06	8.9E+00
635	EPSBSFFAC011	ENS-AC-011 (P11 NON-CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	4.5E-05	8.8E+00
636	EPSCBSO52LCP11	EPS 52/LCP11 (BREAKER) SPURIOUS OPEN	3.1E-06	2.4E-05	8.8E+00
637	HPICF4PMAD001-123	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	9.5E-06	7.3E-05	8.7E+00
638	EPSBSFFAC001C	ESS-AC-001C (C CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	4.5E-05	8.7E+00
639	CIACF2MVCDCIV-ALL	RCS-MOV-203,204 FAIL TO CLOSE (CCF)	3.3E-05	2.5E-04	8.7E+00
640	SWSORPROR04C	EWS-OR04C (ORIFICE) PLUG	2.4E-05	1.8E-04	8.6E+00
641	SWSORPR2026	EWS-FE-2026 (ORIFICE) PLUG	2.4E-05	1.8E-04	8.6E+00
642	CWSORPR1232	NCS-FE-1232 (ORIFICE) PLUG	2.4E-05	1.8E-04	8.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 45 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
643	CWSXVPR104C	NCS-VLV-104C PLUG	2.4E-06	1.8E-05	8.6E+00
644	CWSXVPR018C	NCS-VLV-018C PLUG	2.4E-06	1.8E-05	8.6E+00
645	CWSCVPR016C	NCS-VLV-016C PLUG	2.4E-06	1.8E-05	8.6E+00
646	CWSXVPR005C	NCS-VLV-005C PLUG	2.4E-06	1.8E-05	8.6E+00
647	CWSXVPR101C	NCS-VLV-101C PLUG	2.4E-06	1.8E-05	8.6E+00
648	CWSXVPR008C	NCS-VLV-008C PLUG	2.4E-06	1.8E-05	8.6E+00
649	SWSXVPR520C	EWS-VLV-520C PLUG	2.4E-06	1.8E-05	8.6E+00
650	SWSXVPR517C	EWS-VLV-517C PLUG	2.4E-06	1.8E-05	8.6E+00
651	CWSPCYR001C	NCS-RPP-001C (C-CCW PUMP) FAIL TO RUN	6.2E-05	4.7E-04	8.6E+00
652	EPSCF4IVFF002-123	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	5.0E-07	3.8E-06	8.6E+00
653	CWSCF4PCBD001-R-134	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	6.3E-05	8.5E+00
654	EPSCBSO52STLC	EPS 52/STLC (BREAKER) SPURIOUS OPEN	3.0E-06	2.2E-05	8.4E+00
655	EPSCBSO52STHC	EPS 52/STHC (BREAKER) SPURIOUS OPEN	3.0E-06	2.2E-05	8.4E+00
656	EPSCBSO52LCC	EPS 52/LCC (BREAKER) SPURIOUS OPEN	3.0E-06	2.2E-05	8.4E+00
657	SWSSTPRST02C	EWS-ST02C (STRAINER) PLUG	1.7E-04	1.2E-03	8.4E+00
658	CWSORPR1227	NCS-FE-1227 (ORIFICE) PLUG	2.4E-05	1.8E-04	8.4E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 46 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
659	HPICF4PMSR001-123	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	2.4E-05	8.2E+00
660	EPSCF4DLLRDG-124	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	1.8E-03	8.2E+00
661	EPSCF4DLADDG-123	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	3.8E-04	8.2E+00
662	EPSCF4DLSRDG-124	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	2.8E-04	8.2E+00
663	EPSCF4SEFFDG-124	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	9.0E-05	8.2E+00
664	EPSCF4CBFC52EPS-234	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	3.7E-05	8.2E+00
665	EPSCF4CBSO52EPS-124	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.1E-07	8.2E+00
666	ACWTNELFWT	FWT (FIRE SUPPRESSION TANK) EXTERNAL LEAK LARGE	4.8E-08	3.3E-07	7.8E+00
667	ACWPNELPIPEFS	FIRE SERVICE WATER TANK LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	4.1E-09	7.8E+00
668	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	7.8E-02	7.8E+00
669	SWSXVPR511C	EWS-VLV-511C PLUG	2.4E-06	1.6E-05	7.8E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 47 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
670	SWSXVPR514C	EWS-VLV-514C PLUG	2.4E-06	1.6E-05	7.8E+00
671	SWSRIEL001C	NCS-RHX-001C (C-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	4.8E-06	7.7E+00
672	SWSXVEL514C	EWS-VLV-514C EXTERNAL LEAK LARGE	7.2E-08	4.8E-07	7.7E+00
673	SWSXVEL511C	EWS-VLV-511C EXTERNAL LEAK LARGE	7.2E-08	4.8E-07	7.7E+00
674	SWSPEELSWSC3	EWS C-CCW HX COOLING LINE PIPING EXTERNAL LEAK LARGE	3.6E-09	2.4E-08	7.7E+00
675	EPSCF2CBSO52LCP-ALL	EPS 52/LCP11,21 (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	1.9E-06	7.6E+00
676	HPICF4PMLR001-123	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-06	7.4E-06	7.6E+00
677	CWSRHPF001C	NCS-RHX-001C (C-CCW HX) PLUG / FOUL	1.4E-06	8.9E-06	7.5E+00
678	MSRCF4AVCD515-ALL	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	1.8E-04	1.1E-03	7.5E+00
679	PZRCF2MVOD117-ALL	RCS-MOV-117A,B FAIL TO OPEN (CCF)	1.3E-04	8.1E-04	7.4E+00
680	MSRCF4AVCD515-13	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	3.4E-04	7.4E+00
681	MSRCF4AVCD515-23	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	3.4E-04	7.4E+00
682	MSRCF4AVCD515-34	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	3.4E-04	7.4E+00
683	MSRCF4AVCD515-134	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	1.7E-04	7.4E+00
684	MSRCF4AVCD515-123	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	1.7E-04	7.4E+00
685	MSRCF4AVCD515-234	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	1.7E-04	7.4E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 48 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
686	EPSCF4DLLRDG-134	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	1.6E-03	7.3E+00
687	EPSCF4DLADDG-124	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	5.2E-05	3.3E-04	7.3E+00
688	EPSCF4DLSRDG-134	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.9E-05	2.5E-04	7.3E+00
689	EPSCF4SEFFDG-134	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	1.3E-05	7.9E-05	7.3E+00
690	EPSCF4CBFC52EPS-124	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.2E-06	3.3E-05	7.3E+00
691	EPSCF4CBSO52EPS-134	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.9E-07	7.3E+00
692	SWSCF4PMBD001-R-14	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	4.5E-04	7.2E+00
693	RSSCF4MVOD004-123	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	9.0E-06	7.2E+00
694	CWSCF4PCBD001-R-12	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	2.4E-04	7.2E+00
695	HPICF4CVOD004-123	SIS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.6E-06	7.1E+00
696	HPICF4CVOD010-123	SIS-VLV-010A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.6E-06	7.1E+00
697	HPICF4CVOD013-123	SIS-VLV-013A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.6E-06	7.1E+00
698	HPICF4CVOD012-123	SIS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.7E-07	1.6E-06	7.1E+00
699	CWSRIEL001C	NCS-RHX-001C (C-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	4.4E-06	7.1E+00
700	CWSPMEL001C	NCS-RPP-001C (C-CCW PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E-06	7.1E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 49 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
701	HPIXVEL115C	NCS-VLV-115C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
702	CWSXVEL104C	NCS-VLV-104C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
703	HPIXVEL111C	NCS-VLV-111C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
704	HPIXVEL114C	NCS-VLV-114C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
705	HPIXVEL119C	NCS-VLV-119C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
706	HPIXVEL116C	NCS-VLV-116C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
707	CWSXVEL101C	NCS-VLV-101C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
708	CWSXVEL008C	NCS-VLV-008C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
709	CWSXVEL018C	NCS-VLV-018C EXTERNAL LEAK LARGE	7.2E-08	4.4E-07	7.1E+00
710	CWSCVEL016C	NCS-VLV-016C EXTERNAL LEAK LARGE	4.8E-08	2.9E-07	7.1E+00
711	CWSPNELCWC	NCS CWS TRAIN C PIPING EXTERNAL LEAK LARGE	6.0E-10	3.6E-09	7.1E+00
712	EFWCF4CVOD012-13	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	1.3E-06	6.9E+00
713	NCCMVCD414	VWS-MOV-414 FAIL TO CLOSE	1.0E-03	5.6E-03	6.6E+00
714	NCCMVOD407	VWS-MOV-407 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
715	NCCMVOD425	VWS-MOV-425 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
716	NCCMVOD424	VWS-MOV-424 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
717	NCCMVPR425	VWS-MOV-425 PLUG	2.4E-06	1.3E-05	6.6E+00
718	NCCMVPR424	VWS-MOV-424 PLUG	2.4E-06	1.3E-05	6.6E+00
719	NCCMVPR407	VWS-MOV-407 PLUG	2.4E-06	1.3E-05	6.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 50 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
720	NCCMVOM414	VWS-MOV-414 SPURIOUS OPEN	9.6E-07	5.4E-06	6.6E+00
721	NCCMVCM407	VWS-MOV-407 SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
722	NCCMVCM424	VWS-MOV-424 SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
723	NCCMVCM425	VWS-MOV-425 SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
724	NCCMVIL414	VWS-MOV-414 INTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
725	NCCAVOD1212	NCS-PCV-1212 FAIL TO OPEN	1.2E-03	6.7E-03	6.6E+00
726	NCCOO04PICA1212	(HE) NCC MISCALIBRATION OF NCS-PICA-1212	8.0E-04	4.5E-03	6.6E+00
727	NCCIPFF1212	NCS-PICA-1212 FAIL TO OPERATE	2.7E-05	1.5E-04	6.6E+00
728	NCCAVOM056B	NCS-RCV-056B SPURIOUS OPEN	4.8E-06	2.7E-05	6.6E+00
729	NCCSVOM003B	NCS-VLV-003B SPURIOUS OPEN	4.8E-06	2.7E-05	6.6E+00
730	NCCAVCM1212	NCS-PCV-1212 SPURIOUS CLOSE	4.8E-06	2.7E-05	6.6E+00
731	NCCAVPR1212	NCS-PCV-1212 PLUG	2.4E-06	1.3E-05	6.6E+00
732	NCCAVIL056B	NCS-RCV-056B INTERNAL LEAK LARGE	1.2E-07	6.7E-07	6.6E+00
733	NCCXVEL045B	NCS-VLV-045B EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
734	NCCTKEL001B	NCS-RTK-001B (B-CCW SURGE TANK) EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
735	NCCAVEL1212	NCS-PCV-1212 EXTERNAL LEAF LARGE	2.2E-08	1.2E-07	6.6E+00
736	NCCAVEL056B	NCS-RCV-056B EXTERNAL LEAK LARGE	2.2E-08	1.2E-07	6.6E+00
737	NCCPNELPIPE1	NCS B-CCW SURGE TANK PRESSURIZING LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	3.4E-09	6.6E+00
738	NCCMVOD422	VWS-MOV-422 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 51 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
739	NCCMVOD403	VWS-MOV-403 FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
740	NCCCVOD421	VWS-VLV-421 FAIL TO OPEN	1.2E-05	6.7E-05	6.6E+00
741	NCCMVPR422	VWS-MOV-422 PLUG	2.4E-06	1.3E-05	6.6E+00
742	NCCMVPR403	VWS-MOV-403 PLUG	2.4E-06	1.3E-05	6.6E+00
743	NCCCVPR421	VWS-VLV-421 PLUG	2.4E-06	1.3E-05	6.6E+00
744	NCCMVCM403	VWS-MOV-403 SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
745	NCCMVCM422	VWS-MOV-422 SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
746	NCCRIEL001C	VCS-CAH-001C (C-CONTAINMENT FAN COOLER UNIT) EXTERNAL LEAK LARGE	7.2E-07	4.0E-06	6.6E+00
747	NCCRIEL001D	VCS-CAH-001D (D-CONTAINMENT FAN COOLER UNIT) EXTERNAL LEAK LARGE	7.2E-07	4.0E-06	6.6E+00
748	NCCRIEL001A	VCS-CAH-001A (A-CONTAINMENT FAN COOLER UNIT) EXTERNAL LEAK LARGE	7.2E-07	4.0E-06	6.6E+00
749	NCCRIEL001B	VCS-CAH-001B (B-CONTAINMENT FAN COOLER UNIT) EXTERNAL LEAK LARGE	7.2E-07	4.0E-06	6.6E+00
750	NCCXVEL413C	VWS-VLV-413C EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
751	NCCXVEL413B	VWS-VLV-413B EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
752	NCCXVEL415	VWS-VLV-415 EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
753	NCCXVEL413D	VWS-VLV-413D EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
754	NCCXVEL413A	VWS-VLV-413A EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 52 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
755	NCCXVEL412B	VWS-VLV-412B EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
756	NCCXVEL412A	VWS-VLV-412A EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
757	NCCXVEL412D	VWS-VLV-412D EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
758	NCCXVEL412C	VWS-VLV-412C EXTERNAL LEAK LARGE	7.2E-08	4.0E-07	6.6E+00
759	NCCCVEL421	VWS-VLV-421 EXTERNAL LEAK LARGE	4.8E-08	2.7E-07	6.6E+00
760	NCCCVEL423	VWS-VLV-423 EXTERNAL LEAK LARGE	4.8E-08	2.7E-07	6.6E+00
761	NCCMVEL403	VWS-MOV-403 EXTERNAL LEAF LARGE	2.4E-08	1.3E-07	6.6E+00
762	NCCMVEL425	VWS-MOV-425 EXTERNAL LEAF LARGE	2.4E-08	1.3E-07	6.6E+00
763	NCCMVEL407	VWS-MOV-407 EXTERNAL LEAF LARGE	2.4E-08	1.3E-07	6.6E+00
764	NCCMVEL422	VWS-MOV-422 EXTERNAL LEAK LARGE	2.4E-08	1.3E-07	6.6E+00
765	NCCMVEL401	VWS-MOV-401 EXTERNAL LEAF LARGE	2.4E-08	1.3E-07	6.6E+00
766	NCCMVEL409	VWS-MOV-409 EXTERNAL LEAF LARGE	2.4E-08	1.3E-07	6.6E+00
767	NCCMVEL411D	VWS-MOV-411D EXTERNAL LEAK LARGE	2.4E-08	1.3E-07	6.6E+00
768	NCCMVEL411C	VWS-MOV-411C EXTERNAL LEAK LARGE	2.4E-08	1.3E-07	6.6E+00
769	NCCMVEL411B	VWS-MOV-411B EXTERNAL LEAK LARGE	2.4E-08	1.3E-07	6.6E+00
770	NCCMVEL424	VWS-MOV-424 EXTERNAL LEAF LARGE	2.4E-08	1.3E-07	6.6E+00
771	NCCMVEL411A	VWS-MOV-411A EXTERNAL LEAK LARGE	2.4E-08	1.3E-07	6.6E+00
772	NCCMVEL414	VWS-MOV-414 EXTERNAL LEAK LARGE	2.4E-08	1.3E-07	6.6E+00
773	NCCAVEL2423C	VWS-TCV-2423C EXTERNAL LEAK LARGE	2.2E-08	1.2E-07	6.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 53 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
774	NCCAVEL2423D	VWS-TCV-2423D EXTERNAL LEAK LARGE	2.2E-08	1.2E-07	6.6E+00
775	NCCAVEL2420A	VWS-TCV-2420A EXTERNAL LEAK LARGE	2.2E-08	1.2E-07	6.6E+00
776	NCCAVEL2420B	VWS-TCV-2420B EXTERNAL LEAK LARGE	2.2E-08	1.2E-07	6.6E+00
777	NCCPNELPIPE2	VWS ALTERNATE CONTAINMENT COOLING LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	3.4E-09	6.6E+00
778	NCCMVOD411C	VWS-MOV-411C FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
779	NCCMVOD411A	VWS-MOV-411A FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
780	NCCMVOD411B	VWS-MOV-411B FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
781	NCCMVOD411D	VWS-MOV-411D FAIL TO OPEN	1.0E-03	5.6E-03	6.6E+00
782	NCCRHPR001D	VCS-CAH-001D (D-CONTAINMENT FAN COOLER UNIT) PLUG	1.4E-05	8.0E-05	6.6E+00
783	NCCRHPR001A	VCS-CAH-001A (A-CONTAINMENT FAN COOLER UNIT) PLUG	1.4E-05	8.0E-05	6.6E+00
784	NCCRHPR001C	VCS-CAH-001C (C-CONTAINMENT FAN COOLER UNIT) PLUG	1.4E-05	8.0E-05	6.6E+00
785	NCCRHPR001B	VCS-CAH-001B (B-CONTAINMENT FAN COOLER UNIT) PLUG	1.4E-05	8.0E-05	6.6E+00
786	NCCAVCM2423C	VWS-TCV-2423C SPURIOUS CLOSE	4.8E-06	2.7E-05	6.6E+00
787	NCCAVCM2423D	VWS-TCV-2423D SPURIOUS CLOSE	4.8E-06	2.7E-05	6.6E+00
788	NCCAVCM2420A	VWS-TCV-2420A SPURIOUS CLOSE	4.8E-06	2.7E-05	6.6E+00
789	NCCAVCM2420B	VWS-TCV-2420B SPURIOUS CLOSE	4.8E-06	2.7E-05	6.6E+00
790	NCCMVPR411A	VWS-MOV-411A PLUG	2.4E-06	1.3E-05	6.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 54 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
791	NCCAVPR2420B	VWS-TCV-2420B PLUG	2.4E-06	1.3E-05	6.6E+00
792	NCCMVPR411B	VWS-MOV-411B PLUG	2.4E-06	1.3E-05	6.6E+00
793	NCCAVPR2420A	VWS-TCV-2420A PLUG	2.4E-06	1.3E-05	6.6E+00
794	NCCXVPR412A	VWS-VLV-412A PLUG	2.4E-06	1.3E-05	6.6E+00
795	NCCXVPR412D	VWS-VLV-412D PLUG	2.4E-06	1.3E-05	6.6E+00
796	NCCXVPR412B	VWS-VLV-412B PLUG	2.4E-06	1.3E-05	6.6E+00
797	NCCAVPR2423C	VWS-TCV-2423C PLUG	2.4E-06	1.3E-05	6.6E+00
798	NCCAVPR2423D	VWS-TCV-2423D PLUG	2.4E-06	1.3E-05	6.6E+00
799	NCCMVPR411C	VWS-MOV-411C PLUG	2.4E-06	1.3E-05	6.6E+00
800	NCCXVPR412C	VWS-VLV-412C PLUG	2.4E-06	1.3E-05	6.6E+00
801	NCCMVPR411D	VWS-MOV-411D PLUG	2.4E-06	1.3E-05	6.6E+00
802	NCCMVCM411D	VWS-MOV-411D SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
803	NCCMVCM411B	VWS-MOV-411B SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
804	NCCMVCM411A	VWS-MOV-411A SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
805	NCCMVCM411C	VWS-MOV-411C SPURIOUS CLOSE	9.6E-07	5.4E-06	6.6E+00
806	RSSCF4CVOD005-124	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	1.2E-06	6.6E+00
807	EPSCF4ATFFS-ALL	SWITCH FAIL TO OPERATE (CCF)	3.8E-05	2.1E-04	6.5E+00
808	EPSTRFF008	ESS-AT-008 (6.9KV-480V P1 NON-CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	4.5E-05	6.5E+00
809	EPSBSFFAM008	ENS-AM-008 (P2 NON-CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	3.1E-05	6.5E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 55 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
810	EPSBSFFAL008	ENS-AL-008 (P2 NON-CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	3.1E-05	6.5E+00
811	EPSBSFFAC013	ENS-AC-013 (P21 NON-CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	3.1E-05	6.5E+00
812	NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN	2.0E-02	1.1E-01	6.4E+00
813	CWSCF2MVOD007-ALL	NCS-MOV-007C,D FAIL TO OPEN (CCF)	4.7E-05	2.6E-04	6.4E+00
814	CWSCF2MVOD020-ALL	NCS-MOV-020C,D FAIL TO OPEN (CCF)	4.7E-05	2.6E-04	6.4E+00
815	EFWXVEL026B	EFS-VLV-026B EXTERNAL LEAK LARGE	7.2E-08	3.9E-07	6.4E+00
816	EFWPNELTESTB	EFS C,D-EFW PUMP TEST LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	3.2E-09	6.4E+00
817	EPSCBSO52STLP2	EPS 52/STLP2 (BREAKER) SPURIOUS OPEN	3.1E-06	1.7E-05	6.4E+00
818	EPSCBSO52LCP21	EPS 52/LCP21 (BREAKER) SPURIOUS OPEN	3.1E-06	1.7E-05	6.4E+00
819	EPSCBSO52STHP2	EPS 52/STHP2 (BREAKER) SPURIOUS OPEN	3.1E-06	1.7E-05	6.4E+00
820	RSSCF4CVOD005-234	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	1.2E-06	6.2E+00
821	MSRCF4AVCD515-24	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	2.7E-04	6.1E+00
822	MSRCF4AVCD515-12	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	2.7E-04	6.1E+00
823	MSRCF4AVCD515-14	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	5.2E-05	2.7E-04	6.1E+00
824	MSRCF4AVCD515-124	NMS-SMV-515A,B,C,D FAIL TO CLOSE (CCF)	2.6E-05	1.3E-04	6.0E+00
825	SWSCF4CVOD602-R-34	EWS-VLV-602A,B,C,D FAIL TO RE-OPEN (CCF)	1.0E-07	5.0E-07	6.0E+00
826	SWSCF4CVOD502-R-34	EWS-VLV-502A,B,C,D FAIL TO RE-OPEN (CCF)	1.0E-07	5.0E-07	6.0E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 56 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
827	CWSCF4CVOD016-R-14	NCS-VLV-016AB,C,D FAIL TO RE-OPEN (CCF)	1.0E-07	5.0E-07	6.0E+00
828	EFWXVEL013B	EFS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	3.6E-07	6.0E+00
829	EFWCVEL012B	EFS-VLV-012B EXTERNAL LEAK LARGE	4.8E-08	2.4E-07	6.0E+00
830	EPSCF4IVFF002-234	ESS-AU-002A,B,C,D (MOV INVERTER) FAIL TO OPERATE (CCF)	5.0E-07	2.5E-06	6.0E+00
831	EFWXVEL026A	EFS-VLV-026A EXTERNAL LEAK LARGE	7.2E-08	3.5E-07	5.8E+00
832	EFWPNELTESTA	EFS A,B-EFW PUMP TEST LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	2.9E-09	5.8E+00
833	EPSCBFO52UAT-AC	EPS 52/UATA,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	2.4E-05	5.8E+00
834	EPSCBFO52RAT-AC	EPS 52/RATA,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	2.4E-05	5.8E+00
835	EPSCF4CBSC52RAT-13	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.6E-07	5.8E+00
836	EPSCF4CBSC52UAT-13	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.6E-07	5.8E+00
837	EPSCF4CBSOB-ALL	BREAKER (BETWEEN 480V MCC AND MOV 480V MCC) SPURIOUS OPEN (CCF)	1.6E-07	7.6E-07	5.8E+00
838	SWSPMEL001C	EWS-OPP-001C (C-ESW PUMP) EXTERNAL LEAK LARGE	1.9E-07	8.8E-07	5.6E+00
839	EFWCVEL018C	EFS-VLV-018C EXTERNAL LEAK LARGE	4.8E-08	2.2E-07	5.5E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 57 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
840	EFWMVEL017C	EFS-MOV-017C EXTERNAL LEAK LARGE	2.4E-08	1.1E-07	5.5E+00
841	EFWMVEL014C	EFS-MOV-014C EXTERNAL LEAK LARGE	2.4E-08	1.1E-07	5.5E+00
842	EFWPNELSGC	EFS C-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	2.7E-09	5.5E+00
843	SWSCF4PMBD001-R-123	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	1.5E-05	6.8E-05	5.4E+00
844	RSSCF4CVOD005-123	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	9.5E-07	5.3E+00
845	RSSCF4PMAD001-13	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.3E-05	5.4E-05	5.3E+00
846	MSRAVCD500E	NMS-TCV-500E FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
847	MSRAVCD500L	NMS-TCV-500L FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
848	MSRAVCD500D	NMS-TCV-500D FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
849	MSRAVCD500K	NMS-TCV-500K FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
850	MSRAVCD500M	NMS-TCV-500M FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
851	MSRAVCD500F	NMS-TCV-500F FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
852	MSRAVCD500H	NMS-TCV-500H FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
853	MSRAVCD500B	NMS-TCV-500B FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
854	MSRAVCD500P	NMS-TCV-500P FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
855	MSRAVCD500G	NMS-TCV-500G FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
856	MSRAVCD500A	NMS-TCV-500A FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
857	MSRAVCD500C	NMS-TCV-500C FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 58 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
858	MSRAVCD500N	NMS-TCV-500N FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
859	MSRAVCD500Q	NMS-TCV-500Q FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
860	MSRAVCD500J	NMS-TCV-500J FAIL TO CLOSE	1.2E-03	5.0E-03	5.1E+00
861	CWSCF4PCBD001-R-234	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	8.4E-06	3.4E-05	5.1E+00
862	RSSCF4MVOD145-24	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	2.2E-05	4.9E+00
863	RSSCF4MVOD004-134	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	1.5E-06	5.4E-06	4.7E+00
864	EPSBSFFAM001A	ESS-AM-001A (A CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	2.1E-05	4.7E+00
865	EFWCF4MVFC017-12	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	2.1E-06	4.7E+00
866	EFWCF4MVFC017-24	EFS-MOV-017A,B,C,D FAIL TO CONTROL (CCF)	5.6E-07	2.1E-06	4.7E+00
867	RWSCF4SUPR001-24	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	1.1E-05	4.6E+00
868	RSSRXEL001C	RHS-RHX-001C (C-CS/RHR HX) SHELL EXTERNAL LEAK LARGE	9.6E-08	3.5E-07	4.6E+00
869	CWSXVEL005C	NCS-VLV-005C EXTERNAL LEAK LARGE	7.2E-08	2.6E-07	4.6E+00
870	RSSXVEL125C	NCS-VLV-125C EXTERNAL LEAK LARGE	7.2E-08	2.6E-07	4.6E+00
871	RSSXVEL128C	NCS-VLV-128C EXTERNAL LEAK LARGE	7.2E-08	2.6E-07	4.6E+00
872	RSSXVEL131C	NCS-VLV-131C EXTERNAL LEAK LARGE	7.2E-08	2.6E-07	4.6E+00
873	CWSMVEL020C	NCS-MOV-020C EXTERNAL LEAK LARGE	2.4E-08	8.7E-08	4.6E+00
874	CWSMVEL007C	NCS-MOV-007C EXTERNAL LEAK LARGE	2.4E-08	8.7E-08	4.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 59 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
875	RSSCF4PMSR001-24	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	1.2E-05	4.5E+00
876	RWSCF4SUPR001-12	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	9.6E-06	4.2E+00
877	CHIOO01CHIB	(HE) FAIL TO START THE STANDBY CHARGING INJECTION PUMP B	2.6E-03	8.1E-03	4.1E+00
878	CCWRSA	CCW RECOVERY (AFTER CORE MELT)	1.6E-02	4.8E-02	4.0E+00
879	RSAOO02FWP	(HE) FAIL TO OPERATE FIRE SUPRESSION PUMP	8.5E-03	2.6E-02	4.0E+00
880	CFAMVODFSV5	CSS-MOV-011 FAIL TO OPEN	1.0E-03	3.1E-03	4.0E+00
881	CFAORPRFSO1	ORIFICE FSO1 PLUG	2.4E-05	7.5E-05	4.0E+00
882	CFACVODFSV6	CSS-VLV-012 FAIL TO OPEN	1.2E-05	3.7E-05	4.0E+00
883	CFACVPRFSV6	CSS-VLV-012 PLUG	2.4E-06	7.5E-06	4.0E+00
884	CFAMVPRFSV5	CSS-MOV-011 PLUG	2.4E-06	7.5E-06	4.0E+00
885	RSSCF4PMLR001-24	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.2E-06	3.5E-06	4.0E+00
886	RSSMVOD004B	CSS-MOV-004B FAIL TO OPEN	9.0E-04	2.7E-03	4.0E+00
887	CFAMVODFSV2	MOTER-OPERATED VALVE FSV2 FAIL TO OPEN	1.0E-03	3.0E-03	4.0E+00
888	CFAFMPRFSF1	FLOW METER FSF1 PLUG	2.4E-05	7.2E-05	4.0E+00
889	CFAMVPRFSV2	MOTER-OPERATED VALVE FSV2 PLUG	2.4E-06	7.2E-06	4.0E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 60 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
890	CFAXVPRFSV1	MANUAL VALVE FSV1 PLUG	2.4E-06	7.2E-06	4.0E+00
891	HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	2.6E-03	7.6E-03	3.9E+00
892	EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START	6.5E-03	1.9E-02	3.9E+00
893	EFWPTSR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	2.4E-03	7.0E-03	3.9E+00
894	EFWPTLR001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION	1.5E-03	4.5E-03	3.9E+00
895	EFWPTEL001A	EFS-RPP-001A (A-EFW PUMP) EXTERNAL LEAK LARGE	2.2E-07	6.4E-07	3.9E+00
896	RSSCF4MVOD004-12	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	1.6E-05	3.9E+00
897	RSSOO01CSP	(HE) FAIL TO START CV SPRAY SYSTEM	5.0E-03	1.4E-02	3.8E+00
898	EFWMVOD103A	EFS-MOV-103A FAIL TO OPEN	9.6E-04	2.7E-03	3.8E+00
899	RSSXVEL141C	NCS-VLV-141C EXTERNAL LEAK LARGE	7.2E-08	2.0E-07	3.8E+00
900	RSSXVEL144C	NCS-VLV-144C EXTERNAL LEAK LARGE	7.2E-08	2.0E-07	3.8E+00
901	RTPDASF	DAS FAILURE	1.0E-02	2.8E-02	3.8E+00
902	EPSCBFO52UAT-AB	EPS 52/UATA,B (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.4E-05	3.7E+00
903	EPSCBFO52RAT-AB	EPS 52/RATA,B (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.4E-05	3.7E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 61 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
904	EPSCF4CBSC52UAT-12	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	9.2E-08	3.7E+00
905	EPSCF4CBSC52RAT-12	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	9.2E-08	3.7E+00
906	EFWTMTA001A	EFS-RPP-001A (A-EFW PUMP) TEST & MAINTENANCE	5.0E-03	1.4E-02	3.7E+00
907	RSSCF4MVOD004-14	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	1.5E-05	3.7E+00
908	SWSCF2PMYR001BD-ALL	EWS-OPP-001B,D (ESW PUMP) FAIL TO RUN (CCF)	8.9E-06	2.4E-05	3.7E+00
909	SWSCF2PMBD001BD-ALL	EWS-OPP-001B,D (ESW PUMP) FAIL TO START (CCF)	1.4E-04	3.6E-04	3.7E+00
910	EFWCF4CVOD012-23	EFS-VLV-012A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	5.9E-07	3.6E+00
911	EFWCF4CVOD018-34	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	5.9E-07	3.6E+00
912	EFWCF4CVOD018-24	EFS-VLV-018A,B,C,D FAIL TO OPEN (CCF)	2.3E-07	5.9E-07	3.6E+00
913	RSSCVOD005B	CSS-VLV-005B FAIL TO OPEN	1.0E-05	2.6E-05	3.5E+00
914	RSSCVPR005B	CSS-VLV-005B PLUG	2.4E-06	6.1E-06	3.5E+00
915	SGNCF4ICVR0012-23	CONTAINMENT PRESSURE SENSOR CCF	8.5E-07	2.1E-06	3.5E+00
916	SGNCF4ICVR0012-24	CONTAINMENT PRESSURE SENSOR CCF	8.5E-07	2.1E-06	3.5E+00
917	SGNCF4ICVR0012-34	CONTAINMENT PRESSURE SENSOR CCF	8.5E-07	2.1E-06	3.5E+00
918	SGNCF4ICVR0012-12	CONTAINMENT PRESSURE SENSOR CCF	8.5E-07	2.1E-06	3.5E+00
919	SGNCF4ICVR0012-14	CONTAINMENT PRESSURE SENSOR CCF	8.5E-07	2.1E-06	3.5E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 62 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
920	SGNCF4ICVR0012-13	CONTAINMENT PRESSURE SENSOR CCF	8.5E-07	2.1E-06	3.5E+00
921	EPSBSFFAM001B	ESS-AM-001B (B CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	1.4E-05	3.5E+00
922	RSSCF4MVOD004-24	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	1.4E-05	3.5E+00
923	RSSCF4MVOD004-13	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	1.4E-05	3.5E+00
924	EPSBSFFDD002D	ESS-DD-002D (D1 DC SWITCHBOARD BUS) FAILURE	5.8E-06	1.4E-05	3.5E+00
925	RSSMVPR004B	CSS-MOV-004B PLUG	2.4E-06	5.8E-06	3.4E+00
926	RSSMVCM004B	CSS-MOV-004B SPURIOUS CLOSE	9.6E-07	2.3E-06	3.4E+00
927	EPSBSFFDD001A	ESS-DD-001A (A DC SWITCHBOARD BUS) FAILURE	5.8E-06	1.4E-05	3.4E+00
928	RSSCF4MVOD004-23	CSS-MOV-004A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	1.4E-05	3.4E+00
929	EPSTRFF001A	ESS-AT-001A (6.9KV-480V A CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	1.9E-05	3.4E+00
930	EPSBSFFAL001A	ESS-AL-001A (A CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	1.4E-05	3.4E+00
931	EFWCVOD012A	EFS-VLV-012A FAIL TO OPEN	9.5E-06	2.2E-05	3.4E+00
932	EFWXVPR013A	EFS-VLV-013A PLUG	2.4E-06	5.6E-06	3.4E+00
933	EFWCVPR012A	EFS-VLV-012A PLUG	2.4E-06	5.6E-06	3.4E+00
934	RSSXVPR002B	CSS-VLV-002B PLUG	2.4E-06	5.6E-06	3.3E+00
935	EFWXVIL023A	EFS-VLV-023A INTERNAL LEAK LARGE	1.1E-05	2.4E-05	3.3E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 63 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
936	EFWXVEL021A	EFS-VLV-021A EXTERNAL LEAK LARGE	7.2E-08	1.7E-07	3.3E+00
937	EFWXVEL023A	EFS-VLV-023A EXTERNAL LEAK LARGE	7.2E-08	1.7E-07	3.3E+00
938	EFWCVEL020A	EFS-VLV-020A EXTERNAL LEAK LARGE	4.8E-08	1.1E-07	3.3E+00
939	EFWCVEL022A	EFS-VLV-022A EXTERNAL LEAK LARGE	4.8E-08	1.1E-07	3.3E+00
940	EPSTRFF001D	ESS-AT-001D (6.9KV-480V D CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	1.9E-05	3.3E+00
941	EPSBSFFAL001D	ESS-AL-001D (D CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	1.3E-05	3.3E+00
942	RSSCF4CVOD005-134	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.2E-07	5.0E-07	3.3E+00
943	EPSCBSO72DDAD	EPS 72/DDAD (BREAKER) SPURIOUS OPEN	3.0E-06	6.7E-06	3.2E+00
944	EPSCBSO72DDDD	EPS 72/DDDD (BREAKER) SPURIOUS OPEN	3.0E-06	6.7E-06	3.2E+00
945	EPSCF4CBSO72DD2-34	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.5E-08	3.2E+00
946	EPSCF4CBSO72DD2-24	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.5E-08	3.2E+00
947	EPSCF4CBSO72DD1-14	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.5E-08	3.2E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 64 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
948	EPSCF4CBSO72DD1-13	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.5E-08	3.2E+00
949	EPSCF4CBSO72DD1-134	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.5E-08	3.2E+00
950	EPSCF4CBSO72DD2-234	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	6.5E-08	3.2E+00
951	EPSBSFFAC001D	ESS-AC-001D (D CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	1.2E-05	3.1E+00
952	EPSBSFFAL002A	ESS-AL-002A (A1 CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	1.2E-05	3.0E+00
953	EPSBSFFAC002A	ESS-AC-002A (A1 CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	1.2E-05	3.0E+00
954	EFWMVPR103A	EFS-MOV-103A PLUG	2.4E-06	4.8E-06	3.0E+00
955	EFWMVCM103A	EFS-MOV-103A SPURIOUS CLOSE	9.6E-07	1.9E-06	3.0E+00
956	EFWMVEL103A	EFS-MOV-103A EXTERNAL LEAK LARGE	2.4E-08	4.8E-08	3.0E+00
957	EFWPNELSTA	EFS A-T/D EFW PUMP STEAM SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.2E-09	3.0E+00
958	MSPMLWTH	WATER HUMMER IN STEAM LINE	1.0E-02	2.0E-02	3.0E+00
959	CFAFMFFFSF1	FLOW METER FSF1 RUPTURE	7.2E-07	1.4E-06	3.0E+00
960	CFAXVELFSV1	MANUAL VALVE FSV1 EXTERNAL LEAK LARGE	7.2E-08	1.4E-07	3.0E+00
961	CFAMVELFSV2	MOTER-OPERATED VALVE FSV2 EXTERNAL LEAK LARGE	2.4E-08	4.8E-08	3.0E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 65 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
962	CFAPNELPIPE4	FROM FWT (FIRE SUPPRESSION TANK) TO TIE LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.2E-09	3.0E+00
963	RSSCF4CVOD005-24	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.0E-07	3.9E-07	3.0E+00
964	RSSCF4CVOD004-24	RHS-VLV-004A,B,C,D FAIL TO OPEN (CCF)	2.0E-07	3.9E-07	3.0E+00
965	RSSCF4RHPR001-24	RHS-RHX-001A,B,C,D (CS/RHR HX) PLUG / FOUL (CCF)	1.7E-07	3.4E-07	3.0E+00
966	EFWXVPR009A	EFS-VLV-009A PLUG	2.4E-06	4.7E-06	3.0E+00
967	EPSCF4IVFF001-134	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	9.8E-07	3.0E+00
968	CWSCF2PCBD001BD-ALL	NCS-RPP-001B,D (CCW PUMP) FAIL TO START (CCF)	7.5E-05	1.5E-04	2.9E+00
969	CHIPMBD001B-R	CVS-RPP-001B (B-CHI PUMP) FAIL TO RE-START	1.8E-03	3.5E-03	2.9E+00
970	EPSCBSO52LCD	EPS 52/LCD (BREAKER) SPURIOUS OPEN	3.0E-06	5.7E-06	2.9E+00
971	EPSCBSO52STLA	EPS 52/STLA (BREAKER) SPURIOUS OPEN	3.0E-06	5.7E-06	2.9E+00
972	EPSCBSO52STHA	EPS 52/STHA (BREAKER) SPURIOUS OPEN	3.0E-06	5.7E-06	2.9E+00
973	CWSCF2PCYR001BD-ALL	NCS-RPP-001B,D (CCW PUMP) FAIL TO RUN (CCF)	5.0E-06	9.3E-06	2.9E+00
974	RSSCF2MVCD145-ALL	NCS-MOV-145C,D FAIL TO CLOSE (CCF)	4.7E-05	8.8E-05	2.9E+00
975	RSSCF4CVOD005-23	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.0E-07	3.6E-07	2.8E+00
976	RSSCF4PMAD001-34	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.3E-05	2.3E-05	2.8E+00
977	RSSCF4CVOD005-12	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.0E-07	3.6E-07	2.8E+00
978	SGNST-BOP2	BO-SIGNAL (TRAIN P2) FAILURE	1.2E-03	2.2E-03	2.8E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 66 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
979	EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	3.1E-02	2.7E+00
980	EPSDLADDGP2	EPS B-AAC GTG FAIL TO START	4.7E-03	8.4E-03	2.7E+00
981	EPSSEFFDGP2	EPS B-AAC GTG SEQUENCER FAIL TO OPERATE	2.9E-03	5.1E-03	2.7E+00
982	EPSDLSRDGP2	EPS B-AAC GTG FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION	2.8E-03	5.0E-03	2.7E+00
983	EPSCBFC52AACBP	EPS 52/AACBP (BREAKER) FAIL TO CLOSE	3.7E-04	6.7E-04	2.7E+00
984	EPSCBSO52AACBP	EPS 52/AACBP (BREAKER) SPURIOUS OPEN	3.1E-06	5.5E-06	2.7E+00
985	EPSCF4DLLRDG-12	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	4.4E-04	2.7E+00
986	EPSCF4DLADDG-23	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	7.4E-05	2.7E+00
987	EPSCF4DLSRDG-12	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	6.9E-05	2.7E+00
988	EPSCF4SEFFDG-12	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	4.3E-05	2.7E+00
989	EPSCF4CBFC52EPS-34	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	8.6E-06	2.7E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 67 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
990	EPSCBFO52UAT-BC	EPS 52/UATB,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	8.6E-06	2.7E+00
991	EPSCF4CBSO52EPS-12	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.8E-08	2.7E+00
992	EPSCF4CBSC52UAT-23	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	5.8E-08	2.7E+00
993	MSPRVCD465	NMS-PCV-465 FAIL TO RE-CLOSE	1.0E-03	1.7E-03	2.7E+00
994	EPSCBSO52LCA1	EPS 52/LCA1 (BREAKER) SPURIOUS OPEN	3.1E-06	5.2E-06	2.7E+00
995	EPSCBSO52LLAA	EPS 52/LLAA (BREAKER) SPURIOUS OPEN	3.1E-06	5.2E-06	2.7E+00
996	EPSCBSO52LLDA	EPS 52/LLDA (BREAKER) SPURIOUS OPEN	3.1E-06	5.2E-06	2.7E+00
997	HPIOO02FWBD	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE AND START SAFETY INJECTION PUMP	3.8E-03	6.4E-03	2.7E+00
998	SWSCF4PMBD001-R-23	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	1.2E-04	2.7E+00
999	CWSCF4MVCD020-ALL	NCS-MOV-020A,B,C,D FAIL TO CLOSE (CCF)	1.3E-05	2.1E-05	2.7E+00
1000	CWSCF4MVCD007-ALL	NCS-MOV-007A,B,C,D FAIL TO CLOSE (CCF)	1.3E-05	2.1E-05	2.7E+00
1001	EPSCBSO52STHD	EPS 52/STHD (BREAKER) SPURIOUS OPEN	3.0E-06	4.9E-06	2.6E+00
1002	EPSCBSO52STLD	EPS 52/STLD (BREAKER) SPURIOUS OPEN	3.0E-06	4.9E-06	2.6E+00
1003	EPSCBFO52RAT-A	EPS 52/RATA (BREAKER) FAIL TO OPEN	3.5E-04	5.7E-04	2.6E+00
1004	EPSCBFO52UAT-A	EPS 52/UATA (BREAKER) FAIL TO OPEN	3.5E-04	5.7E-04	2.6E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 68 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1005	EPSCBSC52RATA	EPS 52/RATA (BREAKER) SPURIOUS CLOSE	3.0E-06	4.9E-06	2.6E+00
1006	EPSCBSC52UATA	EPS 52/UATA (BREAKER) SPURIOUS CLOSE	3.0E-06	4.9E-06	2.6E+00
1007	EFWPTAD001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO START	6.5E-03	1.1E-02	2.6E+00
1008	EFWPTSR001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	2.4E-03	3.9E-03	2.6E+00
1009	EFWPTLR001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION	1.5E-03	2.5E-03	2.6E+00
1010	EFWPTEL001D	EFS-RPP-001D (D-EFW PUMP) EXTERNAL LEAK LARGE	2.2E-07	3.6E-07	2.6E+00
1011	CWSCF4PCBD001-R-34	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	6.4E-05	2.6E+00
1012	EPSBSFFDD001C	ESS-DD-001C (C DC SWITCHBOARD BUS) FAILURE	5.8E-06	9.3E-06	2.6E+00
1013	EFWMVOD103D	EFS-MOV-103D FAIL TO OPEN	9.6E-04	1.5E-03	2.6E+00
1014	EPSCBFC89AACD	EPS 89/AACD (SELECTOR CIRCUIT) FAIL TO CLOSE	3.7E-04	5.8E-04	2.6E+00
1015	EPSCBFO52EPSD	EPS 52/EPSD (BREAKER) FAIL TO OPEN	3.7E-04	5.8E-04	2.6E+00
1016	EPSCBFC52AACD	EPS 52/AACD (BREAKER) FAIL TO CLOSE	3.7E-04	5.8E-04	2.6E+00
1017	EPSCBSO52AACD	EPS 52/AACD (BREAKER) SPURIOUS OPEN	3.1E-06	4.8E-06	2.6E+00
1018	EPSCBSO89AACD	EPS 89/AACD (SELECTOR CIRCUIT) SPURIOUS OPEN	3.1E-06	4.8E-06	2.6E+00
1019	EPSCBSC52EPSD	EPS 52/EPSD (BREAKER) SPURIOUS CLOSE	3.1E-06	4.8E-06	2.6E+00
1020	EPSTMDGP2	EPS B-AAC GTG TEST & MAINTENANCE	1.2E-02	1.9E-02	2.5E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 69 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1021	EPSCF4DLLRDG-34	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	3.9E-04	2.5E+00
1022	EPSCF4DLADDG-14	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	6.5E-05	2.5E+00
1023	EPSCF4DLSRDG-34	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	6.1E-05	2.5E+00
1024	EPSCF4SEFFDG-34	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	3.8E-05	2.5E+00
1025	EPSCF4CBFC52EPS-12	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	7.6E-06	2.5E+00
1026	EPSCF4CBSO52EPS-34	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.1E-08	2.5E+00
1027	EPSCF4DLLRDG-24	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	2.5E-04	3.8E-04	2.5E+00
1028	EPSCF4DLADDG-13	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	4.3E-05	6.5E-05	2.5E+00
1029	EPSCF4DLSRDG-24	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	4.0E-05	6.1E-05	2.5E+00
1030	EPSCF4SEFFDG-24	EPS CLASS 1E GTG A,B,C,D SEQUENCER FAIL TO OPERATE (CCF)	2.5E-05	3.8E-05	2.5E+00
1031	EPSCF4CBFC52EPS-23	EPS 52/EPSA,B,C,D (BREAKER) FAIL TO CLOSE (CCF)	5.0E-06	7.5E-06	2.5E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 70 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1032	EPSCF4CBSO52EPS-24	EPS 52/EPSA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.1E-08	2.5E+00
1033	MSPMVCD507A	NMS-MOV-507A FAIL TO CLOSE	1.0E-03	1.5E-03	2.5E+00
1034	HPICF4PMAD001-234	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO START (CCF)	9.5E-06	1.4E-05	2.5E+00
1035	EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	2.7E-02	2.5E+00
1036	EPSDLADDGP1	EPS A-AAC GTG FAIL TO START	4.7E-03	7.2E-03	2.5E+00
1037	EPSSEFFDGP1	EPS A-AAC GTG SEQUENCER FAIL TO OPERATE	2.9E-03	4.4E-03	2.5E+00
1038	EPSDLSRDGP1	EPS A-AAC GTG FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION	2.8E-03	4.2E-03	2.5E+00
1039	EPSCBFC52AACAP	EPS 52/AACAP (BREAKER) FAIL TO CLOSE	3.7E-04	5.7E-04	2.5E+00
1040	EPSCBSO52AACAP	EPS 52/AACAP (BREAKER) SPURIOUS OPEN	3.1E-06	4.7E-06	2.5E+00
1041	SGNST-BOP1	BO-SIGNAL (TRAIN P1) FAILURE	1.2E-03	1.8E-03	2.5E+00
1042	RSSCF4CVOD005-14	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.0E-07	2.9E-07	2.4E+00
1043	RSSCF4CVOD005-13	CSS-VLV-005A,B,C,D FAIL TO OPEN (CCF)	2.0E-07	2.9E-07	2.4E+00
1044	RSSCVEL005B	CSS-VLV-005B EXTERNAL LEAK LARGE	4.8E-08	6.9E-08	2.4E+00
1045	CFAMVELFSV5	CSS-MOV-011 EXTERNAL LEAK LARGE	2.4E-08	3.5E-08	2.4E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 71 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1046	CFAPNELPIPE2	FROM TIE LINE TO CSS-VLV-012 PIPING EXTERNAL LEAK LARGE	6.0E-10	8.7E-10	2.4E+00
1047	RSSCF4MVOD145-14	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	7.9E-06	2.4E+00
1048	MSRAVCD515A	NMS-SMV-515A FAIL TO CLOSE	7.9E-04	1.1E-03	2.4E+00
1049	RSSCF4PMAD001-14	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.3E-05	1.7E-05	2.4E+00
1050	EFWCF2PMAD001BC-ALL	EFS-RPP-001B,C (EFW PUMP) FAIL TO START (CCF)	2.2E-04	3.0E-04	2.4E+00
1051	MSRAVOM515A	NMS-SMV-515A SPURIOUS OPEN	4.8E-06	6.5E-06	2.3E+00
1052	MSRAVOM3615	NMS-HCV-3615 SPURIOUS OPEN	4.8E-06	6.5E-06	2.3E+00
1053	MSRAVIL515A	NMS-SMV-515A INTERNAL LEAK LARGE	1.2E-07	1.6E-07	2.3E+00
1054	MSRAVIL3615	NMS-HCV-3615 INTERNAL LEAK LARGE	1.2E-07	1.6E-07	2.3E+00
1055	HVACF2AHSR401-ALL	VRS-RAH-401B,C (EFW PUMP AIR HANDLING UNIT) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.2E-04	1.6E-04	2.3E+00
1056	RWSSUPR001C	SIS-CSR-001C (C-ESS/CS STRAINER) PLUG DURING OPERATION	2.1E-04	2.8E-04	2.3E+00
1057	VCWCF2CHYR001-ALL	VWS-PEQ-001B,C (ESSENTIAL CHILLER UNIT) FAIL TO RUN (CCF)	1.0E-04	1.3E-04	2.3E+00
1058	EFWTMTA001D	EFS-RPP-001D (D-EFW PUMP) TEST & MAINTENANCE	5.0E-03	6.5E-03	2.3E+00
1059	EPSTMDGP1	EPS A-AAC GTG TEST & MAINTENANCE	1.2E-02	1.6E-02	2.3E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 72 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1060	RSSPMAD001C	RHS-RPP-001C (C-CS/RHR PUMP) FAIL TO START	1.4E-03	1.8E-03	2.3E+00
1061	HVACF2AHAD401-ALL	VRS-RAH-401B,C (EFW PUMP AIR HANDLING UNIT) FAIL TO START (CCF)	3.8E-05	4.7E-05	2.3E+00
1062	RSSMVOD145C	NCS-MOV-145C FAIL TO OPEN	9.0E-04	1.1E-03	2.2E+00
1063	RSSPMSR001C	RHS-RPP-001C (C-CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION	3.8E-04	4.7E-04	2.2E+00
1064	SWSCF4PMBD001-R-24	EWS-OPP-001A,B,C,D (ESW PUMP) FAIL TO RE-START (CCF)	7.1E-05	8.8E-05	2.2E+00
1065	EPSCBFC52AACA	EPS 52/AACA (BREAKER) FAIL TO CLOSE	3.7E-04	4.5E-04	2.2E+00
1066	EPSCBFO52EPSA	EPS 52/EPSA (BREAKER) FAIL TO OPEN	3.7E-04	4.5E-04	2.2E+00
1067	EPSCBFC89AACA	EPS 89/AACA (SELECTOR CIRCUIT) FAIL TO CLOSE	3.7E-04	4.5E-04	2.2E+00
1068	EPSCBSC52EPSA	EPS 52/EPSA (BREAKER) SPURIOUS CLOSE	3.1E-06	3.7E-06	2.2E+00
1069	EPSCBSO52AACA	EPS 52/AACA (BREAKER) SPURIOUS OPEN	3.1E-06	3.7E-06	2.2E+00
1070	EPSCBSO89AACA	EPS 89/AACA (SELECTOR CIRCUIT) SPURIOUS OPEN	3.1E-06	3.7E-06	2.2E+00
1071	RWSCF4SUPR001-14	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	3.6E-06	2.2E+00
1072	RSSPMLR001C	RHS-RPP-001C (C-CS/RHR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION	1.3E-04	1.6E-04	2.2E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 73 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1073	RSSCF4MVOD145-12	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	5.7E-06	6.8E-06	2.2E+00
1074	HPICF4PMSR001-234	SIS-RPP-001A,B,C,D (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	3.9E-06	2.2E+00
1075	RSSCF4PMSR001-14	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	3.9E-06	2.2E+00
1076	CWSCF4PCBD001-R-13	NCS-RPP-001A,B,C,D (CCW PUMP) FAIL TO RE-START (CCF)	3.9E-05	4.6E-05	2.2E+00
1077	EFWCVOD012D	EFS-VLV-012D FAIL TO OPEN	9.5E-06	1.1E-05	2.2E+00
1078	EFWCVPR012D	EFS-VLV-012D PLUG	2.4E-06	2.8E-06	2.2E+00
1079	EFWXVPR013D	EFS-VLV-013D PLUG	2.4E-06	2.8E-06	2.2E+00
1080	RSSTMRP001C	RHS-RHX-001C (C-CS/RHR HX) TEST & MAINTENANCE	5.0E-03	5.9E-03	2.2E+00
1081	RSSTMPI001C	RHS-RPP-001C (C-CS/RHR PUMP) TEST & MAINTENANCE	4.0E-03	4.7E-03	2.2E+00
1082	EFWCF2PMSR001BC-ALL	EFS-RPP-001B,C (EFW PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-05	2.0E-05	2.2E+00
1083	EPSBSFFAC003C	ESS-AC-003C (C MOV 480V MCC BUS) FAILURE	5.8E-06	6.7E-06	2.2E+00
1084	EFWXVIL023D	EFS-VLV-023D INTERNAL LEAK LARGE	1.1E-05	1.2E-05	2.2E+00
1085	EFWXVEL023D	EFS-VLV-023D EXTERNAL LEAK LARGE	7.2E-08	8.3E-08	2.2E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 74 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1086	EFWXVEL021D	EFS-VLV-021D EXTERNAL LEAK LARGE	7.2E-08	8.3E-08	2.2E+00
1087	EFWCVEL020D	EFS-VLV-020D EXTERNAL LEAK LARGE	4.8E-08	5.5E-08	2.2E+00
1088	EFWCVEL022D	EFS-VLV-022D EXTERNAL LEAK LARGE	4.8E-08	5.5E-08	2.2E+00
1089	EFWCVEL018B	EFS-VLV-018B EXTERNAL LEAK LARGE	4.8E-08	5.3E-08	2.1E+00
1090	EFWMVEL017B	EFS-MOV-017B EXTERNAL LEAK LARGE	2.4E-08	2.7E-08	2.1E+00
1091	EFWMVEL014B	EFS-MOV-014B EXTERNAL LEAK LARGE	2.4E-08	2.7E-08	2.1E+00
1092	EFWPNELSGB	EFS B-SG SUPPLY LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	6.6E-10	2.1E+00
1093	EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT	1.7E-02	1.9E-02	2.1E+00
1094	RSSCF4PMSR001-12	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	3.3E-06	3.6E-06	2.1E+00
1095	RSSORPR1248	NCS-FE-1248 (ORIFICE) PLUG	2.4E-05	2.5E-05	2.1E+00
1096	RSSORPR1252	NCS-FE-1252 (ORIFICE) PLUG	2.4E-05	2.5E-05	2.1E+00
1097	RSSORPR621	RHS-FE-621 (ORIFICE) PLUG	2.4E-05	2.5E-05	2.1E+00
1098	RSSORPR624	RHS-FE-624 (ORIFICE) PLUG	2.4E-05	2.5E-05	2.1E+00
1099	RSSORPR007C	RHS-OR007C (ORIFICE) PLUG	2.4E-05	2.5E-05	2.1E+00

Table19.1-45 Basic Events (Hardware Failure, Human Error) RAW for LRF (Sheet 75 of 75)

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1100	RSSCVOD004C	RHS-VLV-004C FAIL TO OPEN	1.0E-05	1.1E-05	2.1E+00
1101	RSSRHPR001C	RHS-RHX-001C (C-CS/RHR HX) PLUG / FOUL	8.9E-06	9.4E-06	2.1E+00
1102	RSSXVPR128C	NCS-VLV-128C PLUG	2.4E-06	2.5E-06	2.1E+00
1103	RSSXVPR125C	NCS-VLV-125C PLUG	2.4E-06	2.5E-06	2.1E+00
1104	RSSXVPR131C	NCS-VLV-131C PLUG	2.4E-06	2.5E-06	2.1E+00
1105	RSSXVPR013C	RHS-VLV-013C PLUG	2.4E-06	2.5E-06	2.1E+00
1106	RSSCVPR004C	RHS-VLV-004C PLUG	2.4E-06	2.5E-06	2.1E+00
1107	EPSTRFFRATA4	EPS RATA4 (RESERVE AUXILIARY TRANSFORMER) FAIL TO OPERATE	8.2E-06	8.5E-06	2.0E+00
1108	MSPCF4MVOD508-ALL	NMS-MOV-508A,B,C,D FAIL TO OPEN (CCF)	2.2E-05	2.3E-05	2.0E+00
1109	MSPCF4MVOD508-234	NMS-MOV-508A,B,C,D FAIL TO OPEN (CCF)	1.2E-05	1.3E-05	2.0E+00
1110	RSSORPR1244	NCS-FE-1244 (ORIFICE) PLUG	2.4E-05	2.5E-05	2.0E+00

Table19.1-46 Common Cause Failure FV Importance for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF	1.00E-05	1.8E-01	1.8E+04
2	RSSCF4MVOD145-ALL	NCS-MOV-145A,B,C,D FAIL TO OPEN (CCF)	8.37E-05	1.2E-01	1.5E+03
3	EPSCF4DLLRDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	9.88E-04	7.9E-02	8.0E+01
4	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.13E-06	5.0E-02	2.4E+04
5	RTPBTSWCCF	BASIC SOFTWARE CCF	1.00E-07	4.0E-02	3.9E+05
6	SGNBTSWCCF3	NON-SAFETY (PCMS) APPLICATION SOFTWARE CCF	1.00E-04	3.5E-02	3.5E+02
7	EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.47E-03	2.9E-02	2.1E+01
8	RSSCF4PMAD001-ALL	RHS-RPP-001A,B,C,D (CS/RHR PUMP) FAIL TO START (CCF)	1.88E-05	2.8E-02	1.5E+03
9	RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	9.74E-06	2.0E-02	2.0E+03
10	EPSCF4DLADDG-ALL	EPS CLASS 1E GTG A,B,C,D FAIL TO START (CCF)	2.11E-04	1.7E-02	8.0E+01

Table19.1- 47 Common Cause Failure RAW for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	RTPBTSWCCF	BASIC SOFTWARE CCF	1.0E-07	4.0E-02	3.9E+05
2	EPSCF4CBSO52STH-ALL	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.0E-02	6.5E+04
3	EPSCF4CBSO52STL-ALL	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.0E-02	6.5E+04
4	SWSCF4PMYR-FF	EWS-OPP-001A,B,C,D (A,B,C,D-ESW PUMP) FAIL TO RUN (CCF)	1.2E-08	7.6E-04	6.3E+04
5	CWSCF4RHPR-FF	NCS-RHX-001A,B,C,D (A,B,C,D-CCW HX) PLUG / FOUL (CCF)	3.6E-08	2.1E-03	5.8E+04
6	CWSCF4PCYR-FF	NCS-RPP-001A,B,C,D (A,B,C,D-CCW PUMP) FAIL TO RUN (CCF)	6.7E-09	3.9E-04	5.8E+04
7	EPSCF4CBSO52LC-ALL	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	7.8E-03	4.9E+04
8	SGNBTHWCCF	DIGITAL I&C HARDWARE CCF	2.1E-06	5.0E-02	2.4E+04
9	SGNBTSWCCF2	GROUP-2 APPLICATION SOFTWARE CCF	1.0E-05	1.8E-01	1.8E+04
10	EPSCF4CBSO72DB-ALL	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.4E-03	9.0E+03

Table19.1- 48 Human Error FV Importance for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	1.7E-01	9.1E+00
2	NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN	2.0E-02	1.1E-01	6.4E+00
3	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	7.8E-02	7.8E+00
4	ACWOO02CT-DP2	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY NON-ESSENTIAL CHILLED WATER SYSTEM COOLING TOWER	5.1E-01	7.4E-02	1.1E+00
5	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.4E-02	2.6E+01
6	RSAOO02FWP	(HE) FAIL TO OPERATE FIRE SUPRESSION PUMP	8.5E-03	2.6E-02	4.0E+00
7	HITOO02	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW	2.7E-02	2.3E-02	1.8E+00
8	EFWOO01006AB	(HE) FAIL TO CHANGEOVER EFW PIT	1.7E-02	1.9E-02	2.1E+00
9	HITOO02-DP3	(HE) FAIL TO CONTROL HIGH HEAD INJECTION FLOW	1.7E-01	1.8E-02	1.1E+00
10	PZROO02PORV-DP3	(HE) FAIL TO OPERATE RCS FORCED DEPRESSURIZATION	1.5E-01	1.6E-02	1.1E+00

Table19.1-49 Human Error RAW for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	SGNOO04ICVR12	(HE) MISCALIBRATION OF C/V PRESSURE SENSORS A,B,C,D	6.7E-05	3.6E-03	5.5E+01
2	MSROO02515A	(HE) FAIL TO CLOSE NMS-SMV-515A	2.6E-03	6.4E-02	2.6E+01
3	NCCOO04PI1254	(HE) NCC MISCALIBRATION OF PI-1254	8.0E-04	1.5E-02	1.9E+01
4	EPSOO02RDG	(HE) FAIL TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	1.7E-01	9.1E+00
5	ACWOO02FS	(HE) FAIL TO ESTABLISH THE ALTERNATE CCWS BY FIRE PROTECTION WATER SUPPLY SYSTEM	1.1E-02	7.8E-02	7.8E+00
6	NCCOO04PICA1212	(HE) NCC MISCALIBRATION OF NCS-PICA-1212	8.0E-04	4.5E-03	6.6E+00
7	NCCOO02CCW	(HE) FAIL TO OPERATE ALTERNATE C/V COOLING BY C/V FAN	2.0E-02	1.1E-01	6.4E+00
8	CHIOO01CHIB	(HE) FAIL TO START THE STANDBY CHARGING INJECTION PUMP B	2.6E-03	8.1E-03	4.1E+00
9	RSAOO02FWP	(HE) FAIL TO OPERATE FIRE SUPRESSION PUMP	8.5E-03	2.6E-02	4.0E+00
10	HPIOO02FWBD-S	(HE) FAIL TO OPEN SAFETY DEPRESSURIZATION VALVE	2.6E-03	7.6E-03	3.9E+00

Table19.1-50 Hardware Single Failure FV Importance for LRF

Rank	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	EPSDLLRDGP2-L2	EPS B-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	3.1E-02	2.7E+00
2	RTPDASF	DAS FAILURE	1.0E-02	2.8E-02	3.8E+00
3	EPSDLLRDGP1-L2	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	2.7E-02	2.5E+00
4	EFWPTAD001A	EFS-RPP-001A (A-EFW PUMP) FAIL TO START	6.5E-03	1.9E-02	3.9E+00
5	SGNST-EFWPA	A-SG WATER LEVEL HIGH/LOW SIGNAL FAILURE	1.2E-03	1.9E-02	1.6E+01
6	EPSDLLRDGC	EPS C-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	1.4E-02	1.8E+00
7	EPSDLLRDGD	EPS D-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	1.1E-02	1.7E+00
8	EFWPTAD001D	EFS-RPP-001D (D-EFW PUMP) FAIL TO START	6.5E-03	1.1E-02	2.6E+00
9	EPSDLADDGP2	EPS B-AAC GTG FAIL TO START	4.7E-03	8.4E-03	2.7E+00
10	EPSDLADDGP1	EPS A-AAC GTG FAIL TO START	4.7E-03	7.2E-03	2.5E+00

Table19.1-51 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	2.8E-03	2.8E+04
2	RWSXVEL024	RWS-VLV-024 EXTERNAL LEAK LARGE	7.2E-08	1.4E-04	2.0E+03
3	RWSXVEL001	RWS-VLV-001 EXTERNAL LEAK LARGE	7.2E-08	1.4E-04	2.0E+03
4	RWSCVEL023	RWS-VLV-023 EXTERNAL LEAK LARGE	4.8E-08	9.6E-05	2.0E+03
5	RWSMVEL002	RWS-MOV-002 EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03
6	RWSPNELPIPE2	RWS PIPING BETWEEN RWSP AND RWS-VLV-002 EXTERNAL LEAK LARGE	6.0E-10	1.2E-06	2.0E+03
7	RWSPNELPIPE1	RWS PIPING BETWEEN RWSP AND RWS-VLV-023 EXTERNAL LEAK LARGE	6.0E-10	1.2E-06	2.0E+03
8	RWSTNEL001	RWS-CPT-001 (RWSP) EXTERNAL LEAK LARGE	4.8E-08	9.5E-05	2.0E+03
9	HPIMVEL001A	SIS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03
10	HPIMVEL001D	SIS-MOV-001D EXTERNAL LEAK LARGE	2.4E-08	4.8E-05	2.0E+03

Table19.1-52 Dominant Plant Damage States of LRF

No	PDS	Conditional Containment Failure Probability for each PDS	Frequency	Percentage Contribution	Cumulative Percentage
1	4K	1.0E+00	2.2E-08	22.7%	22.7%
2	1D	1.0E+00	1.2E-08	11.7%	34.4%
3	3D	1.0E+00	1.1E-08	11.2%	45.7%
4	4L	1.0E+00	1.0E-08	10.3%	55.9%
5	4D	1.0E+00	9.5E-09	9.6%	65.6%
6	3A	1.2E-02	6.4E-09	6.5%	72.1%
7	4H	1.0E+00	5.8E-09	5.9%	77.9%
8	3H	1.0E+00	3.3E-09	3.3%	81.3%
9	6H	1.0E+00	3.1E-09	3.1%	84.4%
10	8A	6.7E-01	2.8E-09	2.8%	87.2%
11	2I	1.0E+00	2.8E-09	2.8%	90.0%
12	1K	1.0E+00	2.1E-09	2.2%	92.1%
13	6D	1.0E+00	2.1E-09	2.1%	94.3%
14	1H	1.0E+00	1.1E-09	1.2%	95.4%
15	5E	1.3E-02	9.6E-10	1.0%	96.4%
Total LRF			9.9E-08		

Table19.1- 53 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 two types, Parametric (P) or Modeling (M).				

Table19.1- 54 HCLPF Values of Structures and Categories of Components (Sheet 1 of 6)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Building / Structure			
Reactor Building	Structural Failure	1.50	3
Safety Power Source Buildings	Structural Failure	1.35	3
Containment	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

Table19.1- 54 HCLPF Values of Structures and Categories of Components (Sheet 2 of 6)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Mechanical Equipment (continue)			
Component Cooling Water System Piping	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 Piping	Structural Failure	0.80	1
Containment Spray Nozzles	Structural Failure	0.80	1
Pumps and Electric motor			
High Head Injection Pumps	Functional Failure	0.62	1
High Head Injection Pumps	Structural Failure	0.62	1
CS/RHR Pumps	Functional Failure	0.62	1
CS/RHR Pumps	Structural Failure	0.62	1
Motor Driven EFW Pumps	Functional Failure	0.62	1
Component Cooling Water Pumps	Structural/ Functional Failure	0.62	1
Essential Service Water Pumps	Structural/ Functional Failure	0.62	1
HVAC Chiller Pumps	Functional Failure	0.62	1
Turbine Driven EFW Pumps	Functional Failure	0.75	1
M/D EFW Pumps Areas Ventilation Fans	Functional Failure	0.67	1
HVAC Chillers	Functional Failure	0.50	2
HVAC Chillers	Structural Failure	0.50	2

Table19.1- 54 HCLPF Values of Structures and Categories of Components (Sheet 3 of 6)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Motor-Operated Valve			
CCW CS/RHR heat exchanger outlet valves	Functional Failure	0.80	1
Containment Spray Header Containment Isolation Valves	Functional Failure	0.80	1
EFW Isolation Valves	Functional Failure	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 Failure	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 Failure	0.80	1
Refueling water Auxiliary Tank Lines Isolation Valve	Functional Failure	0.80	1
Electrical Equipment			
Ceramic Insulators (Offsite Power System)	Functional Failure	0.08	1
Emergency Gas Turbine Generators	Functional Failure	0.50	2
Batteries and Racks	Functional Failure	1.13	1
6.9kV/480V Safety Power Transformers	Functional Failure	0.72	1
Instrument Power Backup Panels (Transformer)	Functional Failure	0.72	1
Metal Crud Switchgears	Functional Failure	0.96	1
Power Centers	Functional Failure	0.96	1
Motor Control Centers	Functional Failure	0.96	1

Table19.1- 54 HCLPF Values of Structures and Categories of Components (Sheet 4 of 6)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Electrical Equipment (continue)			
Gas Turbine Generators Control Panels	Functional Failure	1.13	1
Gas Turbine Generators Control Centers	Functional Failure	1.13	1
DC Power Contorol Centers	Functional Failure	1.13	1
Solenoid Power Distribution Panels	Functional Failure	1.13	1
Safety Logic Cabinets	Functional Failure	1.13	1
Reactor Protection Cabinets	Functional Failure	1.13	1
Engineered Safety Features Acution Cabinets	Functional Failure	1.13	1
Safety Remote I/O Panels	Functional Failure	1.13	1
EFW Pumps Outlet Flow Control Valves Panels	Functional Failure	1.13	1
HVAC Chiller Panels	Functional Failure	1.13	1
Battery Charger Panels	Functional Failure	0.75	1
Inverters (Instrument Power Panels)	Functional Failure	0.75	1
Instrument Power Distribution Panels	Functional Failure	0.75	1
Emergency Feedwater Pump Actuation Cabinets	Functional Failure	1.13	1
Safety and Check Valves			
Pressurizer Safety Valves	Functional Failure	0.80	1
HHI Pump outlet Check Valves	Functional Failure	0.80	1
RV/Hotleg Injection Line Check Valves	Functional Failure	0.80	1
RV Injection Line First Check Valves	Functional Failure	0.80	1
RV Injection Line Second Check Valves	Functional Failure	0.80	1
Accumulators Check Valves	Functional Failure	0.80	1

Table19.1- 54 HCLPF Values of Structures and Categories of Components (Sheet 5 of 6)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
Safety and Check Valves (continue)			
Accumulators Check Valves	Functional Failure	0.80	1
CS/RHR Pumps Suction side Line Check Valves	Functional Failure	0.80	1
Containment Spray Line Check Valves	Functional Failure	0.80	1
EFW Isolation Check Valves	Functional Failure	0.80	1
EFW Pit outlet Check Valves	Functional Failure	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 Failure	0.80	1
CCW Pump outlet Check Valves	Functional Failure	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 Failure	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 Valve	Functional Failure	0.80	1
Instrument Air Pipe Line CV Isolation Valve	Functional Failure	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

Table19.1- 54 HCLPF Values of Structures and Categories of Components (Sheet 6 of 6)

EQUIPMENT NAME	FAILURE MODE	HCLPF (g:PGA)	basis
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 Failure	0.62	1
Spent Fuel Pit Water Cooling System Piping	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)

Table19.1-55 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

Table19.1-55 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-RSSRISFRHEXABCD	1.7	0.46	0.58	SE_CCW
Component cooling heat exchangers	Structural Failure	SE-CWSRISFCCWHXABCD	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

Table19.1-55 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

Table19.1-55 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-RSSPMSFCSPABC D	1.8	0.46	0.62	SE_CCW

Table19.1-55 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

Table19.1-55 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

Table19.1-55 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)

Table19.1-55 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)

Table19.1-55 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

Table19.1-55 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

Table19.1-55 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

Table19.1-55 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- 56 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**

Table19.1-57 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- 58 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- 58 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	

Table19.1-59 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 19.1-60 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	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			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	4.1E-07	33.8	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			EPSCF4CBTD6H-ALL	6.9KV AC BUS INCOMER CIRCUIT BREAKER (6HA,B,C,D) FAIL TO OPEN CCF
			RCP----SEAL	RCP SEAL LOCA
3	8.9E-08	7.4	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			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
4	6.6E-08	5.5	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			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)
			RCP----SEAL	RCP SEAL LOCA
5	2.9E-08	2.4	YARD-B29	IGNITION SOURCE-YARD TRANSFORMERS (OTHERS)
			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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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	IGNITION SOURCE−TRANSIENT COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			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)
			RCP----SEAL	RCP SEAL LOCA
8	2.2E-09	2.6	FA6-101-04-B37	IGNITION SOURCE-TRANSIENT COMBUSTIBLES COMBUSTIBLE FIRES CAUSED BY WELDING AND CUTTING
			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)
			RCP----SEAL	RCP SEAL LOCA
9	1.0E-09	1.2	FA6-101-04-B36	IGNITION SOURCE−TRANSIENT 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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	IGNITION SOURCE-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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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 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
8	7.9E-10	1.7	FA2-205-B15 PZRMVOD58RA SGNST-ISB	IGNITION SOURCE-ELECTRICAL CABINETS SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPENOF 32) MAIN STEAM LINE ISOLATION VALVE AOV-515B(533B) ISOLATION SIGNAL TRAIN B FAIL
9	7.9E-10	1.7	FA2-205-B15 PZRMVOD58RA SGNST-ISA	IGNITION SOURCE-ELECTRICAL CABINETS SAFETY DEPRESSURIZATION VALVE MOV-117A(58RA) FAIL TO OPENOF 32) MAIN STEAM LINE ISOLATION VALVE AOV-515A(533A) ISOLATION SIGNAL TRAIN A FAIL
10	4.3E-10	0.9	FA2-205-B15 EFWOO01PW2AB EFWTMPAB HPIOO02FWBD-S	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) C-EMERGENCY FEED WATER PUMP(FWP2B) OUTAGE 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRAVCD533D	MAIN STEAM ISOLATION VALVE AOV-515C FAIL TO CLOSED
2	4.3E-09	9.9	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			MSRAVCD533C	A/V 533C FAIL TO CLOSE
3	2.3E-09	5.3	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			SGNST-ISD	MAIN STEAM LINE ISOLATION VALVE AOV-515D(533D) ISOLATION SIGNAL TRAIN D FAIL
4	2.3E-09	5.3	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			HPIOO02FWBD-S	OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
			SGNST-ISC	MAIN STEAM LINE ISOLATION VALVE AOV-515C(533C) ISOLATION SIGNAL TRAIN C FAIL
5	1.5E-09	3.4	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			MSRAVCD533C	A/V 533C FAIL TO CLOSE
			PZRMVOD58RB	SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN
6	1.5E-09	3.4	FA2-202-B15	IGNITION SOURCE-ELECTRICAL CABINETS
			MSRAVCD533D	MAIN STEAM ISOLATION VALVE AOV-515C FAIL TO CLOSED
			PZRMVOD58RB	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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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 EFWOO01PW2AB HPIOO02FWBD-S SWSTMPESWPB	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) ESW PUMP-B OUTAGE
8	1.1E-09	2.5	FA2-202-B15 EFWOO01PW2AB HPIOO02FWBD-S VCWCHBDB	IGNITION SOURCE-ELECTRICAL CABINETS OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) CHILLER FAIL TO START (RUNNING)
9	9.6E-10	2.2	FA2-202-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
10	7.9E-10	1.8	FA2-202-B15 PZRMVOD58RB SGNST-ISC	IGNITION SOURCE-ELECTRICAL CABINETS SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN MAIN STEAM LINE ISOLATION VALVE AOV-515C(533C) ISOLATION SIGNAL TRAIN C FAIL

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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 EFWOO01PW2AB PZRMVOD58RB SWSTMPESWPB	IGNITION SOURCE－DIESEL GENERATORS OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN ESW PUMP-B OUTAGE
7	7.0E-10	1.9	FA3-104-B8 EFWOO01PW2AB HPIOO02FWBD HVAFALRDGFAA	IGNITION SOURCE－DIESEL GENERATORS OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) OPERATOR FAILS BLEED AND FEED OPERATION (HE) B-EMERGENCY FEED WATER PUMP AREA HVAC SYSTEM FAN FAIL TO RUN (STANDBY) (>1H)
8	6.9E-10	1.9	FA3-104-B25 EFWOO01PW2AB HPIOO02FWBD VCWCHBDB	IGNITION SOURCE－TRANSIENT COMBUSTIBLE 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)
9	6.1E-10	1.7	FA3-104-B8 EFWOO01PW2AB PZRMVOD58RB VCWCHBDB	IGNITION SOURCE－DIESEL GENERATORS OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) SAFETY DEPRESSURIZATION VALVE MOV-117B(58RB) FAIL TO OPEN CHILLER FAIL TO START (RUNNING)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-60 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47).

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table19.1- 61 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-62 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-62 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-62 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-63 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-64 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-65 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-66 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-67 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-68 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	VCWCHBDB	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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-69 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

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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	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	9.1E-07	11.6	!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
3	7.6E-07	9.6	!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)

Component identifiers used in this table are specific to PRA. Corresponding components for the identifiers can be identified in US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 EFWOO01PW2AB EFWPTADFWP1A HPIOO02FWBD-S	1.0E+00 2.0E-02 6.6E-03 2.6E-03	PARTIAL LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) A-EMERGENCY FEED WATER PUMP(FWP1A) FAIL TO START OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE)
2	2.7E-07	4.1	!16PLOCW_IF EFWOO01PW2AB HPIOO02FWBD-S OPSLOOP	1.0E+00 2.0E-02 2.6E-03 5.3E-03	PARTIAL LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) OPERATOR FAILS TO OPEN RELIEF VALVES FOR BLEED AND FEED (HE) CONSEQUENTIAL LOOP GIVEN A REACTOR TRIP
3	2.6E-07	3.8	!16PLOCW_IF EFWOO01PW2AB EFWTMTAA HPIOO02FWBD-S	1.0E+00 2.0E-02 5.0E-03 2.6E-03	PARTIAL LOSS OF COMPONENT COOLING WATER OPERATOR FAILS TO OPEN EFW PIT DISCHARGE CROSS TIE-LINE FOR CONTINUOUS SG FEED WATER (HE) A-EMERGENCY FEED WATER PUMP(FWP1A) OUTAGE 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 EFWCF2CVODEFW03-ALL HPIOO02FWBD	1.0E+00 2.4E-06 3.8E-03	LOSS OF FEED WATER FLOW EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN OPERATOR FAILS BLEED AND FEED OPERATION (HE)
2	9.0E-09	3.7	!13TRANS_IF EFWCF2CVODEFW03-ALL HPIOO02FWBD	1.0E+00 2.4E-06 3.8E-03	GENERAL TRANSIENT EFW PIT DISCHARGE LINE C/V VLV-008A,B(EFW03A,B) FAIL TO OPEN OPERATOR FAILS BLEED AND FEED OPERATION (HE)
3	6.3E-09	2.6	!13TRANS_IF EFWCF4CVODXW1-ALL HPIOO02FWBD	1.0E+00 1.7E-06 3.8E-03	GENERAL TRANSIENT EFW PUMP DISCHARGE LINE C/V VLV-012A,B,C,D(TW1A,B,MW1A,B) FAIL TO OPEN CCF 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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)
			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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-70 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-71 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-71 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-71 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-71 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-71 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-72 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-73 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-74 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-75 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-76 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-77 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-78 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 US-APWR PRA report (Reference 19.1-47)

Table 19.1-79 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 open 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 19.1-80 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 open 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 19.1-81 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 19.1-81 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 19.1-82 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 19.1-83 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 Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A Class 1E 480V motor control center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E 480V motor control center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E 480V motor control center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E 480V motor control center bus	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 Class 1E gas turbine generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E gas turbine generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E gas turbine generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E gas turbine 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 19.1-84 Status of RCS penetrations

Item	POS 3	POS 4-1	POS 4-2	POS 4-3	POS 8-1	POS 8-2	POS 8-3	POS 9	POS 11
Pressurizer safety valve	Installed	Installed	Removed	Removed	Removed	Removed	Installed	Installed	Installed
Pressurizer manhole	Close	Close	Close	Open	Open	Close	Close	Close	Close
Pressurizer spray vent line	Close	Open	Open	Open	Open	Open	Open	Close	Close
SG manhole	Close	Close	Open	Open	Open	Open	Close	Close	Close
RV upper plenum	Close	Close	Close	Close	Close	Close	Close	Close	Close
SG nozzle lid	Open	Open	Open	Close	Close	Open	Open	Open	Open
Status of RCS penetrations	Close	Vented	Open	Open	Open	Open	Vented	Close	Close
GI	Not available	Not available	Available	Not available	Not available	Available	Not available	Not available	Not available
SG	Available	Available*	Not available	Not available	Not available	Not available	Available*	Available	Available

(*) It is necessary for the operators to close the pressurizer spray vent line in order to make heat removal by SGs available.

Table 19.1-85 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 1	Charging pumps 1 of 1
	Pump A: standby Pump B: outage	Pump A: standby Pump B: outage Needs RWSAT makeup
Mission time	24 hours	24 hours
Operator actions	Manual starting of Charging pump.	Manual starting of Charging pump. RWSAT makeup

Table 19.1-85 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 19.1-85 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 19.1-85 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

Table19.1-86 Summary of Front-line System Failure Probabilities for LPSD PRA

Fault Tree Name	Fault Tree Description	Fault Tree Probability
Injection by CVCS using alternate component cooling (SC)		
ACW-00	FAILURE OF INJECTION BY CHARGING PUMP USING ALTERNATE COMPONENT COOLING SYSTEM (LOCS)	2.9E-02
ACW-00LOOP	FAILURE OF INJECTION BY CHARGING PUMP USING ALTERNATE COMPONENT COOLING SYSTEM (LOOP)	3.2E-02
Charging injection system (MC,CV)		
CHI-00-A	FAILURE OF RCS MAKEUP BY CHARGING PUMP (LOCA, OVDR)	5.5E-03
CHI-00-B	FAILURE OF INJECTION BY CHARGING PUMP (LOCA, OVDR)	2.5E-02
CHI-00-C	FAILURE OF INJECTION BY CHARGING PUMP (LOCA, OVDR, LORH)	2.4E-02
CHI-00-D	FAILURE OF INJECTION BY CHARGING PUMP (LOOP)	2.7E-02
High head injection system (SI)		
HPI2	FAILURE OF INJECTION BY SAFETY INJECTION PUMP (LOCA,OVDR,FLML,LORH)	5.1E-03
HPI2-LOOP	FAILURE OF INJECTION BY SAFETY INJECTION PUMP (LOOP)	5.4E-03
Isolation of CS/RHR hot leg suction valves (LOA)		
LOA	FAILURE OF MANUAL ISOLATION OF THE LEAKAGE TRAIN OF RHR SYSTEM	2.6E-03
Isolation of low pressure letdown line (LOB)		
LOB	FAILURE OF MANUAL ISOLATION OF LOW-PRESSURE LETDOWN LINE (OVDR, FLML)	5.0E-03
Power supply by Class 1E GTG A,B,C		
MGT	FAILURE OF POWER SUPPLY BY CLASS 1E GTG A,B,C	1.8E-03
CCW/essential service water Restart (PR)		
PRS-00	FAILURE OF CCW/ESW PUMP RESTART	1.1E-04
Containment spray system/residual heat removal system (RH)		
RSS2	FAILURE OF HEAT REMOVAL BY STANDBY CS/RHR PUMPS (LOCA,OVDR, FLML)	1.3E-02
RSS6-00	FAILURE OF HEAT REMOVAL BY CS/RHR PUMPS (LOOP)	2.7E-03
Power supply by AAC GTG		
SGT	FAILURE OF POWER SUPPLY BY AAC GTG	5.4E-02

Table19.1-87 Summary of Support System Failure Probabilities for LPSD PRA (Sheet 1 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
Class 1E 480V load center bus		
EPS-480A	EPS A CLASS 1E 480V LOAD CENTER BUS FAILURE	2.8E-05
EPS-480A(LOOP)	EPS A CLASS 1E 480V LOAD CENTER BUS FAILURE (LOOP)	2.5E-03
EPS-480B	EPS B CLASS 1E 480V LOAD CENTER BUS FAILURE	4.4E-05
EPS-480B(LOOP)	EPS B CLASS 1E 480V LOAD CENTER BUS FAILURE (LOOP)	3.2E-02
EPS-480C	EPS C CLASS 1E 480V LOAD CENTER BUS FAILURE	4.4E-05
EPS-480C(LOOP)	EPS C CLASS 1E 480V LOAD CENTER BUS FAILURE (LOOP)	3.2E-02
EPS-480D	EPS D CLASS 1E 480V LOAD CENTER BUS FAILURE	5.5E-05
EPS-480D(LOOP)	EPS D CLASS 1E 480V LOAD CENTER BUS FAILURE (LOOP)	5.4E-02
Class 1E 6.9kV bus		
EPS-69KA	EPS A CLASS 1E 6.9KV BUS FAILURE	7.1E-06
EPS-69KA(LOOP)	EPS A CLASS 1E 6.9KV BUS FAILURE (LOOP)	2.4E-03
EPS-69KB	EPS B CLASS 1E 6.9KV BUS FAILURE	2.3E-05
EPS-69KB(LOOP)	EPS B CLASS 1E 6.9KV BUS FAILURE (LOOP)	3.2E-02
EPS-69KC	EPS C CLASS 1E 6.9KV BUS FAILURE	2.3E-05
EPS-69KC(LOOP)	r	3.2E-02
EPS-69KD	EPS D CLASS 1E 6.9KV BUS FAILURE	3.5E-05
EPS-69KD(LOOP)	EPS D CLASS 1E 6.9KV BUS FAILURE (LOOP)	5.4E-02
Class 1E 480V MCC bus		
EPS-MCA	EPS A CLASS 1E 480V MCC BUS FAILURE	3.7E-05
EPS-MCA(LOOP)	EPS A CLASS 1E 480V MCC BUS FAILURE (LOOP)	2.5E-03
EPS-MCA1	EPS A1 CLASS 1E 480V MCC BUS FAILURE	4.9E-05
EPS-MCA1(LOOP)	EPS A1 CLASS 1E 480V MCC BUS FAILURE (LOOP)	2.5E-03
EPS-MCB	EPS B CLASS 1E 480V MCC BUS FAILURE	5.3E-05
EPS-MCB(LOOP)	EPS B CLASS 1E 480V MCC BUS FAILURE (LOOP)	3.2E-02
EPS-MCC	EPS C CLASS 1E 480V MCC BUS FAILURE	5.3E-05
EPS-MCC(LOOP)	EPS C CLASS 1E 480V MCC BUS FAILURE (LOOP)	3.2E-02

Table19.1-87 Summary of Support System Failure Probabilities for LPSD PRA (Sheet 2 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
EPS-MCD	EPS D CLASS 1E 480V MCC BUS FAILURE	6.4E-05
EPS-MCD(LOOP)	EPS D CLASS 1E 480V MCC BUS FAILURE (LOOP)	5.4E-02
EPS-MCD1	EPS D1 CLASS 1E 480V MCC BUS FAILURE	7.7E-05
EPS-MCD1(LOOP)	EPS D1 CLASS 1E 480V MCC BUS FAILURE (LOOP)	5.4E-02
Class 1E 125V dc bus		
EPS-SBA	EPS A DC SWITCHBOARD BUS FAILURE	5.8E-06
EPS-SBA(LOOP)	EPS A DC SWITCHBOARD BUS FAILURE (LOOP)	6.2E-06
EPS-SBB	EPS B DC SWITCHBOARD BUS FAILURE	5.8E-06
EPS-SBB(LOOP)	EPS B DC SWITCHBOARD BUS FAILURE (LOOP)	1.3E-05
EPS-SBC	EPS C DC SWITCHBOARD BUS FAILURE	5.8E-06
EPS-SBC(LOOP)	EPS C DC SWITCHBOARD BUS FAILURE (LOOP)	1.3E-05
EPS-SBD	EPS D DC SWITCHBOARD BUS FAILURE	5.8E-06
EPS-SBD(LOOP)	EPS D DC SWITCHBOARD BUS FAILURE (LOOP)	6.2E-06
120V ac vital bus		
EPS-VITALA	EPS A I&C PANELBOARD BUS FAILURE	5.8E-06
EPS-VITALA(LOOP)	EPS A I&C PANELBOARD BUS FAILURE (LOOP)	1.3E-05
EPS-VITALB	EPS B I&C PANELBOARD BUS FAILURE	5.8E-06
EPS-VITALB(LOOP)	EPS B I&C PANELBOARD BUS FAILURE (LOOP)	1.5E-04
EPS-VITALC	EPS C I&C PANELBOARD BUS FAILURE	5.8E-06
EPS-VITALC(LOOP)	EPS C I&C PANELBOARD BUS FAILURE (LOOP)	1.5E-04
EPS-VITALD	EPS D I&C PANELBOARD BUS FAILURE	5.8E-06
EPS-VITALD(LOOP)	EPS D I&C PANELBOARD BUS FAILURE (LOOP)	1.3E-05
Component cooling water system		
CWS-CCA12	LOSS OF FUNCTION CCWS-A1 HEADER (Except LOOP)	3.7E-05
CWS-CCA12-LOOP	LOSS OF FUNCTION CCWS-A1 HEADER (LOOP)	2.8E-04
CWS-CCA2	LOSS OF FUNCTION CCWS-A HEADER (Except LOOP)	3.2E-05
CWS-CCA2-LOOP	LOSS OF FUNCTION CCWS-A HEADER (LOOP)	2.8E-04

Table19.1-87 Summary of Support System Failure Probabilities for LPSD PRA (Sheet 3 of 3)

Fault Tree Name	Fault Tree Description	Fault Tree Probability
CWS-CCB2	LOSS OF FUNCTION CCWS-B HEADER (Except LOOP)	3.2E-05
CWS-CCB2-LOOP	LOSS OF FUNCTION CCWS-B HEADER (LOOP)	2.8E-04
CWS-CCC12	LOSS OF FUNCTION CCWS-C1 TRAIN (Except LOOP)	5.9E-04
CWS-CCC12-LOOP	LOSS OF FUNCTION CCWS-C1 TRAIN (LOOP)	3.3E-02
CWS-CCC2	LOSS OF FUNCTION CCWS-C TRAIN (Except LOOP)	5.7E-04
CWS-CCC2-LOOP	LOSS OF FUNCTION CCWS-C TRAIN (LOOP)	3.3E-02
CWS-CCB2	LOSS OF FUNCTION CCWS-B HEADER (Except LOOP)	3.2E-05
CWS-CCB2-LOOP	LOSS OF FUNCTION CCWS-B HEADER (LOOP)	2.8E-04
CWS-CCC12	LOSS OF FUNCTION CCWS-C1 TRAIN (Except LOOP)	5.9E-04
CWS-CCC12-LOOP	LOSS OF FUNCTION CCWS-C1 TRAIN (LOOP)	3.3E-02
CWS-CCC2	LOSS OF FUNCTION CCWS-C TRAIN (Except LOOP)	5.7E-04
CWS-CCC2-LOOP	LOSS OF FUNCTION CCWS-C TRAIN (LOOP)	3.3E-02
Essential service water system		
SWS-SWCA3	EWS TRAIN A FAILURE (Except LOOP)	4.2E-04
SWS-SWCA3-LOOP	EWS TRAIN A FAILURE (LOOP)	2.9E-03
SWS-SWCB3	EWS TRAIN B FAILURE (Except LOOP)	4.4E-04
SWS-SWCB3-LOOP	EWS TRAIN B FAILURE (LOOP)	3.3E-02
SWS-SWCC3	EWS TRAIN C FAILURE (Except LOOP)	4.4E-04
SWS-SWCC3-LOOP	EWS TRAIN C FAILURE (LOOP)	3.3E-02

Table19.1-88 Frequency of Initiating Events for LPSD PRA

IE	Event description	IE_{POS3}	IE_{POS4-1}	IE_{POS4-2}	IE_{POS4-3}	IE_{POS8-1}	IE_{POS8-2}	IE_{POS8-3}	IE_{POS9}	IE_{POS11}	Reference
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	3.7E-06	N/A	N/A	3.7E-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	5.7E-07	5.7E-07	N/A	5.7E-07	5.7E-07	N/A	N/A	Fault tree analysis
LORH	Loss of RHRS caused by other failures	3.0E-07	8.9E-06	1.6E-06	7.9E-07	9.5E-06	1.6E-06	1.4E-06	1.3E-06	5.7E-06	Fault tree analysis
LOCS	Loss of CCW/ESW	9.8E-09	3.1E-08	9.6E-09	4.8E-09	2.6E-07	2.0E-08	1.8E-08	1.6E-08	1.9E-07	Fault tree analysis
LOOP	Loss of offsite power	2.6E-05	4.4E-04	1.3E-04	6.7E-05	6.2E-04	1.3E-04	1.2E-04	1.1E-04	4.9E-04	NUREG/CR-6890

N/A not applicable

Table19.1-89 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
LOCA	Loss of coolant accident	1.2E-08	1.2E-08	1.1E-08	2.2E-08	2.2E-08	1.1E-08	1.2E-08	1.2E-08	1.2E-08	1.3E-07
OVDR	Loss of RHRS due to over-drain	N/A	1.1E-09	N/A	N/A	1.8E-09	N/A	N/A	N/A	N/A	2.9E-09
FLML	Loss of RHRS caused by failing to maintain water level	N/A	N/A	3.2E-10	3.0E-09	N/A	3.2E-10	4.4E-10	N/A	N/A	4.1E-09
LORH	Loss of RHRS caused by other failures	2.2E-11	6.7E-10	2.9E-10	2.9E-10	3.5E-09	2.9E-10	1.1E-10	9.8E-11	4.3E-10	5.8E-09
LOCS	Loss of CCW/essential service water	2.9E-10	9.0E-10	5.6E-11	1.4E-10	7.5E-09	1.1E-10	5.2E-10	4.8E-10	5.5E-09	1.5E-08
LOOP	Loss of offsite power	9.1E-10	1.0E-08	6.4E-09	4.3E-09	2.5E-08	3.8E-09	2.5E-09	2.2E-09	9.6E-09	6.5E-08
TOTAL		1.4E-08	2.5E-08	1.8E-08	3.0E-08	6.0E-08	1.6E-08	1.6E-08	1.5E-08	2.8E-08	2.2E-07

N/A: not applicable

1: POS which carried out detailed quantitative evaluation

2: POS which carried out simple evaluation

Table19.1-90 Dominant Sequences of POS 8-1 for LPSD PRA

Number	Sequence ID	Sequence Name	Sequence Frequency (/ry)	Percent Contrib.	Percent Contrib.Total
1	05 LOOP-0006	05 LOOP-RHB-SG-SIB-CVB-GI	1.6E-08	27.3%	27.3%
2	01 LOCA-0011	01 LOCA-MC1-SG-SIA1-CVA1-GI	1.6E-08	27.1%	54.4%
3	04 LOCS-0003	04 LOCS-GI-SC1	7.5E-09	12.4%	66.8%
4	05 LOOP-0037	05 LOOP-GT-SP-AC	5.7E-09	9.5%	76.4%
5	01 LOCA-0006	01 LOCA-RHA-SG-SIA1-CVA1-GI	3.6E-09	6.1%	82.4%
6	03 LORH-0005	03 LORH-SG-SIA3-CVA3-GI	3.6E-09	5.9%	88.3%
7	01 LOCA-0015	01 LOCA-LOA-SIA1-CVA1-GI	2.4E-09	3.9%	92.3%
8	05 LOOP-0009	05 LOOP-PR-GI-SC2	1.9E-09	3.1%	95.4%
9	02 OVDR-0011	02 OVDR-MC1-SG-SIA2-CVA2-GI	1.4E-09	2.2%	97.6%
10	05 LOOP-0015	05 LOOP-GT-RHB-SG-SIB-CVB-GI	4.4E-10	0.7%	98.4%
11	02 OVDR-0015	02 OVDR-LOB-SIA2-CVA2-GI	3.3E-10	0.5%	98.9%
12	05 LOOP-0036	05 LOOP-GT-SP-PR-GI-SC2	3.1E-10	0.5%	99.4%
13	02 OVDR-0006	02 OVDR-RHA-SG-SIA2-CVA2-GI	1.3E-10	0.2%	99.7%
14	05 LOOP-0024	05 LOOP-GT-AC-RHB-SG-SIB-CVB-GI	9.3E-11	0.2%	99.8%
15	05 LOOP-0033	05 LOOP-GT-SP-RHB-SG-SIB-CVB-GI	8.3E-11	0.1%	99.9%
16	05 LOOP-0018	05 LOOP-GT-PR-GI-SC2	2.1E-11	0.0%	100.0%
17	05 LOOP-0027	05 LOOP-GT-AC-PR-GI-SC2	1.0E-11	0.0%	100.0%
TOTAL =			6.0E-08	100.0%	

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 1 of 16)

No.	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
1	1.4E-08	23.1	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CHIOO02P	2.6E-03	OPERATOR FAILS TO START STANDBY CHARGING PUMP
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
2	1.4E-08	22.8	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			CHIOO02P+RWS-DP3	1.6E-01	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			RSSOO02P	2.6E-03	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
3	5.7E-09	9.5	SDLOCS	2.6E-07	LOSS OF CCW/ESW
			ACWOO02SC	2.2E-02	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 2 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
4	3.3E-09	5.4	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CHIOO02RWS-DP3	1.6E-01	OPERATOR FAILS TO REFILL RWSAT WATER FROM RWSP
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			RSSOO02LINE+P	3.8E-03	OPERATOR FAILS TO ESTABLISH RHR INJECTION LINE AND START STANBY PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
5	3.2E-09	5.3	SDLORH	9.5E-06	LOSS OF RHR CAUSED BY OTHER FAILURES
			CHIOO02P+RWS-DP2	6.8E-02	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S	4.9E-03	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 3 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
6	2.2E-09	3.7	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CHIOO02P+RWS-DP3	1.6E-01	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			LOAOO02LC	2.6E-03	OPERATOR FAILS TO ISOLATE THE LEAKAGE TRAIN OF RHR SYSTEM
7	1.3E-09	2.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLLRDG-ALL	1.1E-03	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	2.1E-02	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
8	1.1E-09	1.8	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLLRDG-ALL	1.1E-03	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSDLLRDGP1	1.8E-02	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 4 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
9	9.8E-10	1.6	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CHIPMBD001A	2.0E-03	CVS-RPP-001A (A-CHI PUMP) FAIL TO START
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S	4.9E-03	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
10	8.2E-10	1.4	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			ACWOO02SC	2.2E-02	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM
			ESWCF3PMBD001ABC-ALL	6.0E-05	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RE-START (CCF)
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
11	7.2E-10	1.2	SDOVDR	1.5E-03	LOSS OF RHR DUE TO OVER DRAIN
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S	4.9E-03	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
			SGNBTSWCCF1	1.0E-04	PCMS APPLICATION SOFTWARE GROUP1 FAILURE CCF

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 5 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
12	4.5E-10	0.8	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			ACWOO02SC	2.2E-02	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM
			CWSCF3PCBD001ABC-ALL	3.3E-05	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RE-START (CCF)
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
13	3.9E-10	0.6	SDLOCS	2.6E-07	LOSS OF CCW/ESW
			CHIPMAD001A-R	1.5E-03	CVS-RPP-001A (A-CHI PUMP) FAIL TO RE-START
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
14	3.3E-10	0.6	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-S	9.1E-01	SUCCESS OF OFFSITE POWER RECOVERY
			CHIOO01RECOV	5.8E-02	OPERATOR FAILS TO START CHARGING PUMP AND SAFETY INJECTION PUMP - LOCAL ACTION
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
			SGNBTSWCCF	1.0E-05	PSMS APPLICATION SOFTWARE FAILURE CCF
15	2.8E-10	0.5	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLLRDG-ALL	1.1E-03	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSDLADDGP1	4.7E-03	EPS A-AAC GTG FAIL TO START

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 6 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
16	2.8E-10	0.5	SDLOOP AC2-F EPSCBFO52UAT-ABC	6.2E-04 8.6E-02 5.2E-06	LOSS OF OFFSITE POWER FAILURE OF OFFSITE POWER RECOVERY EPS 52/UATA,B,C (BREAKER) FAIL TO OPEN (CCF)
17	2.8E-10	0.5	SDLOOP AC2-F EPSCBFO52RAT-ABC	6.2E-04 8.6E-02 5.2E-06	LOSS OF OFFSITE POWER FAILURE OF OFFSITE POWER RECOVERY EPS 52/RATA,B,C (BREAKER) FAIL TO OPEN (CCF)
18	2.7E-10	0.4	SDLOOP AC2-F EPSCF3DLADDG-ALL EPSOO02RDG	6.2E-04 8.6E-02 2.4E-04 2.1E-02	LOSS OF OFFSITE POWER FAILURE OF OFFSITE POWER RECOVERY EPS CLASS 1E GTG A,B,C FAIL TO START (CCF) OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
19	2.6E-10	0.4	SDLOCS ACWMVCD316A GI	2.6E-07 1.0E-03 1.0E+00	LOSS OF CCW/ESW NCS-MOV-316A FAIL TO CLOSE GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
20	2.6E-10	0.4	SDLOCS ACWMVOD322A GI	2.6E-07 1.0E-03 1.0E+00	LOSS OF CCW/ESW NCS-MOV-322A FAIL TO OPEN GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
21	2.6E-10	0.4	SDLOCS ACWMVOD321A GI	2.6E-07 1.0E-03 1.0E+00	LOSS OF CCW/ESW NCS-MOV-321A FAIL TO OPEN GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 7 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
22	2.6E-10	0.4	SDLOCS ACWMVOD325A GI	2.6E-07 1.0E-03 1.0E+00	LOSS OF CCW/ESW NCS-MOV-325A FAIL TO OPEN GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
23	2.6E-10	0.4	SDLOCS ACWMVOD324A GI	2.6E-07 1.0E-03 1.0E+00	LOSS OF CCW/ESW NCS-MOV-324A FAIL TO OPEN GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
24	2.5E-10	0.4	SDOVDR CHIOO02P CVCAVCD024C GI HPIOO02S-DP2 SG	1.5E-03 2.6E-03 1.2E-03 1.0E+00 5.5E-02 1.0E+00	LOSS OF RHR DUE TO OVER DRAIN OPERATOR FAILS TO START STANDBY CHARGING PUMP RHS-AOV-024C FAIL TO CLOSE GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 8 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
25	2.5E-10	0.4	SDOVDR	1.5E-03	LOSS OF RHR DUE TO OVER DRAIN
			CHIOO02P	2.6E-03	OPERATOR FAILS TO START STANDBY CHARGING PUMP
			CVCAVCD024B	1.2E-03	RHS-AOV-024B FAIL TO CLOSE
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
26	2.2E-10	0.4	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLADDG-ALL	2.4E-04	EPS CLASS 1E GTG A,B,C FAIL TO START (CCF)
			EPSDLLRDGP1	1.8E-02	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
27	2.0E-10	0.3	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLSRDG-ALL	1.8E-04	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)
			EPSOO02RDG	2.1E-02	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 9 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
28	1.7E-10	0.3	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			CHIPMBD001A	2.0E-03	CVS-RPP-001A (A-CHI PUMP) FAIL TO START
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			RSSOO02P	2.6E-03	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
29	1.7E-10	0.3	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLLRDG-ALL	1.1E-03	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSSEFFDGP1	2.9E-03	EPS A-AAC GTG SEQUENCER FAIL TO OPERATE
30	1.7E-10	0.3	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLLRDG-ALL	1.1E-03	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSDLSRDGP1	2.8E-03	EPS A-AAC GTG FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 10 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
31	1.7E-10	0.3	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLSRDG-ALL	1.8E-04	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)
			EPSDLLRDGP1	1.8E-02	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
32	1.5E-10	0.3	SDOVDR	1.5E-03	LOSS OF RHR DUE TO OVER DRAIN
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			RTPBTSWCCF	1.0E-07	BASIC SOFTWARE FAILURE CCF
33	1.2E-10	0.2	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-S	9.1E-01	SUCCESS OF OFFSITE POWER RECOVERY
			EPSOO02RDG	2.1E-02	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SGNBTSWCCF	1.0E-05	PSMS APPLICATION SOFTWARE FAILURE CCF
34	1.1E-10	0.2	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CWSPNELCCWB	1.1E-06	NCS CWS TRAIN B PIPING EXTERNAL LEAK LARGE
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 11 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
35	1.0E-10	0.2	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-S	9.1E-01	SUCCESS OF OFFSITE POWER RECOVERY
			EPSDLLRDGP1	1.8E-02	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SGNBTSWCCF	1.0E-05	PSMS APPLICATION SOFTWARE FAILURE CCF
36	9.3E-11	0.2	SDLORH	9.5E-06	LOSS OF RHR CAUSED BY OTHER FAILURES
			CHIPMBD001A	2.0E-03	CVS-RPP-001A (A-CHI PUMP) FAIL TO START
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S	4.9E-03	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
37	8.8E-11	0.2	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF2DLLRDGP-ALL	1.5E-03	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)
			EPSCF3DLLRDG-ALL	1.1E-03	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 12 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
38	8.8E-11	0.2	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CWSPNELCCWA	8.8E-07	NCS CWS TRAIN A PIPING EXTERNAL LEAK LARGE
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
39	8.5E-11	0.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3SEFFDG-ALL	7.5E-05	EPS CLASS 1E GTG A,B,C SEQUENCER FAIL TO OPERATE (CCF)
			EPSOO02RDG	2.1E-02	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
40	8.2E-11	0.1	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CWSPNELCCWA1	8.2E-07	NCS CWS A1-HEADER LINE PIPING EXTERNAL LEAK LARGE
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 13 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
41	7.5E-11	0.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
			SWSCF3PMYR001ABC-ALL	1.2E-07	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RUN (CCF)
42	7.3E-11	0.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3DLLRDG-ALL	1.1E-03	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)
			SGNST-BOP1	1.2E-03	BO-SIGNAL (TRAIN P1) FAILURE
43	7.2E-11	0.1	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CWSRIEL001A1	7.2E-07	NCS-RHX-001A (A-CCW HX) TUBE EXTERNAL LEAK LARGE
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 14 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
44	7.2E-11	0.1	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CWSRIEL001B1	7.2E-07	NCS-RHX-001B (B-CCW HX) TUBE EXTERNAL LEAK LARGE
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
45	7.1E-11	0.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			AC2-F	8.6E-02	FAILURE OF OFFSITE POWER RECOVERY
			EPSCF3SEFFDG-ALL	7.5E-05	EPS CLASS 1E GTG A,B,C SEQUENCER FAIL TO OPERATE (CCF)
			EPSDLLRDGP1	1.8E-02	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION
46	6.9E-11	0.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			RSSOO02P	2.6E-03	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS
			RWSOO04XV051	8.0E-04	MISALIGNMENT OF RWS-VLV-051 AFTER TEST OR MAINTENANCE
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 15 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
47	6.6E-11	0.1	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CHICF2MVCD121BC-ALL	1.4E-04	CVS-LCV-121B,C FAIL TO CLOSE (CCF)
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S	4.9E-03	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
48	6.5E-11	0.1	SDLOCA	1.0E-04	LOSS OF COOLANT ACCIDENT
			CHIOO02RWS-DP2	6.7E-02	OPERATOR FAILS TO REFILL RWSAT WATER FROM RWSP
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S	4.9E-03	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			RSSPMBD001C	2.0E-03	RHS-RPP-001C (C-CS/RHR PUMP) FAIL TO START
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-91 Dominant Cutsets of POS 8-1 for LPSD PRA (Sheet 16 of 16)

No	Cutsets freq.(/ry)	Percent	Cutsets	Frequency/ probability	Basic Event Description
49	6.1E-11	0.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			RSSOO02P	2.6E-03	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS
			RWSXVOD021	7.0E-04	RWS-VLV-021 FAIL TO OPEN
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG
50	6.1E-11	0.1	SDLOOP	6.2E-04	LOSS OF OFFSITE POWER
			GI	1.0E+00	GUARANTEED FAILURE OF GRAVITATIONAL INJECTION FROM SFP
			HPIOO02S-DP2	5.5E-02	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
			RSSOO02P	2.6E-03	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS
			RWSXVOD052	7.0E-04	RWS-VLV-052 FAIL TO OPEN
			SG	1.0E+00	GUARANTEED FAILURE OF DECAY HEAT REMOVAL BY SG

Table 19.1-92 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 Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E 6.9kV bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E 480V load center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
A Class 1E 480V motor control center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E 480V motor control center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E 480V motor control center bus	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E 480V motor control center bus	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 Class 1E gas turbine generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
B Class 1E gas turbine generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
C Class 1E gas turbine generator	N/A	N/A	△	△	△	△	N/A	N/A	N/A	△	△	△	△	N/A	△	N/A	N/A
D Class 1E gas turbine 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 19.1-93 Basic Events (Hardware Failure, Human Error) FV Importance of POS 8-1 for LPSD PRA (Sheet 1 of 4)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
1	HPIOO02S-DP2	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP	5.5E-02	5.8E-01	1.1E+01
2	CHIOO02P+RWS-DP3	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP	1.6E-01	2.7E-01	2.4E+00
3	RSSOO02P	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS	2.6E-03	2.4E-01	9.7E+01
4	CHIOO02P	OPERATOR FAILS TO START STANDBY CHARGING PUMP	2.6E-03	2.4E-01	9.5E+01
5	ACWOO02SC	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM	2.2E-02	1.2E-01	6.2E+00
6	HPIOO02S	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP	4.9E-03	9.9E-02	2.1E+01
7	AC2-F	FAILURE OF OFFSITE POWER RECOVERY	8.6E-02	9.8E-02	2.0E+00
8	RSSOO02LINE+P	OPERATOR FAILS TO ESTABLISH RHR INJECTION LINE AND START STANBY PUMP	3.8E-03	5.7E-02	1.6E+01
9	CHIOO02RWS-DP3	OPERATOR FAILS TO REFILL RWSAT WATER FROM RWSP	1.6E-01	5.6E-02	1.3E+00
10	EPSCF3DLLRDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-03	5.6E-02	5.1E+01

Table 19.1-93 Basic Events (Hardware Failure, Human Error) FV Importance of POS 8-1 for LPSD PRA (Sheet 2 of 4)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
11	CHIOO02P+RWS-DP2	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP	6.8E-02	5.3E-02	1.7E+00
12	EPSOO02RDG	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	4.2E-02	2.9E+00
13	LOAOO02LC	OPERATOR FAILS TO ISOLATE THE LEAKAGE TRAIN OF RHR SYSTEM	2.6E-03	3.8E-02	1.6E+01
14	EPSDLLRDGP1	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	3.4E-02	2.9E+00
15	CHIPMBD001A	CVS-RPP-001A (A-CHI PUMP) FAIL TO START	2.0E-03	2.3E-02	1.2E+01
16	ESWCF3PMBD001ABC-ALL	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RE-START (CCF)	6.0E-05	2.0E-02	3.3E+02
17	SGNBTSWCCF1	PCMS APPLICATION SOFTWARE GROUP1 FAILURE CCF	1.0E-04	1.5E-02	1.5E+02
18	AC2-S	SUCCESS OF OFFSITE POWER RECOVERY	9.1E-01	1.4E-02	1.0E+00
19	SGNBTSWCCF	PSMS APPLICATION SOFTWARE FAILURE CCF	1.0E-05	1.4E-02	1.4E+03
20	EPSCF3DLADDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO START (CCF)	2.4E-04	1.2E-02	5.1E+01

Table 19.1-93 Basic Events (Hardware Failure, Human Error) FV Importance of POS 8-1 for LPSD PRA (Sheet 3 of 4)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
21	CWSCF3PCBD001ABC-ALL	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RE-START (CCF)	3.3E-05	1.1E-02	3.3E+02
22	EPSDLLRDGB	EPS B-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	1.0E-02	1.6E+00
23	EPSDLADDGP1	EPS A-AAC GTG FAIL TO START	4.7E-03	9.0E-03	2.9E+00
24	EPSCF3DLSRDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)	1.8E-04	8.8E-03	5.1E+01
25	CHIPMAD001A-R	CVS-RPP-001A (A-CHI PUMP) FAIL TO RE-START	1.5E-03	7.9E-03	6.2E+00
26	CHIOO01RECOV	OPERATOR FAILS TO START CHARGING PUMP AND SAFETY INJECTION PUMP - LOCAL ACTION	5.8E-02	7.1E-03	1.1E+00
27	EPSDLLRDGA	EPS A-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	7.0E-03	1.4E+00
28	CVCAVCD024B	RHS-AOV-024B FAIL TO CLOSE	1.2E-03	6.9E-03	6.7E+00
29	CVCAVCD024C	RHS-AOV-024C FAIL TO CLOSE	1.2E-03	6.9E-03	6.7E+00
30	EPSDLLRDGC	EPS C-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	6.2E-03	1.4E+00

Table 19.1-93 Basic Events (Hardware Failure, Human Error) FV Importance of POS 8-1 for LPSD PRA (Sheet 4 of 4)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	FV Importance	RAW
31	EPSSEFFDGP1	EPS A-AAC GTG SEQUENCER FAIL TO OPERATE	2.9E-03	5.5E-03	2.9E+00
32	EPSDLSRDGP1	EPS A-AAC GTG FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION	2.8E-03	5.3E-03	2.9E+00
33	ACWMVOD325A	NCS-MOV-325A FAIL TO OPEN	1.0E-03	5.3E-03	6.2E+00
34	ACWMVOD322A	NCS-MOV-322A FAIL TO OPEN	1.0E-03	5.3E-03	6.2E+00
35	ACWMVCD316A	NCS-MOV-316A FAIL TO CLOSE	1.0E-03	5.3E-03	6.2E+00
36	ACWMVOD324A	NCS-MOV-324A FAIL TO OPEN	1.0E-03	5.3E-03	6.2E+00
37	ACWMVOD321A	NCS-MOV-321A FAIL TO OPEN	1.0E-03	5.3E-03	6.2E+00
38	CHIOO02RWS-DP2	OPERATOR FAILS TO REFILL RWSAT WATER FROM RWSP	6.7E-02	5.1E-03	1.1E+00

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 1 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
1	RTPBTSWCCF	BASIC SOFTWARE FAILURE CCF	1.0E-07	3.7E+04	3.7E-03
2	SWSCF3PMYR001ABC-ALL	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RUN (CCF)	1.2E-07	1.2E+04	1.5E-03
3	CWSCF3PCYR001ABC-ALL	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RUN (CCF)	6.7E-08	1.2E+04	8.2E-04
4	CWSCF3RHPF001ABC-ALL	NCS-RHX-001A,B,C (CCW HX) PLUG / FOUL(CCF)	3.6E-08	1.2E+04	4.4E-04
5	ACWCVEL306A	NCS-VLV-306A EXTERNAL LEAK LARGE	4.8E-08	2.3E+03	1.1E-04
6	ACWMVEL316A	NCS-MOV-316A EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
7	CWSPNELCCWB	NCS CWS TRAIN B PIPING EXTERNAL LEAK LARGE	1.1E-06	2.3E+03	2.5E-03
8	CWSPNELCCWA	NCS CWS TRAIN A PIPING EXTERNAL LEAK LARGE	8.8E-07	2.3E+03	2.0E-03
9	CWSPNELCCWA1	NCS CWS A1-HEADER LINE PIPING EXTERNAL LEAK LARGE	8.2E-07	2.3E+03	1.9E-03
10	CWSRIEL001B1	NCS-RHX-001B (B-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	2.3E+03	1.7E-03

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 2 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
11	CWSRIEL001A1	NCS-RHX-001A (A-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	2.3E+03	1.7E-03
12	CWSPMEL001B	NCS-RPP-001B (B-CCW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.3E+03	4.5E-04
13	CWSPMEL001A	NCS-RPP-001A (A-CCW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.3E+03	4.5E-04
14	HPIXVEL119B	NCS-VLV-119B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
15	HPIXVEL114B	NCS-VLV-114B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
16	HPIXVEL111B	NCS-VLV-111B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
17	HPIXVEL115B	NCS-VLV-115B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
18	HPIXVEL116B	NCS-VLV-116B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
19	CWSXVEL104B	NCS-VLV-104B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
20	CWSXVEL005B	NCS-VLV-005B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 3 of 80)

RANK	Basic Event ID	Basic Event Description	Basic EventProbability	RAW	FV Importance
21	CWSXVEL101B	NCS-VLV-101B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
22	CWSXVEL018B	NCS-VLV-018B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
23	CWSXVEL008B	NCS-VLV-008B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
24	CHIXVEL312A	NCS-VLV-312A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
25	CHIXVEL301A	NCS-VLV-301A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
26	CWSXVEL034A	NCS-VLV-034A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
27	CWSXVEL033A	NCS-VLV-033A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
28	CHIXVEL315A	NCS-VLV-315A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
29	CHIXVEL311A	NCS-VLV-311A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
30	CWSXVEL018A	NCS-VLV-018A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 4 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
31	CWSXVEL101A	NCS-VLV-101A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
32	CWSXVEL005A	NCS-VLV-005A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
33	CWSXVEL008A	NCS-VLV-008A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
34	CWSXVEL104A	NCS-VLV-104A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
35	HPIXVEL119A	NCS-VLV-119A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
36	HPIXVEL116A	NCS-VLV-116A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
37	HPIXVEL114A	NCS-VLV-114A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
38	HPIXVEL111A	NCS-VLV-111A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
39	HPIXVEL115A	NCS-VLV-115A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
40	CWSCVEL016B	NCS-VLV-016B EXTERNAL LEAK LARGE	4.8E-08	2.3E+03	1.1E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 5 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
41	CWSCVEL016A	NCS-VLV-016A EXTERNAL LEAK LARGE	4.8E-08	2.3E+03	1.1E-04
42	CWSMVEL007B	NCS-MOV-007B EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
43	CWSMVEL020B	NCS-MOV-020B EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
44	CWSMVEL020A	NCS-MOV-020A EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
45	CWSMVEL007A	NCS-MOV-007A EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
46	RSSRXEL001B	RHS-RHX-001B (B-CS/RHR HX) SHELL EXTERNAL LEAK LARGE	9.6E-08	2.3E+03	2.2E-04
47	RSSRXEL001A	RHS-RHX-001A (A-CS/RHR HX) SHELL EXTERNAL LEAK LARGE	9.6E-08	2.3E+03	2.2E-04
48	RSSXVEL144B	NCS-VLV-144B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
49	RSSXVEL144A	NCS-VLV-144A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
50	RSSXVEL141A	NCS-VLV-141A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 6 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
51	RSSXVEL141B	NCS-VLV-141B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
52	RSSXVEL125A	NCS-VLV-125A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
53	RSSXVEL131B	NCS-VLV-131B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
54	RSSXVEL131A	NCS-VLV-131A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
55	RSSXVEL128B	NCS-VLV-128B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
56	RSSXVEL125B	NCS-VLV-125B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
57	RSSXVEL128A	NCS-VLV-128A EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04
58	RSSMVEL145B	NCS-MOV-145B EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
59	RSSMVEL145A	NCS-MOV-145A EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
60	CWSCF3RHPF001ABC-12	NCS-RHX-001A,B,C (CCW HX) PLUG / FOUL(CCF)	1.8E-08	2.3E+03	4.2E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 7 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
61	SGNBTSWCCF	PSMS APPLICATION SOFTWARE FAILURE CCF	1.0E-05	1.4E+03	1.4E-02
62	EPSCBFO52RAT-ABC	EPS 52/RATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.9E+02	4.6E-03
63	EPSCBFO52UAT-ABC	EPS 52/UATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.9E+02	4.6E-03
64	EPSCF4CBSC52RAT-123	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	8.9E+02	2.6E-05
65	EPSCF4CBSC52UAT-123	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	8.9E+02	2.6E-05
66	EPSCF4CBSC52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	8.9E+02	1.4E-04
67	EPSCF4CBSC52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	1.6E-07	8.9E+02	1.4E-04
68	ESWCF3PMBD001ABC-ALL	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RE-START (CCF)	6.0E-05	3.3E+02	2.0E-02
69	CWSCF3PCBD001ABC-ALL	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RE-START (CCF)	3.3E-05	3.3E+02	1.1E-02
70	ESWCF3CVOD602ABC-ALL	EWS-VLV-602A,B,C FAIL TO RE-OPEN (CCF)	3.0E-07	3.3E+02	9.8E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 8 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
71	ESWCF3CVOD502ABC-ALL	EWS-VLV-502A,B,C FAIL TO RE-OPEN (CCF)	3.0E-07	3.3E+02	9.8E-05
72	CWSCF3CVOD016ABC-ALL	NCS-VLV-016A,B,C FAIL TO RE-OPEN (CCF)	3.0E-07	3.3E+02	9.8E-05
73	CWSCF3RHPF001ABC-13	NCS-RHX-001A,B,C (CCW HX) PLUG / FOUL(CCF)	1.8E-08	3.2E+02	5.8E-06
74	RWSXVEL024	RWS-VLV-024 EXTERNAL LEAK LARGE	7.2E-08	2.2E+02	1.6E-05
75	RWSTNEL001	RWS-CPT-001 (RWSP) EXTERNAL LEAK LARGE	4.8E-08	2.2E+02	1.1E-05
76	RWSCVEL023	RWS-VLV-023 EXTERNAL LEAK LARGE	4.8E-08	2.2E+02	1.1E-05
77	RWSPNELPIPE1	RWS PIPING BETWEEN RWSP AND RWS-VLV-023 EXTERNAL LEAK LARGE	6.0E-10	2.2E+02	1.3E-07
78	RWSXVEL001	RWS-VLV-001 EXTERNAL LEAK LARGE	7.2E-08	2.2E+02	1.6E-05
79	RSSPNEL01D	CSS PIPING BETWEEN RWSP AND CSS-MOV-001D EXTERNAL LEAK LARGE	2.9E-08	2.2E+02	6.3E-06
80	RSSPNEL01B	CSS PIPING BETWEEN RWSP AND CSS-MOV-001B EXTERNAL LEAK LARGE	2.9E-08	2.2E+02	6.3E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 9 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
81	RSSPNEL01C	CSS PIPING BETWEEN RWSP AND CSS-MOV-001C EXTERNAL LEAK LARGE	2.8E-08	2.2E+02	6.2E-06
82	RSSPNEL01A	CSS PIPING BETWEEN RWSP AND CSS-MOV-001A EXTERNAL LEAK LARGE	2.8E-08	2.2E+02	6.2E-06
83	HPIPNELSUCTSA	SIS A-SI PUMP SUCTION LINE (INSIDE C/V) PIPING EXTERNAL LEAK LARGE	2.8E-08	2.2E+02	6.1E-06
84	HPIPNELSUCTSB	SIS B-SI PUMP SUCTION LINE (INSIDE C/V) PIPING EXTERNAL LEAK LARGE	2.8E-08	2.2E+02	6.1E-06
85	HPIPNELSUCTSD	SIS D-SI PUMP SUCTION LINE (INSIDE C/V) PIPING EXTERNAL LEAK LARGE	2.8E-08	2.2E+02	6.1E-06
86	HPIPNELSUCTSC	SIS C-SI PUMP SUCTION LINE (INSIDE C/V) PIPING EXTERNAL LEAK LARGE	2.8E-08	2.2E+02	6.1E-06
87	RWSMVEL002	RWS-MOV-002 EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
88	HPIMVEL001A	SIS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
89	HPIMVEL001C	SIS-MOV-001C EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
90	HPIMVEL001B	SIS-MOV-001B EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 10 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
91	HPIMVEL001D	SIS-MOV-001D EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
92	RSSMVELCSS001B	CSS-MOV-001B EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
93	RSSMVELCSS001A	CSS-MOV-001A EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
94	RSSMVELCSS001C	CSS-MOV-001C EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
95	RSSMVELCSS001D	CSS-MOV-001D EXTERNAL LEAK LARGE	2.4E-08	2.2E+02	5.3E-06
96	RWSPNELPIPE2	RWS PIPING BETWEEN RWSP AND RWS-VLV-002 EXTERNAL LEAK LARGE	6.0E-10	1.6E+02	9.5E-08
97	SGNBTSWCCF1	PCMS APPLICATION SOFTWARE GROUP1 FAILURE CCF	1.0E-04	1.5E+02	1.5E-02
98	EPSCBFO52RAT-ABD	EPS 52/RATA,B,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	1.5E+02	7.8E-04
99	EPSCBFO52UAT-ABD	EPS 52/UATA,B,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	1.5E+02	7.8E-04
100	EPSCBFO52RAT-AB	EPS 52/RATA,B (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.5E+02	7.4E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 11 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
101	EPSCBFO52UAT-AB	EPS 52/UATA,B (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.5E+02	7.4E-04
102	EPSCF4CBSC52RAT-12	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.5E+02	5.0E-06
103	EPSCF4CBSC52UAT-12	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.5E+02	5.0E-06
104	EPSCF4CBSC52RAT-124	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.5E+02	4.4E-06
105	EPSCF4CBSC52UAT-124	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	1.5E+02	4.4E-06
106	RSSOO02P	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS	2.6E-03	9.7E+01	2.4E-01
107	CHIOO02P	OPERATOR FAILS TO START STANDBY CHARGING PUMP	2.6E-03	9.5E+01	2.4E-01
108	RSSRIEL001C	RHS-RHX-001C (C-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	8.2E+01	5.9E-05
109	RSSPMEL001C	RHS-RPP-001C (C-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	8.2E+01	1.6E-05
110	RSSXVEL013C	RHS-VLV-013C EXTERNAL LEAK LARGE	7.2E-08	8.2E+01	5.9E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 12 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
111	RSSXVEL002C	CSS-VLV-002C EXTERNAL LEAK LARGE	7.2E-08	8.2E+01	5.9E-06
112	RSSCVEL004C	RHS-VLV-004C EXTERNAL LEAK LARGE	4.8E-08	8.2E+01	3.9E-06
113	RSSMVEL021C	RHS-MOV-021C EXTERNAL LEAK LARGE	2.4E-08	8.2E+01	2.0E-06
114	RSSMVEL004C	CSS-MOV-004C EXTERNAL LEAK LARGE	2.4E-08	8.2E+01	2.0E-06
115	RSSAVEL623	RHS-HCV-623 EXTERNAL LEAK LARGE	2.2E-08	8.2E+01	1.8E-06
116	RSSAVEL621	RHS-FCV-621 EXTERNAL LEAK LARGE	2.2E-08	8.2E+01	1.8E-06
117	RSSPNEL04C	RHS C-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	2.6E-07	8.1E+01	2.1E-05
118	RSSPNEL05C	RHS RHR OPERATION SUCTION LINE C (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	5.8E-08	8.1E+01	4.6E-06
119	RSSPNEL12C	RHS-FCV-621 LINE PIPING EXTERNAL LEAK LARGE	2.6E-08	8.1E+01	2.0E-06
120	RSSPNEL03C	CSS PIPING BETWEEN CSS-MOV-001C AND C-CS/RHR PUMP EXTERNAL LEAK LARGE	6.7E-09	8.1E+01	5.4E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 13 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
121	RSSPNEL08C	RHS ALTERNATE CORE COOLING LINE C (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	1.8E-09	8.1E+01	1.4E-07
122	EPSCF3DLLRDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-03	5.1E+01	5.6E-02
123	EPSCF3DLADDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO START (CCF)	2.4E-04	5.1E+01	1.2E-02
124	EPSCF3DLSRDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)	1.8E-04	5.1E+01	8.8E-03
125	EPSCF3SEFFDG-ALL	EPS CLASS 1E GTG A,B,C SEQUENCER FAIL TO OPERATE (CCF)	7.5E-05	5.1E+01	3.7E-03
126	EPSCF3CBTD52EPS-ALL	EPS 52/EPSA,B,C (BREAKER) FAIL TO CLOSE (CCF)	2.0E-05	5.1E+01	1.0E-03
127	EPSCF3CBSO52EPS-ALL	EPS 52/EPSA,B,C (BREAKER) SPURIOUS OPEN (CCF)	2.1E-07	5.1E+01	1.0E-05
128	EPSCF4IVFF001-ALL	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.5E-06	5.1E+01	7.5E-05
129	EPSCF4CBSO72AU-ALL	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	5.1E+01	7.9E-06
130	EPSCF4CBSO52UA-ALL	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	5.1E+01	7.9E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 14 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
131	EPSCF4IVFF001-123	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	5.1E+01	2.5E-05
132	EPSCF4CBSO52UA-123	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	5.1E+01	1.5E-06
133	EPSCF4CBSO72AU-123	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	5.1E+01	1.5E-06
134	EPSCF4CBSO72DB-ALL	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	5.1E+01	7.8E-06
135	EPSCF4BYFF-ALL	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	5.0E-08	5.1E+01	2.5E-06
136	EPSCF4CBSO72DB-123	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	4.8E+01	1.4E-06
137	EPSCF4BYFF-123	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	4.8E+01	5.9E-07
138	EPSCBFO52RAT-ACD	EPS 52/RATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.8E+01	1.9E-04
139	EPSCBFO52UAT-ACD	EPS 52/UATA,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	3.8E+01	1.9E-04
140	EPSCBFO52UAT-AC	EPS 52/UATA,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	3.8E+01	1.8E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 15 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
141	EPSCBFO52RAT-AC	EPS 52/RATA,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	3.8E+01	1.8E-04
142	EPSCF4CBSC52UAT-13	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	3.8E+01	1.3E-06
143	EPSCF4CBSC52RAT-13	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	3.8E+01	1.3E-06
144	EPSCF4CBSC52RAT-134	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	3.8E+01	1.1E-06
145	EPSCF4CBSC52UAT-134	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	3.8E+01	1.1E-06
146	EPSBSFFAM001A	ESS-AM-001A (A CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	3.0E+01	1.6E-04
147	EPSBSFFDD001A	ESS-DD-001A (A DC SWITCHBOARD BUS) FAILURE	5.8E-06	2.8E+01	1.6E-04
148	CWSCF3RHPF001ABC-23	NCS-RHX-001A,B,C (CCW HX) PLUG / FOUL(CCF)	1.8E-08	2.6E+01	4.6E-07
149	SWSSTPRST02A	EWS-ST02A (STRAINER) PLUG	1.7E-04	2.4E+01	3.9E-03
150	SWSPMYR001A-CG3	EWS-OPP-001A (A-ESW PUMP) FAIL TO RUN	1.2E-04	2.4E+01	2.8E-03

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 16 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
151	SWSORPRESS0003A	EWS-ESS0003A (ORIFICE) PLUG	2.4E-05	2.4E+01	5.6E-04
152	SWSORPR2024	EWS-FE-2024 (ORIFICE) PLUG	2.4E-05	2.4E+01	5.6E-04
153	SWSORPROR04A	EWS-OR04A (ORIFICE) PLUG	2.4E-05	2.4E+01	5.6E-04
154	CWSORPR1230	NCS-FE-1230 (ORIFICE) PLUG	2.4E-05	2.4E+01	5.6E-04
155	SWSFMPR2060	EWS-FT-2060 (FLOW METER) PLUG	2.4E-05	2.4E+01	5.6E-04
156	CWSXVPR008A	NCS-VLV-008A PLUG	2.4E-06	2.4E+01	5.6E-05
157	CWSXVPR101A	NCS-VLV-101A PLUG	2.4E-06	2.4E+01	5.6E-05
158	SWSXVPR601A	EWS-VLV-601A PLUG	2.4E-06	2.4E+01	5.6E-05
159	SWSCVPR602A	EWS-VLV-602A PLUG	2.4E-06	2.4E+01	5.6E-05
160	CWSXVPR104A	NCS-VLV-104A PLUG	2.4E-06	2.4E+01	5.6E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 17 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
161	CWSCVPR016A	NCS-VLV-016A PLUG	2.4E-06	2.4E+01	5.6E-05
162	CWSXVPR018A	NCS-VLV-018A PLUG	2.4E-06	2.4E+01	5.6E-05
163	SWSXVPR511A	EWS-VLV-511A PLUG	2.4E-06	2.4E+01	5.6E-05
164	SWSXVPR520A	EWS-VLV-520A PLUG	2.4E-06	2.4E+01	5.6E-05
165	SWSXVPR517A	EWS-VLV-517A PLUG	2.4E-06	2.4E+01	5.6E-05
166	SWSXVPR514A	EWS-VLV-514A PLUG	2.4E-06	2.4E+01	5.6E-05
167	CWSRIEL001A2	NCS-RHX-001A (A-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	2.4E+01	1.7E-05
168	SWSPEELSWPA2	EWS A-ESW PUMP COOLING LINE PIPING EXTERNAL LEAK LARGE	3.8E-07	2.4E+01	8.7E-06
169	SWSPEELSWPA3	EWS A-CCW HX COOLING LINE PIPING EXTERNAL LEAK LARGE	2.1E-07	2.4E+01	5.0E-06
170	SWSPMEL001A	EWS-OPP-001A (A-ESW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.4E+01	4.5E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 18 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
171	SWSXVEL601A	EWS-VLV-601A EXTERNAL LEAK LARGE	7.2E-08	2.4E+01	1.7E-06
172	SWSXVEL511A	EWS-VLV-511A EXTERNAL LEAK LARGE	7.2E-08	2.4E+01	1.7E-06
173	SWSXVEL514A	EWS-VLV-514A EXTERNAL LEAK LARGE	7.2E-08	2.4E+01	1.7E-06
174	SWSCVEL602A	EWS-VLV-602A EXTERNAL LEAK LARGE	4.8E-08	2.4E+01	1.1E-06
175	CWSPCYR001A-CG3	NCS-RPP-001A (A-CCW PUMP) FAIL TO RUN	6.7E-05	2.4E+01	1.6E-03
176	SWSPEELSWPA1	EWS A-ESW PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	3.9E-06	2.4E+01	8.9E-05
177	SWSMVPR503A	EWS-MOV-503A PLUG	2.4E-06	2.4E+01	5.5E-05
178	SWSXVPR506A	EWS-VLV-506A PLUG	2.4E-06	2.4E+01	5.5E-05
179	SWSXVPR508A	EWS-VLV-508A PLUG	2.4E-06	2.4E+01	5.5E-05
180	SWSCVPR502A	EWS-VLV-502A PLUG	2.4E-06	2.4E+01	5.5E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 19 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
181	SWSMVCM503A	EWS-MOV-503A SPURIOUS CLOSE	9.6E-07	2.4E+01	2.2E-05
182	SWSXVEL508A	EWS-VLV-508A EXTERNAL LEAK LARGE	7.2E-08	2.4E+01	1.7E-06
183	SWSXVEL506A	EWS-VLV-506A EXTERNAL LEAK LARGE	7.2E-08	2.4E+01	1.7E-06
184	SWSXVEL509A	EWS-VLV-509A EXTERNAL LEAK LARGE	7.2E-08	2.4E+01	1.7E-06
185	SWSXVEL507A	EWS-VLV-507A EXTERNAL LEAK LARGE	7.2E-08	2.4E+01	1.7E-06
186	SWSCVEL502A	EWS-VLV-502A EXTERNAL LEAK LARGE	4.8E-08	2.4E+01	1.1E-06
187	SWSMVEL503A	EWS-MOV-503A EXTERNAL LEAK LARGE	2.4E-08	2.4E+01	5.5E-07
188	CWSRHPF001A1-CG3	NCS-RHX-001A (A-CCW HX) PLUG / FOUL	1.4E-06	2.4E+01	3.1E-05
189	EPSCBFO52UAT-ALL	EPS 52/UATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)	2.0E-05	2.3E+01	4.5E-04
190	EPSCBFO52RAT-ALL	EPS 52/RATA,B,C,D (BREAKER) FAIL TO OPEN (CCF)	2.0E-05	2.3E+01	4.5E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 20 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
191	HPIOO02S	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP	4.9E-03	2.1E+01	9.9E-02
192	HPICF2PMAD001AB-ALL	SIS-RPP-001A,B (SI PUMP) FAIL TO START (CCF)	1.5E-04	2.0E+01	2.9E-03
193	HPICF2PMSR001AB-ALL	SIS-RPP-001A,B (SI PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.7E-05	2.0E+01	3.1E-04
194	RWSCF4SUPR001-ALL	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	9.7E-06	2.0E+01	1.8E-04
195	HPICF2PMLR001AB-ALL	SIS-RPP-001A,B (SI PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.7E-06	2.0E+01	1.1E-04
196	RWSCF4SUPR001-124	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	2.0E+01	6.9E-05
197	RWSCF4SUPR001-123	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.7E-06	2.0E+01	6.9E-05
198	RWSCF4SUPR001-12	SIS-CSR-001A,B,C,D (ESS/CS STRAINER) PLUG DURING OPERATION (CCF)	3.0E-06	2.0E+01	5.6E-05
199	HPICF2CVOD010AB-ALL	SIS-VLV-010A,B FAIL TO OPEN (CCF)	2.0E-06	2.0E+01	3.8E-05
200	HPICF2CVOD013AB-ALL	SIS-VLV-013A,B FAIL TO OPEN (CCF)	2.0E-06	2.0E+01	3.8E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 21 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
201	HPICF2CVOD004AB-ALL	SIS-VLV-004A,B FAIL TO OPEN (CCF)	2.0E-06	2.0E+01	3.8E-05
202	HPICF2CVOD012AB-ALL	SIS-VLV-012A,B FAIL TO OPEN (CCF)	2.0E-06	2.0E+01	3.8E-05
203	CHIORPR1260	NCS-FE-1260 (ORIFICE) PLUG	2.4E-05	1.8E+01	4.0E-04
204	CHIORPR1266	NCS-FE-1266 (ORIFICE) PLUG	2.4E-05	1.8E+01	4.0E-04
205	CHIORPROR01A	CVS-OR01A (ORIFICE) PLUG	2.4E-05	1.8E+01	4.0E-04
206	CHICVOD131A	CVS-VLV-131A FAIL TO OPEN	1.2E-05	1.8E+01	2.0E-04
207	CHICVOD129A	CVS-VLV-129A FAIL TO OPEN	1.2E-05	1.8E+01	2.0E-04
208	CHIXVPR301A	NCS-VLV-301A PLUG	2.4E-06	1.8E+01	4.0E-05
209	CHIXVPR315A	NCS-VLV-315A PLUG	2.4E-06	1.8E+01	4.0E-05
210	CHIXVPR311A	NCS-VLV-311A PLUG	2.4E-06	1.8E+01	4.0E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 22 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
211	CHIXVPR312A	NCS-VLV-312A PLUG	2.4E-06	1.8E+01	4.0E-05
212	CHICVPR131A	CVS-VLV-131A PLUG	2.4E-06	1.8E+01	4.0E-05
213	CHIXVPR126A	CVS-VLV-126A PLUG	2.4E-06	1.8E+01	4.0E-05
214	CHIXVPR132A	CVS-VLV-132A PLUG	2.4E-06	1.8E+01	4.0E-05
215	CHIXVPR130A	CVS-VLV-130A PLUG	2.4E-06	1.8E+01	4.0E-05
216	CHICVPR129A	CVS-VLV-129A PLUG	2.4E-06	1.8E+01	4.0E-05
217	EPSCF4CBSO52STL-ALL	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.7E+01	2.6E-06
218	EPSCF4CBSO52STH-ALL	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.7E+01	2.6E-06
219	EPSBSFFDD002A	ESS-DD-002A (A1 DC SWITCHBOARD BUS) FAILURE	5.8E-06	1.7E+01	9.5E-05
220	EPSCBSO72DDAA	EPS 72/DDAA (BREAKER) SPURIOUS OPEN	3.0E-06	1.7E+01	5.0E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 23 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
221	EPSCBSO72DDDA	EPS 72/DDDA (BREAKER) SPURIOUS OPEN	3.0E-06	1.7E+01	5.0E-05
222	EPSCF4CBSO72DD1-34	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.7E+01	5.5E-07
223	EPSCF4CBSO72DD1-24	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.7E+01	5.5E-07
224	EPSCF4CBSO72DD2-24	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.7E+01	5.5E-07
225	EPSCF4CBSO72DD2-14	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.7E+01	5.5E-07
226	EPSCF4CBSO72DD2-124	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.7E+01	4.8E-07
227	EPSCF4CBSO72DD1-234	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.7E+01	4.8E-07
228	EPSCF4CBSO72DD1-ALL	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.7E+01	2.6E-06
229	EPSCF4CBSO72DD2-ALL	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	1.7E+01	2.6E-06
230	EPSCF4CBSO72DD2-34	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.7E+01	5.5E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 24 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
231	EPSCF4CBSO72DD1-14	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.7E+01	5.5E-07
232	EPSCF4CBSO72DD1-134	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.7E+01	4.8E-07
233	EPSCF4CBSO72DD1-124	EPS 72/DDAA,BB,BC,AD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.7E+01	4.8E-07
234	EPSCF4CBSO72DD2-234	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.7E+01	4.8E-07
235	EPSCF4CBSO72DD2-134	EPS 72/DDDA,BA,BD,DD (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.7E+01	4.8E-07
236	EPSCF4CBSO52STH-14	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.6E+01	5.1E-07
237	EPSCF4CBSO52STL-14	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	1.6E+01	5.1E-07
238	EPSCF4CBSO52STH-124	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.6E+01	4.4E-07
239	EPSCF4CBSO52STH-134	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.6E+01	4.4E-07
240	EPSCF4CBSO52STL-134	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.6E+01	4.4E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 25 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
241	EPSCF4CBSO52STL-124	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	1.6E+01	4.4E-07
242	RSSOO02LINE+P	OPERATOR FAILS TO ESTABLISH RHR INJECTION LINE AND START STANBY PUMP	3.8E-03	1.6E+01	5.7E-02
243	LOAOO02LC	OPERATOR FAILS TO ISOLATE THE LEAKAGE TRAIN OF RHR SYSTEM	2.6E-03	1.6E+01	3.8E-02
244	RWSXVEL013A	RWS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	1.4E+01	9.2E-07
245	RWSXVEL006A	RWS-VLV-006A EXTERNAL LEAK LARGE	7.2E-08	1.4E+01	9.2E-07
246	RWSXVEL021	RWS-VLV-021 EXTERNAL LEAK LARGE	7.2E-08	1.4E+01	9.2E-07
247	RWSXVEL014	RWS-VLV-014 EXTERNAL LEAK LARGE	7.2E-08	1.4E+01	9.2E-07
248	RWSXVEL005	RWS-VLV-005 EXTERNAL LEAK LARGE	7.2E-08	1.4E+01	9.2E-07
249	RSSRIEL001A	RHS-RHX-001A (A-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.3E+01	8.7E-06
250	RSSPMEL001A	RHS-RPP-001A (A-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.3E+01	2.3E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 26 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
251	RSSXVEL002A	CSS-VLV-002A EXTERNAL LEAK LARGE	7.2E-08	1.3E+01	8.7E-07
252	RSSXVEL013A	RHS-VLV-013A EXTERNAL LEAK LARGE	7.2E-08	1.3E+01	8.7E-07
253	RSSXVEL031A	RHS-VLV-031A EXTERNAL LEAK LARGE	7.2E-08	1.3E+01	8.7E-07
254	RSSCVEL004A	RHS-VLV-004A EXTERNAL LEAK LARGE	4.8E-08	1.3E+01	5.8E-07
255	RSSMVEL004A	CSS-MOV-004A EXTERNAL LEAK LARGE	2.4E-08	1.3E+01	2.9E-07
256	RSSMVEL021A	RHS-MOV-021A EXTERNAL LEAK LARGE	2.4E-08	1.3E+01	2.9E-07
257	RSSPNEL04A	RHS A-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	2.6E-07	1.3E+01	3.1E-06
258	RSSPNEL05A	RHS RHR OPERATION SUCTION LINE A (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	5.8E-08	1.3E+01	6.9E-07
259	RSSPNEL11A	RHS PIPING BETWEEN RHS-VLV-031A AND ALTERNATE CORE COOLING LINE EXTERNAL LEAK LARGE	1.9E-08	1.3E+01	2.3E-07
260	RSSPNEL03A	CSS PIPING BETWEEN CSS-MOV-001A AND A-CS/RHR PUMP EXTERNAL LEAK LARGE	6.7E-09	1.3E+01	8.1E-08

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 27 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
261	RSSPNEL10A	CSS PIPING BETWEEN RHS-VLV-034A AND A-CS/RHR PUMP SUCTION LINE EXTERNAL LEAK LARGE	3.8E-09	1.3E+01	4.5E-08
262	RSSPNEL08A	RHS ALTERNATE CORE COOLING LINE A (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	1.8E-09	1.3E+01	2.1E-08
263	RWSMVEL004	RWS-MOV-004 EXTERNAL LEAK LARGE	2.4E-08	1.3E+01	2.9E-07
264	RSSRIEL001D	RHS-RHX-001D (D-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.2E+01	8.2E-06
265	RSSRIEL001B	RHS-RHX-001B (B-CS/RHR HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.2E+01	8.2E-06
266	RSSPNEL04D	RHS D-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	2.6E-07	1.2E+01	2.9E-06
267	RSSPMEL001D	RHS-RPP-001D (D-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.2E-06
268	RSSPMEL001B	RHS-RPP-001B (B-CS/RHR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.2E-06
269	RSSXVEL013D	RHS-VLV-013D EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.2E-07
270	RSSXVEL031D	RHS-VLV-031D EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.2E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 28 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
271	RSSXVEL034D	RHS-VLV-034D EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.2E-07
272	RSSXVEL002D	CSS-VLV-002D EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.2E-07
273	RSSXVEL013B	RHS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.2E-07
274	RSSXVEL002B	CSS-VLV-002B EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.2E-07
275	RSSCVEL004D	RHS-VLV-004D EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.5E-07
276	CFACVEL012	CSS-VLV-012 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.5E-07
277	RSSCVEL004B	RHS-VLV-004B EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.5E-07
278	RSSPNEL05D	RHS RHR OPERATION SUCTION LINE D (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	4.7E-08	1.2E+01	5.4E-07
279	RSSMVEL021D	RHS-MOV-021D EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
280	RSSMVEL004D	CSS-MOV-004D EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 29 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
281	RSSMVEL021B	RHS-MOV-021B EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
282	RSSMVEL004B	CSS-MOV-004B EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
283	RSSAVEL611	RHS-FCV-611 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.5E-07
284	RSSAVEL613	RHS-HCV-613 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.5E-07
285	RSSPNEL11D	RHS PIPING BETWEEN RHS-VLV-031D AND ALTERNATE CORE COOLING LINE EXTERNAL LEAK LARGE	1.9E-08	1.2E+01	2.2E-07
286	RSSPNEL03D	CSS PIPING BETWEEN CSS-MOV-001D AND D-CS/RHR PUMP EXTERNAL LEAK LARGE	6.1E-09	1.2E+01	7.0E-08
287	RSSPNEL10D	CSS PIPING BETWEEN RHS-VLV-034D AND D-CS/RHR PUMP SUCTION LINE EXTERNAL LEAK LARGE	3.8E-09	1.2E+01	4.3E-08
288	RSSPNEL08D	RHS ALTERNATE CORE COOLING LINE D (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	1.8E-09	1.2E+01	2.0E-08
289	RSSPNEL07D	CSS C/V SPRAY LINE D (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	1.8E-09	1.2E+01	2.0E-08
290	CHICF2MVCD121BC-ALL	CVS-LCV-121B,C FAIL TO CLOSE (CCF)	1.4E-04	1.2E+01	1.5E-03

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 30 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
291	CHICF4MVOD121-ALL	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	1.1E-04	1.2E+01	1.3E-03
292	CHIAVFC138	CVS-FCV-138 FAIL TO CONTROL	7.2E-05	1.2E+01	8.1E-04
293	CHIORPROR02	CVS-OR02 (ORIFICE) PLUG	2.4E-05	1.2E+01	2.7E-04
294	CHIORPR138	CVS-FE-138 (ORIFICE) PLUG	2.4E-05	1.2E+01	2.7E-04
295	CHIAVCM159	CVS-AOV-159 SPURIOUS CLOSE	4.8E-06	1.2E+01	5.4E-05
296	CHIAVCM138	CVS-FCV-138 SPURIOUS CLOSE	4.8E-06	1.2E+01	5.4E-05
297	CHIAVCM146	CVS-AOV-146 SPURIOUS CLOSE	4.8E-06	1.2E+01	5.4E-05
298	CHIMVPR151	CVS-MOV-151 PLUG	2.4E-06	1.2E+01	2.7E-05
299	CHIXVPR147	CVS-VLV-147 PLUG	2.4E-06	1.2E+01	2.7E-05
300	CHICVPR153	CVS-VLV-153 PLUG	2.4E-06	1.2E+01	2.7E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 31 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
301	CHIXVPR145	CVS-VLV-145 PLUG	2.4E-06	1.2E+01	2.7E-05
302	CHIXVPR133	CVS-VLV-133 PLUG	2.4E-06	1.2E+01	2.7E-05
303	CHIMVPR152	CVS-MOV-152 PLUG	2.4E-06	1.2E+01	2.7E-05
304	CHIAVPR159	CVS-AOV-159 PLUG	2.4E-06	1.2E+01	2.7E-05
305	CHIAVPR146	CVS-AOV-146 PLUG	2.4E-06	1.2E+01	2.7E-05
306	CHICVPR160	CVS-VLV-160 PLUG	2.4E-06	1.2E+01	2.7E-05
307	CHICVPR161	CVS-VLV-161 PLUG	2.4E-06	1.2E+01	2.7E-05
308	CHIAVPR138	CVS-FCV-138 PLUG	2.4E-06	1.2E+01	2.7E-05
309	CHIMVCM151	CVS-MOV-151 SPURIOUS CLOSE	9.6E-07	1.2E+01	1.1E-05
310	CHIMVCM152	CVS-MOV-152 SPURIOUS CLOSE	9.6E-07	1.2E+01	1.1E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 32 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
311	CHIAVIL155	CVS-AOV-155 INTERNAL LEAK LARGE	1.2E-07	1.2E+01	1.3E-06
312	CWSORPR1226	NCS-FE-1226 (ORIFICE) PLUG	2.4E-05	1.2E+01	2.7E-04
313	CHICF4MVOD121-12	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	1.3E-05	1.2E+01	1.5E-04
314	CHICF4MVOD121-23	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	1.3E-05	1.2E+01	1.5E-04
315	CHICF4MVOD121-34	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	1.3E-05	1.2E+01	1.5E-04
316	CHICF4MVOD121-14	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	1.3E-05	1.2E+01	1.5E-04
317	CHICVOD595	CVS-VLV-595 FAIL TO OPEN	1.2E-05	1.2E+01	1.3E-04
318	CHICVOD592	CVS-VLV-592 FAIL TO OPEN	1.2E-05	1.2E+01	1.3E-04
319	CWSXVPR034A	NCS-VLV-034A PLUG	2.4E-06	1.2E+01	2.7E-05
320	CWSXVPR033A	NCS-VLV-033A PLUG	2.4E-06	1.2E+01	2.7E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 33 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
321	CHIXVPR591	CVS-VLV-591 PLUG	2.4E-06	1.2E+01	2.7E-05
322	CHICVPR592	CVS-VLV-592 PLUG	2.4E-06	1.2E+01	2.7E-05
323	CHICVPR595	CVS-VLV-595 PLUG	2.4E-06	1.2E+01	2.7E-05
324	CHIXVEL591	CVS-VLV-591 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
325	RWSTNEL002	RWS-OTK-002 (RWSAT) EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
326	CHICVEL592	CVS-VLV-592 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
327	CHICVEL594	CVS-VLV-594 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
328	CHICVEL595	CVS-VLV-595 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
329	CHIMVEL121E	CVS-LCV-121E EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
330	CHIMVEL121G	CVS-LCV-121G EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 34 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
331	CHIMVEL121F	CVS-LCV-121F EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
332	CHIMVEL121D	CVS-LCV-121D EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
333	CHIPNELPIPE2	CVS PIPING BETWEEN RWSAT AND CHI PUMP EXTERNAL LEAK LARGE	6.0E-10	1.2E+01	6.7E-09
334	CHIPMBD001A	CVS-RPP-001A (A-CHI PUMP) FAIL TO START	2.0E-03	1.2E+01	2.3E-02
335	CHIPMYR001A	CVS-RPP-001A (A-CHI PUMP) FAIL TO RUN	1.2E-04	1.2E+01	1.4E-03
336	CHIRIEL001	CVS-CHX-001 (REGENERATIVE HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	1.2E+01	8.1E-06
337	CHIPMEL001A	CVS-RPP-001A (A-CHI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.2E-06
338	CHIPMEL001B	CVS-RPP-001B (B-CHI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.2E-06
339	CHIXVEL126A	CVS-VLV-126A EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
340	CHIXVEL173	CVS-VLV-173 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 35 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
341	CHIXVEL144	CVS-VLV-144 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
342	CHIXVEL167	CVS-VLV-167 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
343	CHIXVEL132B	CVS-VLV-132B EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
344	CHIXVEL147	CVS-VLV-147 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
345	CHIXVEL130B	CVS-VLV-130B EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
346	CHIXVEL168	CVS-VLV-168 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
347	CHIXVEL145	CVS-VLV-145 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
348	CHIXVEL133	CVS-VLV-133 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
349	CHIXVEL164	CVS-VLV-164 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
350	CHIXVEL130A	CVS-VLV-130A EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 36 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
351	CHIXVEL126B	CVS-VLV-126B EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
352	CHIXVEL132A	CVS-VLV-132A EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
353	CHIXVEL166	CVS-VLV-166 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
354	CHIXVEL170B	CVS-VLV-170B EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
355	CHIXVEL163	CVS-VLV-163 EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
356	CHIXVEL171B	CVS-VLV-171B EXTERNAL LEAK LARGE	7.2E-08	1.2E+01	8.1E-07
357	CHICVEL153	CVS-VLV-153 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
358	CHICVEL131A	CVS-VLV-131A EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
359	CHICVEL160	CVS-VLV-160 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
360	CHICVEL131B	CVS-VLV-131B EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 37 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
361	CHICVEL129A	CVS-VLV-129A EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
362	CHICVEL161	CVS-VLV-161 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
363	CHICVEL125	CVS-VLV-125 EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
364	CHICVEL129B	CVS-VLV-129B EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.4E-07
365	CHIMVEL121B	CVS-LCV-121B EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
366	CHIMVEL121C	CVS-LCV-121C EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
367	CHIMVEL151	CVS-MOV-151 EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
368	CHIMVEL152	CVS-MOV-152 EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.7E-07
369	CHIAVEL138	CVS-FCV-138 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.4E-07
370	CHIAVEL155	CVS-AOV-155 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.4E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 38 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
371	CHIAVEL159	CVS-AOV-159 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.4E-07
372	CHIAVEL140	CVS-FCV-140 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.4E-07
373	CHIAVEL165	CVS-AOV-165 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.4E-07
374	CHIAVEL146	CVS-AOV-146 EXTERNAL LEAK LARGE	2.2E-08	1.2E+01	2.4E-07
375	CHIPNELPIPE1	CVS CHARGING INJECTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	1.2E+01	6.7E-09
376	CHICF4MVOD121-234	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	2.6E-06	1.2E+01	2.9E-05
377	CHICF4MVOD121-134	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	2.6E-06	1.2E+01	2.9E-05
378	CHICF4MVOD121-124	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	2.6E-06	1.2E+01	2.9E-05
379	CHICF4MVOD121-123	CVS-LCV-121D,E,F,G FAIL TO OPEN (CCF)	2.6E-06	1.2E+01	2.9E-05
380	ACWCVPR306A	NCS-VLV-306A PLUG	2.4E-06	1.2E+01	2.7E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 39 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
381	ACWMVPR316A	NCS-MOV-316A PLUG	2.4E-06	1.2E+01	2.7E-05
382	ACWMVCM316A	NCS-MOV-316A SPURIOUS CLOSE	9.6E-07	1.2E+01	1.1E-05
383	CHICF2ILFFVCT12-ALL	VCT WATER LEVEL SENSOR (CHANNEL1,2) FAIL TO OPERATE CCF	1.6E-06	1.2E+01	1.8E-05
384	EPSCF2CBSO52LL1-ALL	EPS 52/LLAA, LLAD (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	1.2E+01	3.1E-06
385	EPSCF2CBSO52LL2-ALL	EPS 52/LLDA, LLDD (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	1.2E+01	3.1E-06
386	EPSCF2CBSO52LC1-ALL	EPS 52/LCA1,D1 (BREAKER) SPURIOUS CLOSE (CCF)	2.8E-07	1.2E+01	3.1E-06
387	RSSPNEL04B	RHS B-CS/RHR PUMP LINE PIPING EXTERNAL LEAK LARGE	2.5E-07	1.2E+01	2.8E-06
388	HPIPMEL001A	SIS-RPP-001A (A-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.1E-06
389	HPIPMEL001B	SIS-RPP-001B (B-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.1E-06
390	HPIPMEL001D	SIS-RPP-001D (D-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.1E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 40 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
391	HPIPMEL001C	SIS-RPP-001C (C-SI PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.1E-06
392	HPIPNELINJSC	SIS C-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	9.2E-08	1.2E+01	1.0E-06
393	HPIPNELINJSD	SIS D-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	9.0E-08	1.2E+01	9.9E-07
394	HPICVEL004D	SIS-VLV-004D EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.3E-07
395	HPICVEL004C	SIS-VLV-004C EXTERNAL LEAK LARGE	4.8E-08	1.2E+01	5.3E-07
396	RSSPNEL05B	RHS RHR OPERATION SUCTION LINE B (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	4.7E-08	1.2E+01	5.2E-07
397	HPIPNELSUCTLC	SIS C-SI PUMP SUCTION LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	3.3E-08	1.2E+01	3.6E-07
398	HPIPNELSUCTLD	SIS D-SI PUMP SUCTION LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	3.1E-08	1.2E+01	3.4E-07
399	RSSPNEL12B	RHS-FCV-611 LINE PIPING EXTERNAL LEAK LARGE	2.6E-08	1.2E+01	2.8E-07
400	HPIMVEL009D	SIS-MOV-009D EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.6E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 41 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
401	HPIMVEL009C	SIS-MOV-009C EXTERNAL LEAK LARGE	2.4E-08	1.2E+01	2.6E-07
402	RSSPNEL03B	CSS PIPING BETWEEN CSS-MOV-001B AND B-CS/RHR PUMP EXTERNAL LEAK LARGE	6.1E-09	1.2E+01	6.7E-08
403	RSSPNEL08B	RHS ALTERNATE CORE COOLING LINE B (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	1.8E-09	1.2E+01	2.0E-08
404	RWSPMEL001B	RWS-RPP-001B (B-RWR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.1E-06
405	RWSPMEL001A	RWS-RPP-001A (A-RWR PUMP) EXTERNAL LEAK LARGE	1.9E-07	1.2E+01	2.1E-06
406	HPIPNELINJSA	SIS A-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	9.2E-08	1.1E+01	9.3E-07
407	HPIPNELINJSB	SIS B-SI PUMP DISCHARGE LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	9.0E-08	1.1E+01	9.1E-07
408	RSSXVEL034A	RHS-VLV-034A EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.3E-07
409	HPICVEL004B	SIS-VLV-004B EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.9E-07
410	HPICVEL004A	SIS-VLV-004A EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.9E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 42 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
411	HPIMVEL009B	SIS-MOV-009B EXTERNAL LEAK LARGE	2.4E-08	1.1E+01	2.4E-07
412	HPIMVEL009A	SIS-MOV-009A EXTERNAL LEAK LARGE	2.4E-08	1.1E+01	2.4E-07
413	RSSPNEL07A	CSS C/V SPRAY LINE A (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	1.8E-09	1.1E+01	1.8E-08
414	HPIOO02S-DP2	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP	5.5E-02	1.1E+01	5.8E-01
415	RWSXVEL006B	RWS-VLV-006B EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07
416	RWSXVEL013B	RWS-VLV-013B EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07
417	RWSXVEL103A	SFS-VLV-103A EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07
418	RWSXVEL101	RWS-VLV-101 EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07
419	RWSXVEL028	SFS-VLV-028 EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07
420	RWSXVEL103B	SFS-VLV-103B EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 43 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
421	RWSXVEL066B	NCS-VLV-066B EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07
422	RWSXVEL066A	NCS-VLV-066A EXTERNAL LEAK LARGE	7.2E-08	1.1E+01	7.2E-07
423	RWSCVEL037	LMS-VLV-037 EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.8E-07
424	RWSCVEL027	SFS-VLV-027 EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.8E-07
425	RWSCVEL065A	NCS-VLV-065A EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.8E-07
426	RWSCVEL065B	NCS-VLV-065B EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.8E-07
427	RWSPNELPIPE4	RWS PIPING BETWEEN RWS-VLV-004 AND RWS-VLV-021 EXTERNAL LEAK LARGE	6.0E-10	1.1E+01	6.0E-09
428	HPIPNELSUCTLA	SIS A-SI PUMP SUCTION LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	3.3E-08	1.1E+01	3.2E-07
429	HPIPNELSUCTLB	SIS B-SI PUMP SUCTION LINE (OUTSIDE C/V) PIPING EXTERNAL LEAK LARGE	3.1E-08	1.1E+01	3.0E-07
430	RWSCVEL012A	RWS-VLV-012A EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.6E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 44 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
431	RWSCVEL012B	RWS-VLV-012B EXTERNAL LEAK LARGE	4.8E-08	1.1E+01	4.6E-07
432	EPSCBFO52RAT-A	EPS 52/RATA (BREAKER) FAIL TO OPEN	3.5E-04	1.0E+01	3.3E-03
433	EPSCBFO52UAT-A	EPS 52/UATA (BREAKER) FAIL TO OPEN	3.5E-04	1.0E+01	3.3E-03
434	EPSCBSC52RATA	EPS 52/RATA (BREAKER) SPURIOUS CLOSE	3.0E-06	1.0E+01	2.8E-05
435	EPSCBSC52UATA	EPS 52/UATA (BREAKER) SPURIOUS CLOSE	3.0E-06	1.0E+01	2.8E-05
436	EPSCBFO52RAT-AD	EPS 52/RATA,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.0E+01	4.5E-05
437	EPSCBFO52UAT-AD	EPS 52/UATA,D (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	1.0E+01	4.5E-05
438	EPSCF4CBSC52UAT-14	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.0E+01	3.1E-07
439	EPSCF4CBSC52RAT-14	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	1.0E+01	3.1E-07
440	RCSCF2ILFF12-ALL	RCS WATER LEVEL SENSOR (NARROW CHANNEL1,2) FAIL TO OPERATE CCF	1.6E-06	1.0E+01	1.4E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 45 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
441	EPSCF3DLLRDG-12	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.1E-04	9.2E+00	4.1E-03
442	EPSCF3DLADDG-12	EPS CLASS 1E GTG A,B,C FAIL TO START (CCF)	9.6E-05	9.2E+00	7.9E-04
443	EPSCF3DLSRDG-12	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)	8.0E-05	9.2E+00	6.5E-04
444	EPSCF3SEFFDG-13	EPS CLASS 1E GTG A,B,C SEQUENCER FAIL TO OPERATE (CCF)	3.8E-05	9.2E+00	3.1E-04
445	EPSCF3CBTD52EPS-12	EPS 52/EPSA,B,C (BREAKER) FAIL TO CLOSE (CCF)	1.0E-05	9.2E+00	8.3E-05
446	EPSCF3CBSO52EPS-12	EPS 52/EPSA,B,C (BREAKER) SPURIOUS OPEN (CCF)	6.7E-08	9.2E+00	5.5E-07
447	EPSCF3DLLRDG-23	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.1E-04	8.6E+00	3.9E-03
448	EPSCF3DLADDG-23	EPS CLASS 1E GTG A,B,C FAIL TO START (CCF)	9.6E-05	8.6E+00	7.3E-04
449	EPSCF3DLSRDG-23	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)	8.0E-05	8.6E+00	6.1E-04
450	EPSCF3SEFFDG-12	EPS CLASS 1E GTG A,B,C SEQUENCER FAIL TO OPERATE (CCF)	3.8E-05	8.6E+00	2.9E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 46 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
451	EPSCF3CBTD52EPS-23	EPS 52/EPSA,B,C (BREAKER) FAIL TO CLOSE (CCF)	1.0E-05	8.6E+00	7.7E-05
452	EPSCBFO52UAT-BC	EPS 52/UATB,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	8.6E+00	3.8E-05
453	EPSCF3CBSO52EPS-23	EPS 52/EPSA,B,C (BREAKER) SPURIOUS OPEN (CCF)	6.7E-08	8.6E+00	5.1E-07
454	EPSCF4CBSC52UAT-23	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	8.6E+00	2.6E-07
455	EPSCBFO52RAT-BCD	EPS 52/RATB,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.6E+00	3.9E-05
456	EPSCBFO52UAT-BCD	EPS 52/UATB,C,D (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.6E+00	3.9E-05
457	EPSCBFO52RAT-BC	EPS 52/RATB,C (BREAKER) FAIL TO OPEN (CCF)	5.0E-06	8.6E+00	3.7E-05
458	EPSCF4CBSC52RAT-23	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	3.4E-08	8.6E+00	2.5E-07
459	EPSCF4CBSC52RAT-234	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	8.6E+00	2.2E-07
460	EPSCF4CBSC52UAT-234	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	8.6E+00	2.2E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 47 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
461	EPSCF4IVFF001-23	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	8.3E+00	7.3E-06
462	EPSCF4CBSO52UA-23	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	8.3E+00	2.4E-07
463	EPSCF4CBSO72AU-23	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	8.3E+00	2.4E-07
464	EPSCF4IVFF001-234	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	8.2E+00	3.6E-06
465	EPSCF4CBSO52UA-234	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.2E+00	2.1E-07
466	EPSCF4CBSO72AU-234	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	8.2E+00	2.1E-07
467	EPSCF4IVFF001-12	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	8.1E+00	7.1E-06
468	EPSCF4CBSO72AU-12	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	8.1E+00	2.4E-07
469	EPSCF4CBSO52UA-12	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	8.1E+00	2.4E-07
470	EPSCF4IVFF001-124	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	7.8E+00	3.4E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 48 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
471	EPSCF4CBSO52UA-124	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	7.8E+00	2.0E-07
472	EPSCF4CBSO72AU-124	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	7.8E+00	2.0E-07
473	EPSCF4CBSO72DB-23	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	7.6E+00	2.2E-07
474	EPSCF4CBSO72DB-234	EPS 72/DBA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	7.6E+00	1.9E-07
475	EPSCF4BYFF-23	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.9E-08	7.6E+00	1.3E-07
476	EPSCF4BYFF-234	ESS-DB-001A,B,C,D (BATTERY) FAIL TO OPERATE (CCF)	1.2E-08	7.6E+00	8.2E-08
477	EPSCF4CBSO52LC-ALL	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	1.6E-07	6.9E+00	9.4E-07
478	CVCAVCD024B	RHS-AOV-024B FAIL TO CLOSE	1.2E-03	6.7E+00	6.9E-03
479	CVCAVCD024C	RHS-AOV-024C FAIL TO CLOSE	1.2E-03	6.7E+00	6.9E-03
480	RSSCF2IPFFHEADAB-ALL	CS/RHR HEADER PRESSURE SENSOR (TRAIN A,B) FAIL TO OPERATE CCF	1.3E-06	6.6E+00	7.1E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 49 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
481	RSSCF3PMAD001ABC-ALL	RHS-RPP-001A,B,C (CS/RHR PUMP) FAIL TO RE-START (CCF)	5.0E-05	6.5E+00	2.7E-04
482	ACWCVEL306B	NCS-VLV-306B EXTERNAL LEAK LARGE	4.8E-08	6.4E+00	2.6E-07
483	EPSCF4CBSO52STL-13	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.4E+00	1.8E-07
484	EPSCF4CBSO52LC-13	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.4E+00	1.8E-07
485	EPSCF4CBSO52STH-13	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	6.4E+00	1.8E-07
486	ACWMVEL316B	NCS-MOV-316B EXTERNAL LEAK LARGE	2.4E-08	6.4E+00	1.3E-07
487	EPSTRFF001A	ESS-AT-001A (6.9KV-480V A CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	6.3E+00	4.4E-05
488	EPSBSFFAL001A	ESS-AL-001A (A CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	6.3E+00	3.1E-05
489	EPSCBSO52STLA	EPS 52/STLA (BREAKER) SPURIOUS OPEN	3.0E-06	6.3E+00	1.6E-05
490	EPSCBSO52STHA	EPS 52/STHA (BREAKER) SPURIOUS OPEN	3.0E-06	6.3E+00	1.6E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 50 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
491	RSSCF3RHPR001ABC-ALL	RHS-RHX-001A,B,C (CS/RHR HX) PLUG / FOUL (CCF)	5.2E-06	6.3E+00	2.8E-05
492	RSSCF3CVOD004ABC-ALL	RHS-VLV-004A,B,C FAIL TO OPEN (CCF)	6.7E-07	6.3E+00	3.6E-06
493	EPSBSFFAC001A	ESS-AC-001A (A CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	6.2E+00	3.0E-05
494	EPSCBSO52LCA	EPS 52/LCA (BREAKER) SPURIOUS OPEN	3.0E-06	6.2E+00	1.6E-05
495	CWSCF3IPFFHEAD-ALL	CCW SUPPLY HEADER PRESSURE SENSOR (TRAIN A,B,C) FAIL TO OPERATE CCF	6.8E-07	6.2E+00	3.6E-06
496	CHIPMAD001A-R	CVS-RPP-001A (A-CHI PUMP) FAIL TO RE-START	1.5E-03	6.2E+00	7.9E-03
497	ACWMVOD325A	NCS-MOV-325A FAIL TO OPEN	1.0E-03	6.2E+00	5.3E-03
498	ACWMVOD322A	NCS-MOV-322A FAIL TO OPEN	1.0E-03	6.2E+00	5.3E-03
499	ACWMVCD316A	NCS-MOV-316A FAIL TO CLOSE	1.0E-03	6.2E+00	5.3E-03
500	ACWMVOD324A	NCS-MOV-324A FAIL TO OPEN	1.0E-03	6.2E+00	5.3E-03

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 51 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
501	ACWMVOD321A	NCS-MOV-321A FAIL TO OPEN	1.0E-03	6.2E+00	5.3E-03
502	CHIPMYR001A-R	CVS-RPP-001A (A-CHI PUMP) FAIL TO RUN	1.2E-04	6.2E+00	6.3E-04
503	ACWCVCD306A	NCS-VLV-306A FAIL TO CLOSE	1.0E-04	6.2E+00	5.3E-04
504	ACWMVPR322A	NCS-MOV-322A PLUG	2.4E-06	6.2E+00	1.3E-05
505	ACWMVPR325A	NCS-MOV-325A PLUG	2.4E-06	6.2E+00	1.3E-05
506	ACWMVPR321A	NCS-MOV-321A PLUG	2.4E-06	6.2E+00	1.3E-05
507	ACWMVPR324A	NCS-MOV-324A PLUG	2.4E-06	6.2E+00	1.3E-05
508	ACWMVCM322A	NCS-MOV-322A SPURIOUS CLOSE	9.6E-07	6.2E+00	5.1E-06
509	ACWMVCM321A	NCS-MOV-321A SPURIOUS CLOSE	9.6E-07	6.2E+00	5.1E-06
510	ACWMVCM325A	NCS-MOV-325A SPURIOUS CLOSE	9.6E-07	6.2E+00	5.1E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 52 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
511	ACWMVCM324A	NCS-MOV-324A SPURIOUS CLOSE	9.6E-07	6.2E+00	5.1E-06
512	ACWMVOM316A	NCS-MOV-316A SPURIOUS OPEN	9.6E-07	6.2E+00	5.1E-06
513	ACWCVIL306A	NCS-VLV-306A INTERNAL LEAK LARGE	7.2E-07	6.2E+00	3.8E-06
514	ACWMVIL316A	NCS-MOV-316A INTERNAL LEAK LARGE	7.2E-08	6.2E+00	3.8E-07
515	ACWMVIL323A	NCS-MOV-323A INTERNAL LEAK LARGE	7.2E-08	6.2E+00	3.8E-07
516	ACWMVIL326A	NCS-MOV-326A INTERNAL LEAK LARGE	7.2E-08	6.2E+00	3.8E-07
517	RSSCF3PMYR001ABC-ALL	RHS-RPP-001A,B,C (CS/RHR PUMP) FAIL TO RUN (CCF)	3.0E-06	6.2E+00	1.6E-05
518	ACWOO02SC	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM	2.2E-02	6.2E+00	1.2E-01
519	RSSCF3CVOD028ABC-ALL	RHS-VLV-028A,B,C FAIL TO OPEN (CCF)	6.7E-07	5.9E+00	3.3E-06
520	RSSCF3CVOD022ABC-ALL	RHS-VLV-022A,B,C FAIL TO OPEN (CCF)	6.7E-07	5.9E+00	3.3E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 53 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
521	RSSCF3CVOD027ABC-ALL	RHS-VLV-027A,B,C FAIL TO OPEN (CCF)	6.7E-07	5.9E+00	3.3E-06
522	ACWTNELFWT	FWT (FIRE SUPPRESSION TANK) EXTERNAL LEAK LARGE	4.8E-08	5.9E+00	2.4E-07
523	EPSCF4CBSO52LC-12	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.9E+00	1.6E-07
524	EPSCF4CBSO52STH-12	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.9E+00	1.6E-07
525	EPSCF4CBSO52STL-12	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.9E+00	1.6E-07
526	EPSCF4CBSO52LC-14	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	5.9E+00	1.6E-07
527	EPSCF4CBSO52STH-123	EPS 52/STHA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	5.9E+00	1.4E-07
528	EPSCF4CBSO52STL-123	EPS 52/STLA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	5.9E+00	1.4E-07
529	EPSCF4CBSO52LC-124	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	5.9E+00	1.4E-07
530	EPSCF4CBSO52LC-123	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	5.9E+00	1.4E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 54 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
531	EPSCF4CBSO52LC-134	EPS 52/LCA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	5.9E+00	1.4E-07
532	ACWMVEL324A	NCS-MOV-324A EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
533	ACWMVEL322A	NCS-MOV-322A EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
534	ACWMVEL321B	NCS-MOV-321B EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
535	ACWMVEL323A	NCS-MOV-323A EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
536	ACWMVEL321A	NCS-MOV-321A EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
537	ACWMVEL324B	NCS-MOV-324B EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
538	ACWMVEL323B	NCS-MOV-323B EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
539	ACWMVEL325B	NCS-MOV-325B EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
540	ACWMVEL326B	NCS-MOV-326B EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 55 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
541	ACWMVEL322B	NCS-MOV-322B EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
542	ACWMVEL325A	NCS-MOV-325A EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
543	ACWMVEL326A	NCS-MOV-326A EXTERNAL LEAK LARGE	2.4E-08	5.3E+00	1.0E-07
544	ACWPNELPIPEFS	FIRE SERVICE WATER TANK LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.3E+00	2.6E-09
545	ACWPNELPIPEB2	ALTERNATIVE CCW B-CHI PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.3E+00	2.6E-09
546	ACWPNELPIPEB1	ALTERNATIVE CCW B-CHI PUMP SUCTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.3E+00	2.6E-09
547	ACWPNELPIPEA1	ALTERNATIVE CCW A-CHI PUMP SUCTION LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.3E+00	2.6E-09
548	ACWPNELPIPEA2	ALTERNATIVE CCW A-CHI PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	6.0E-10	5.3E+00	2.6E-09
549	RWSOO04XV051	MISALIGNMENT OF RWS-VLV-051 AFTER TEST OR MAINTENANCE	8.0E-04	3.9E+00	2.3E-03
550	RWSXVOD021	RWS-VLV-021 FAIL TO OPEN	7.0E-04	3.9E+00	2.1E-03

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 56 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
551	RWSXVOD052	RWS-VLV-052 FAIL TO OPEN	7.0E-04	3.9E+00	2.1E-03
552	RWSORPR025	RWS-025 (ORIFICE) PLUG	2.4E-05	3.9E+00	7.0E-05
553	RWSXVPR052	RWS-VLV-052 PLUG	2.4E-06	3.9E+00	7.0E-06
554	RWSXVPR051	RWS-VLV-051 PLUG	2.4E-06	3.9E+00	7.0E-06
555	RWSXVPR021	RWS-VLV-021 PLUG	2.4E-06	3.9E+00	7.0E-06
556	RWSXVEL051	RWS-VLV-051 EXTERNAL LEAK LARGE	7.2E-08	3.9E+00	2.1E-07
557	RWSXVEL052	RWS-VLV-052 EXTERNAL LEAK LARGE	7.2E-08	3.9E+00	2.1E-07
558	RWSPNELPIPE5	RWS PIPING BETWEEN RWS-VLV-021 AND RWSAT EXTERNAL LEAK LARGE	6.0E-10	3.9E+00	1.8E-09
559	RWSCF2PMAD001AB-ALL	RWS-RPP-001A,B (RWR PUMP) FAIL TO START (CCF)	7.1E-05	3.9E+00	2.1E-04
560	RWSILFF002	RWSAT WATER LEVEL SENSOR FAIL TO OPERATE	3.4E-05	3.9E+00	9.8E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 57 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
561	RWSCF2PMSR001AB-ALL	RWS-RPP-001A,B (RWR PUMP) FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	1.9E-05	3.9E+00	5.5E-05
562	RWSCF2PMLR001AB-ALL	RWS-RPP-001A,B (RWR PUMP) FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	6.5E-06	3.9E+00	1.9E-05
563	RWSXVPR001	RWS-VLV-001 PLUG	2.4E-06	3.9E+00	6.9E-06
564	RWSMVPR002	RWS-MOV-002 PLUG	2.4E-06	3.9E+00	6.9E-06
565	RWSMVPR004	RWS-MOV-004 PLUG	2.4E-06	3.9E+00	6.9E-06
566	RWSMVCM004	RWS-MOV-004 SPURIOUS CLOSE	9.6E-07	3.9E+00	2.8E-06
567	RWSMVCM002	RWS-MOV-002 SPURIOUS CLOSE	9.6E-07	3.9E+00	2.8E-06
568	SWSSTPRST02B	EWS-ST02B (STRAINER) PLUG	1.7E-04	3.8E+00	4.6E-04
569	SWSFMPR2061	EWS-FT-2061 (FLOW METER) PLUG	2.4E-05	3.8E+00	6.6E-05
570	SWSORPROR04B	EWS-OR04B (ORIFICE) PLUG	2.4E-05	3.8E+00	6.6E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 58 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
571	SWSORPRESS0003B	EWS-ESS0003B (ORIFICE) PLUG	2.4E-05	3.8E+00	6.6E-05
572	CWSORPR1231	NCS-FE-1231 (ORIFICE) PLUG	2.4E-05	3.8E+00	6.6E-05
573	SWSORPR2025	EWS-FE-2025 (ORIFICE) PLUG	2.4E-05	3.8E+00	6.6E-05
574	CWSXVPR101B	NCS-VLV-101B PLUG	2.4E-06	3.8E+00	6.6E-06
575	CWSXVPR104B	NCS-VLV-104B PLUG	2.4E-06	3.8E+00	6.6E-06
576	CWSXVPR018B	NCS-VLV-018B PLUG	2.4E-06	3.8E+00	6.6E-06
577	CWSXVPR008B	NCS-VLV-008B PLUG	2.4E-06	3.8E+00	6.6E-06
578	SWSCVPR602B	EWS-VLV-602B PLUG	2.4E-06	3.8E+00	6.6E-06
579	SWSXVPR517B	EWS-VLV-517B PLUG	2.4E-06	3.8E+00	6.6E-06
580	SWSXVPR601B	EWS-VLV-601B PLUG	2.4E-06	3.8E+00	6.6E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 59 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
581	CWSCVPR016B	NCS-VLV-016B PLUG	2.4E-06	3.8E+00	6.6E-06
582	SWSXVPR520B	EWS-VLV-520B PLUG	2.4E-06	3.8E+00	6.6E-06
583	SWSXVPR514B	EWS-VLV-514B PLUG	2.4E-06	3.8E+00	6.6E-06
584	SWSXVPR511B	EWS-VLV-511B PLUG	2.4E-06	3.8E+00	6.6E-06
585	CWSRIEL001B2	NCS-RHX-001B (B-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	3.8E+00	2.0E-06
586	SWSPEELSWPB2	EWS B-ESW PUMP COOLING LINE PIPING EXTERNAL LEAK LARGE	3.8E-07	3.8E+00	1.0E-06
587	SWSPEELSWPB3	EWS B-CCW HX COOLING LINE PIPING EXTERNAL LEAK LARGE	2.1E-07	3.8E+00	5.9E-07
588	SWSPMEL001B	EWS-OPP-001B (B-ESW PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.8E+00	5.3E-07
589	SWSXVEL601B	EWS-VLV-601B EXTERNAL LEAK LARGE	7.2E-08	3.8E+00	2.0E-07
590	SWSXVEL511B	EWS-VLV-511B EXTERNAL LEAK LARGE	7.2E-08	3.8E+00	2.0E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 60 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
591	SWSXVEL514B	EWS-VLV-514B EXTERNAL LEAK LARGE	7.2E-08	3.8E+00	2.0E-07
592	SWSCVEL602B	EWS-VLV-602B EXTERNAL LEAK LARGE	4.8E-08	3.8E+00	1.3E-07
593	SWSPMYR001B-CG3	EWS-OPP-001B (B-ESW PUMP) FAIL TO RUN	1.2E-04	3.8E+00	3.3E-04
594	CWSPCYR001B-CG3	NCS-RPP-001B (B-CCW PUMP) FAIL TO RUN	6.7E-05	3.7E+00	1.8E-04
595	SGNBTSWCCF2	PCMS APPLICATION SOFTWARE GROUP2 FAILURE CCF	1.0E-04	3.7E+00	2.7E-04
596	RCSILFF3	RCS WATER LEVEL SENSOR (MIDDLE) FAIL TO OPERATE	3.4E-05	3.7E+00	9.0E-05
597	SWSPEELSWPB1	EWS B-ESW PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	3.9E-06	3.4E+00	9.5E-06
598	SWSXVPR508B	EWS-VLV-508B PLUG	2.4E-06	3.4E+00	5.8E-06
599	SWSCVPR502B	EWS-VLV-502B PLUG	2.4E-06	3.4E+00	5.8E-06
600	SWSMVPR503B	EWS-MOV-503B PLUG	2.4E-06	3.4E+00	5.8E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 61 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
601	SWSXVPR506B	EWS-VLV-506B PLUG	2.4E-06	3.4E+00	5.8E-06
602	SWSMVCM503B	EWS-MOV-503B SPURIOUS CLOSE	9.6E-07	3.4E+00	2.3E-06
603	SWSXVEL508B	EWS-VLV-508B EXTERNAL LEAK LARGE	7.2E-08	3.4E+00	1.8E-07
604	SWSXVEL506B	EWS-VLV-506B EXTERNAL LEAK LARGE	7.2E-08	3.4E+00	1.8E-07
605	SWSXVEL509B	EWS-VLV-509B EXTERNAL LEAK LARGE	7.2E-08	3.4E+00	1.8E-07
606	SWSXVEL507B	EWS-VLV-507B EXTERNAL LEAK LARGE	7.2E-08	3.4E+00	1.8E-07
607	SWSCVEL502B	EWS-VLV-502B EXTERNAL LEAK LARGE	4.8E-08	3.4E+00	1.2E-07
608	SWSMVEL503B	EWS-MOV-503B EXTERNAL LEAK LARGE	2.4E-08	3.4E+00	5.8E-08
609	CWSRHPF001B1-CG3	NCS-RHX-001B (B-CCW HX) PLUG / FOUL	1.4E-06	3.2E+00	3.0E-06
610	RSSMVCDCSS001C	CSS-MOV-001C FAIL TO CLOSE	1.0E-03	3.1E+00	2.1E-03

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 62 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
611	RSSMVOMCSS001C	CSS-MOV-001C SPURIOUS OPEN	9.6E-07	3.1E+00	2.1E-06
612	SWSPMYR001C-CG3	EWS-OPP-001C (C-ESW PUMP) FAIL TO RUN	1.2E-04	3.1E+00	2.6E-04
613	RSSMVODRHS001C	RHS-MOV-001C FAIL TO OPEN	1.0E-03	3.1E+00	2.1E-03
614	RSSMVOD145C	NCS-MOV-145C FAIL TO OPEN	1.0E-03	3.1E+00	2.1E-03
615	RSSMVOD002C	RHS-MOV-002C FAIL TO OPEN	1.0E-03	3.1E+00	2.1E-03
616	RSSMVOD026C	RHS-MOV-026C FAIL TO OPEN	1.0E-03	3.1E+00	2.1E-03
617	RSSMVOD021C	RHS-MOV-021C FAIL TO OPEN	1.0E-03	3.1E+00	2.1E-03
618	SWSSTPRST02C	EWS-ST02C (STRAINER) PLUG	1.7E-04	3.1E+00	3.6E-04
619	SWSORPROR04C	EWS-OR04C (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05
620	CWSORPR1232	NCS-FE-1232 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 63 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
621	RSSORPR1244	NCS-FE-1244 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05
622	SWSORPRESS0003C	EWS-ESS0003C (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05
623	SWSORPR2026	EWS-FE-2026 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05
624	RSSORPR1248	NCS-FE-1248 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05
625	RSSORPR1252	NCS-FE-1252 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05
626	SWSFMPR2062	EWS-FT-2062 (FLOW METER) PLUG	2.4E-05	3.1E+00	5.1E-05
627	CWSORPR1227	NCS-FE-1227 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.1E-05
628	RSSAVOM024C	RHS-AOV-024C SPURIOUS OPEN	4.8E-06	3.1E+00	1.0E-05
629	RSSAVOM621	RHS-FCV-621 SPURIOUS OPEN	4.8E-06	3.1E+00	1.0E-05
630	RSSAVCM623	RHS-HCV-623 SPURIOUS CLOSE	4.8E-06	3.1E+00	1.0E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 64 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
631	RSSSVOM003C	RHS-VLV-003C SPURIOUS OPEN	4.8E-06	3.1E+00	1.0E-05
632	SWSXVPR601C	EWS-VLV-601C PLUG	2.4E-06	3.1E+00	5.1E-06
633	SWSXVPR520C	EWS-VLV-520C PLUG	2.4E-06	3.1E+00	5.1E-06
634	CWSCVPR016C	NCS-VLV-016C PLUG	2.4E-06	3.1E+00	5.1E-06
635	CWSXVPR104C	NCS-VLV-104C PLUG	2.4E-06	3.1E+00	5.1E-06
636	SWSXVPR511C	EWS-VLV-511C PLUG	2.4E-06	3.1E+00	5.1E-06
637	CWSXVPR008C	NCS-VLV-008C PLUG	2.4E-06	3.1E+00	5.1E-06
638	RSSXVPR128C	NCS-VLV-128C PLUG	2.4E-06	3.1E+00	5.1E-06
639	RSSAVPR623	RHS-HCV-623 PLUG	2.4E-06	3.1E+00	5.1E-06
640	CWSXVPR101C	NCS-VLV-101C PLUG	2.4E-06	3.1E+00	5.1E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 65 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
641	RSSXVPR131C	NCS-VLV-131C PLUG	2.4E-06	3.1E+00	5.1E-06
642	RSSXVPR125C	NCS-VLV-125C PLUG	2.4E-06	3.1E+00	5.1E-06
643	RSSMVPR145C	NCS-MOV-145C PLUG	2.4E-06	3.1E+00	5.1E-06
644	SWSXVPR514C	EWS-VLV-514C PLUG	2.4E-06	3.1E+00	5.1E-06
645	SWSXVPR517C	EWS-VLV-517C PLUG	2.4E-06	3.1E+00	5.1E-06
646	SWSCVPR602C	EWS-VLV-602C PLUG	2.4E-06	3.1E+00	5.1E-06
647	RSSMVPRRHS001C	RHS-MOV-001C PLUG	2.4E-06	3.1E+00	5.1E-06
648	RSSMVPR026C	RHS-MOV-026C PLUG	2.4E-06	3.1E+00	5.1E-06
649	RSSMVPR021C	RHS-MOV-021C PLUG	2.4E-06	3.1E+00	5.1E-06
650	RSSMVPR002C	RHS-MOV-002C PLUG	2.4E-06	3.1E+00	5.1E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 66 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
651	CWSXVPR018C	NCS-VLV-018C PLUG	2.4E-06	3.1E+00	5.1E-06
652	RSSMVOM025C	RHS-MOV-025C SPURIOUS OPEN	9.6E-07	3.1E+00	2.1E-06
653	RSSMVCM026C	RHS-MOV-026C SPURIOUS CLOSE	9.6E-07	3.1E+00	2.1E-06
654	RSSMVCM021C	RHS-MOV-021C SPURIOUS CLOSE	9.6E-07	3.1E+00	2.1E-06
655	RSSMVCM002C	RHS-MOV-002C SPURIOUS CLOSE	9.6E-07	3.1E+00	2.1E-06
656	RSSMVCM145C	NCS-MOV-145C SPURIOUS CLOSE	9.6E-07	3.1E+00	2.1E-06
657	RSSMVCMRHS001C	RHS-MOV-001C SPURIOUS CLOSE	9.6E-07	3.1E+00	2.1E-06
658	RSSMVOM004C	CSS-MOV-004C SPURIOUS OPEN	9.6E-07	3.1E+00	2.1E-06
659	CWSRIEL001C2	NCS-RHX-001C (C-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	3.1E+00	1.5E-06
660	SWSPEELSWPC2	EWS C-ESW PUMP COOLING LINE PIPING EXTERNAL LEAK LARGE	3.8E-07	3.1E+00	8.0E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 67 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
661	SWSPEELSWPC3	EWS C-CCW HX COOLING LINE PIPING EXTERNAL LEAK LARGE	2.1E-07	3.1E+00	4.6E-07
662	SWSPMEL001C	EWS-OPP-001C (C-ESW PUMP) EXTERNAL LEAK LARGE	1.9E-07	3.1E+00	4.1E-07
663	SWSXVEL511C	EWS-VLV-511C EXTERNAL LEAK LARGE	7.2E-08	3.1E+00	1.5E-07
664	SWSXVEL514C	EWS-VLV-514C EXTERNAL LEAK LARGE	7.2E-08	3.1E+00	1.5E-07
665	SWSXVEL601C	EWS-VLV-601C EXTERNAL LEAK LARGE	7.2E-08	3.1E+00	1.5E-07
666	SWSCVEL602C	EWS-VLV-602C EXTERNAL LEAK LARGE	4.8E-08	3.1E+00	1.0E-07
667	CWSPCYR001C-CG3	NCS-RPP-001C (C-CCW PUMP) FAIL TO RUN	6.7E-05	3.1E+00	1.4E-04
668	RSSORPR007C	RHS-OR007C (ORIFICE) PLUG	2.4E-05	3.1E+00	5.0E-05
669	RSSORPR624	RHS-FE-624 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.0E-05
670	RSSORPR621	RHS-FE-621 (ORIFICE) PLUG	2.4E-05	3.1E+00	5.0E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 68 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
671	RSSCVPR004C	RHS-VLV-004C PLUG	2.4E-06	3.1E+00	5.0E-06
672	RSSXVPR013C	RHS-VLV-013C PLUG	2.4E-06	3.1E+00	5.0E-06
673	EPSCF3DLLRDG-13	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.1E-04	3.1E+00	1.1E-03
674	EPSCF3DLADDG-13	EPS CLASS 1E GTG A,B,C FAIL TO START (CCF)	9.6E-05	3.1E+00	2.0E-04
675	EPSCF3DLSRDG-13	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)	8.0E-05	3.1E+00	1.7E-04
676	EPSCF3SEFFDG-23	EPS CLASS 1E GTG A,B,C SEQUENCER FAIL TO OPERATE (CCF)	3.8E-05	3.1E+00	7.8E-05
677	EPSCF3CBTD52EPS-13	EPS 52/EPSA,B,C (BREAKER) FAIL TO CLOSE (CCF)	1.0E-05	3.1E+00	2.1E-05
678	EPSCF3CBSO52EPS-13	EPS 52/EPSA,B,C (BREAKER) SPURIOUS OPEN (CCF)	6.7E-08	3.1E+00	1.4E-07
679	EPSBSFFAC003C	ESS-AC-003C (C MOV 480V MCC BUS) FAILURE	5.8E-06	3.1E+00	1.2E-05
680	EPSTRFF001C	ESS-AT-001C (6.9KV-480V C CLASS 1E STATION SERVICE TRANSFORMER) FAIL TO OPERATE	8.2E-06	3.0E+00	1.7E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 69 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
681	EPSBSFFAC001C	ESS-AC-001C (C CLASS 1E 480V MCC BUS) FAILURE	5.8E-06	3.0E+00	1.2E-05
682	EPSBSFFAL001C	ESS-AL-001C (C CLASS 1E 480V LOAD CENTER BUS) FAILURE	5.8E-06	3.0E+00	1.2E-05
683	ESWCF3PMBD001ABC-23	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RE-START (CCF)	7.9E-05	3.0E+00	1.6E-04
684	CWSCF3PCBD001ABC-23	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RE-START (CCF)	4.4E-05	3.0E+00	8.8E-05
685	ESWCF3CVOD502ABC-23	EWS-VLV-502A,B,C FAIL TO RE-OPEN (CCF)	1.5E-07	3.0E+00	3.0E-07
686	CWSCF3CVOD016ABC-23	NCS-VLV-016A,B,C FAIL TO RE-OPEN (CCF)	1.5E-07	3.0E+00	3.0E-07
687	ESWCF3CVOD602ABC-23	EWS-VLV-602A,B,C FAIL TO RE-OPEN (CCF)	1.5E-07	3.0E+00	3.0E-07
688	SWSPEELSWPC1	EWS C-ESW PUMP DISCHARGE LINE PIPING EXTERNAL LEAK LARGE	3.9E-06	3.0E+00	7.8E-06
689	SWSXVPR506C	EWS-VLV-506C PLUG	2.4E-06	3.0E+00	4.8E-06
690	SWSMVPR503C	EWS-MOV-503C PLUG	2.4E-06	3.0E+00	4.8E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 70 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
691	SWSCVPR502C	EWS-VLV-502C PLUG	2.4E-06	3.0E+00	4.8E-06
692	SWSXVPR508C	EWS-VLV-508C PLUG	2.4E-06	3.0E+00	4.8E-06
693	SWSMVCM503C	EWS-MOV-503C SPURIOUS CLOSE	9.6E-07	3.0E+00	1.9E-06
694	SWSXVEL507C	EWS-VLV-507C EXTERNAL LEAK LARGE	7.2E-08	3.0E+00	1.4E-07
695	SWSXVEL509C	EWS-VLV-509C EXTERNAL LEAK LARGE	7.2E-08	3.0E+00	1.4E-07
696	SWSXVEL506C	EWS-VLV-506C EXTERNAL LEAK LARGE	7.2E-08	3.0E+00	1.4E-07
697	SWSXVEL508C	EWS-VLV-508C EXTERNAL LEAK LARGE	7.2E-08	3.0E+00	1.4E-07
698	SWSCVEL502C	EWS-VLV-502C EXTERNAL LEAK LARGE	4.8E-08	3.0E+00	9.7E-08
699	SWSMVEL503C	EWS-MOV-503C EXTERNAL LEAK LARGE	2.4E-08	3.0E+00	4.8E-08
700	EPSCBSO52STHC	EPS 52/STHC (BREAKER) SPURIOUS OPEN	3.0E-06	3.0E+00	5.9E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 71 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
701	EPSCBSO52STLC	EPS 52/STLC (BREAKER) SPURIOUS OPEN	3.0E-06	3.0E+00	5.9E-06
702	EPSCBSO52LCC	EPS 52/LCC (BREAKER) SPURIOUS OPEN	3.0E-06	3.0E+00	5.9E-06
703	EPSOO02RDG	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	2.9E+00	4.2E-02
704	RSSXVPR141C	NCS-VLV-141C PLUG	2.4E-06	2.9E+00	4.7E-06
705	RSSXVPR144C	NCS-VLV-144C PLUG	2.4E-06	2.9E+00	4.7E-06
706	RSSCVPR028C	RHS-VLV-028C PLUG	2.4E-06	2.9E+00	4.7E-06
707	RSSCVPR027C	RHS-VLV-027C PLUG	2.4E-06	2.9E+00	4.7E-06
708	RSSCVPR022C	RHS-VLV-022C PLUG	2.4E-06	2.9E+00	4.7E-06
709	EPSCF2DLLRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.5E-03	2.9E+00	2.8E-03
710	EPSCF2DLADDGP-ALL	EPS AAC GTG A,B FAIL TO START (CCF)	3.1E-04	2.9E+00	5.9E-04

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 72 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
711	EPSCF2DLSRDGP-ALL	EPS AAC GTG A,B FAIL TO RUN DURING FIRST HOUR OF OPERATION (CCF)	2.3E-04	2.9E+00	4.5E-04
712	EPSCF2SEFFDGP-ALL	EPS AAC GTG A,B SEQUENCER FAIL TO OPERATE (CCF)	1.4E-04	2.9E+00	2.7E-04
713	EPSCF2CBFC52AAC2-ALL	EPS 52/AACAP,52/AACBP (BREAKER) FAIL TO CLOSE (CCF)	2.8E-05	2.9E+00	5.5E-05
714	EPSCF2CBSO5AAC2-ALL	EPS 52/AACAP,52/AACBP (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	2.9E+00	5.5E-07
715	SGNST-BOP1	BO-SIGNAL (TRAIN P1) FAILURE	1.2E-03	2.9E+00	2.3E-03
716	EPPBTSWCCF	AAC SOFTWARE FAILURE CCF	1.0E-04	2.9E+00	1.9E-04
717	EPSCBFC52AACA	EPS 52/AACA (BREAKER) FAIL TO CLOSE	3.7E-04	2.9E+00	7.1E-04
718	EPSCBFO52EPSA	EPS 52/EPSA (BREAKER) FAIL TO OPEN	3.7E-04	2.9E+00	7.1E-04
719	EPSCBFC89AACA	EPS 89/AACA (SELECTER CIRCUIT) FAIL TO CLOSE	3.7E-04	2.9E+00	7.1E-04
720	EPSCBSC52EPSA	EPS 52/EPSA (BREAKER) SPURIOUS CLOSE	3.1E-06	2.9E+00	5.9E-06

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 73 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
721	EPSCBSO52AACA	EPS 52/AACA (BREAKER) SPURIOUS OPEN	3.1E-06	2.9E+00	5.9E-06
722	EPSCBSO89AACA	EPS 89/AACA (SELECTER CIRCUIT) SPURIOUS OPEN	3.1E-06	2.9E+00	5.9E-06
723	EPSCF2CBFO52EPS-ALL	EPS 52/EPSA,D (BREAKER) FAIL TO OPEN (CCF)	2.8E-05	2.9E+00	5.3E-05
724	EPSCF2CBFC89AAC-ALL	EPS 89/AACA,D (SELECTER CIRCUIT) FAIL TO CLOSE (CCF)	2.8E-05	2.9E+00	5.3E-05
725	EPSCF2CBFC52AAC-ALL	EPS 52/AACA,D (BREAKER) FAIL TO CLOSE (CCF)	2.8E-05	2.9E+00	5.3E-05
726	EPSCF2CBSO89AAC-ALL	EPS 89/AACA,D (SELECTER CIRCUIT) SPURIOUS OPEN (CCF)	2.8E-07	2.9E+00	5.3E-07
727	EPSCF2CBSC52EPS-ALL	EPS 52/EPSA,D (BREAKER) SPURIOUS CLOSE (CCF)	2.8E-07	2.9E+00	5.3E-07
728	EPSCF2CBSO52AAC-ALL	EPS 52/AACA,D (BREAKER) SPURIOUS OPEN (CCF)	2.8E-07	2.9E+00	5.3E-07
729	EPSDLLRDGP1	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	2.9E+00	3.4E-02
730	EPSDLADDGP1	EPS A-AAC GTG FAIL TO START	4.7E-03	2.9E+00	9.0E-03

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 74 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
731	EPSSEFFDGP1	EPS A-AAC GTG SEQUENCER FAIL TO OPERATE	2.9E-03	2.9E+00	5.5E-03
732	EPSDLSRDGP1	EPS A-AAC GTG FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION	2.8E-03	2.9E+00	5.3E-03
733	EPSCBFC52AACAP	EPS 52/AACAP (BREAKER) FAIL TO CLOSE	3.7E-04	2.9E+00	7.1E-04
734	EPSCBSO52AACAP	EPS 52/AACAP (BREAKER) SPURIOUS OPEN	3.1E-06	2.9E+00	5.9E-06
735	CWSRHPF001C1-CG3	NCS-RHX-001C (C-CCW HX) PLUG / FOUL	1.4E-06	2.8E+00	2.5E-06
736	CWSPNELCCWC	NCS CWS TRAIN C PIPING EXTERNAL LEAK LARGE	1.1E-06	2.8E+00	2.1E-06
737	RSSMVOM145C	NCS-MOV-145C SPURIOUS OPEN	9.6E-07	2.8E+00	1.7E-06
738	CWSRIEL001C1	NCS-RHX-001C (C-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	2.8E+00	1.3E-06
739	CWSPMEL001C	NCS-RPP-001C (C-CCW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.8E+00	3.5E-07
740	HPIXVEL114C	NCS-VLV-114C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 75 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
741	HPIXVEL116C	NCS-VLV-116C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
742	HPIXVEL119C	NCS-VLV-119C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
743	CWSXVEL005C	NCS-VLV-005C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
744	HPIXVEL115C	NCS-VLV-115C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
745	CWSXVEL018C	NCS-VLV-018C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
746	CWSXVEL008C	NCS-VLV-008C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
747	CWSXVEL101C	NCS-VLV-101C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
748	HPIXVEL111C	NCS-VLV-111C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
749	CWSXVEL104C	NCS-VLV-104C EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
750	CWSCVEL016C	NCS-VLV-016C EXTERNAL LEAK LARGE	4.8E-08	2.8E+00	8.7E-08

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 76 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
751	CWSMVEL020C	NCS-MOV-020C EXTERNAL LEAK LARGE	2.4E-08	2.8E+00	4.4E-08
752	CWSMVEL007C	NCS-MOV-007C EXTERNAL LEAK LARGE	2.4E-08	2.8E+00	4.4E-08
753	CWSPNELCCWC1	NCS CWS C1-HEADER LINE PIPING EXTERNAL LEAK LARGE	7.9E-07	2.8E+00	1.4E-06
754	CWSXVEL034B	NCS-VLV-034B EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
755	CWSXVEL033B	NCS-VLV-033B EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
756	CHIXVEL315B	NCS-VLV-315B EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
757	CHIXVEL301B	NCS-VLV-301B EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
758	CHIXVEL312B	NCS-VLV-312B EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
759	CHIXVEL311B	NCS-VLV-311B EXTERNAL LEAK LARGE	7.2E-08	2.8E+00	1.3E-07
760	RSSCF3PMAD001ABC-23	RHS-RPP-001A,B,C (CS/RHR PUMP) FAIL TO RE-START (CCF)	2.5E-05	2.7E+00	4.2E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 77 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
761	RSSCF3PMAD001ABC-13	RHS-RPP-001A,B,C (CS/RHR PUMP) FAIL TO RE-START (CCF)	2.5E-05	2.6E+00	4.1E-05
762	EPSCF4IVFF001-13	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	1.0E-06	2.6E+00	1.6E-06
763	EPSCF4CBSO52UA-13	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	2.6E+00	5.5E-08
764	EPSCF4CBSO72AU-13	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	3.4E-08	2.6E+00	5.5E-08
765	CWSORPR1225	NCS-FE-1225 (ORIFICE) PLUG	2.4E-05	2.6E+00	3.7E-05
766	RSSPMBD001C-CG3	RHS-RPP-001C (C-CS/RHR PUMP) FAIL TO START	1.9E-03	2.6E+00	3.0E-03
767	RSSPMYR001C-CG3	RHS-RPP-001C (C-CS/RHR PUMP) FAIL TO RUN	1.1E-04	2.5E+00	1.8E-04
768	ESWCF3PMBD001ABC-13	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RE-START (CCF)	7.9E-05	2.5E+00	1.2E-04
769	ESWCF3PMBD001ABC-12	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RE-START (CCF)	7.9E-05	2.5E+00	1.2E-04
770	ESWCF3CVOD502ABC-13	EWS-VLV-502A,B,C FAIL TO RE-OPEN (CCF)	1.5E-07	2.5E+00	2.3E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 78 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
771	ESWCF3CVOD602ABC-13	EWS-VLV-602A,B,C FAIL TO RE-OPEN (CCF)	1.5E-07	2.5E+00	2.3E-07
772	ESWCF3CVOD502ABC-12	EWS-VLV-502A,B,C FAIL TO RE-OPEN (CCF)	1.5E-07	2.5E+00	2.3E-07
773	ESWCF3CVOD602ABC-12	EWS-VLV-602A,B,C FAIL TO RE-OPEN (CCF)	1.5E-07	2.5E+00	2.3E-07
774	CWSCF3PCBD001ABC-13	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RE-START (CCF)	4.4E-05	2.5E+00	6.6E-05
775	CWSCF3PCBD001ABC-12	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RE-START (CCF)	4.4E-05	2.5E+00	6.6E-05
776	EPSBSFFAM001B	ESS-AM-001B (B CLASS 1E 6.9KV BUS) FAILURE	5.8E-06	2.5E+00	8.6E-06
777	RSSCVOD028C-CG3	RHS-VLV-028C FAIL TO OPEN	1.0E-05	2.5E+00	1.5E-05
778	RSSCVOD022C-CG3	RHS-VLV-022C FAIL TO OPEN	1.0E-05	2.5E+00	1.5E-05
779	RSSCVOD027C-CG3	RHS-VLV-027C FAIL TO OPEN	1.0E-05	2.5E+00	1.5E-05
780	RSSCVOD004C-CG3	RHS-VLV-004C FAIL TO OPEN	1.0E-05	2.5E+00	1.5E-05

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 79 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
781	RSSRHPR001C-CG3	RHS-RHX-001C (C-CS/RHR HX) PLUG / FOUL	8.7E-06	2.5E+00	1.3E-05
782	RSSCF3PMYR001ABC-23	RHS-RPP-001A,B,C (CS/RHR PUMP) FAIL TO RUN (CCF)	1.5E-06	2.4E+00	2.1E-06
783	RSSCF3PMYR001ABC-13	RHS-RPP-001A,B,C (CS/RHR PUMP) FAIL TO RUN (CCF)	1.5E-06	2.4E+00	2.1E-06
784	CHIOO02P+RWS-DP3	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP	1.6E-01	2.4E+00	2.7E-01
785	EPSCF4IVFF001-134	ESS-AU-001A,B,C,D (UPS UNIT) FAIL TO OPERATE (CCF)	5.0E-07	2.3E+00	6.3E-07
786	EPSCF4CBSO72AU-134	EPS 72/AUA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.3E+00	3.7E-08
787	EPSCF4CBSO52UA-134	EPS 52/UAA,B,C,D (BREAKER) SPURIOUS OPEN (CCF)	2.9E-08	2.3E+00	3.7E-08
788	RSSCF3CVOD028ABC-13	RHS-VLV-028A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.8E-07
789	RSSCF3CVOD022ABC-13	RHS-VLV-022A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.8E-07
790	RSSCF3CVOD027ABC-13	RHS-VLV-027A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.8E-07

Table 19.1-94 Basic Events (Hardware Failure, Human Error) RAW of POS 8-1 for LPSD PRA (Sheet 80 of 80)

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
791	RSSCF3CVOD004ABC-13	RHS-VLV-004A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.8E-07
792	RSSCF3RHPR001ABC-13	RHS-RHX-001A,B,C (CS/RHR HX) PLUG / FOUL (CCF)	2.4E-07	2.2E+00	3.0E-07
793	RSSCF3CVOD028ABC-23	RHS-VLV-028A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.3E-07
794	RSSCF3CVOD027ABC-23	RHS-VLV-027A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.3E-07
795	RSSCF3CVOD022ABC-23	RHS-VLV-022A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.3E-07
796	RSSCF3CVOD004ABC-23	RHS-VLV-004A,B,C FAIL TO OPEN (CCF)	4.6E-07	2.2E+00	5.3E-07
797	RSSCF3RHPR001ABC-23	RHS-RHX-001A,B,C (CS/RHR HX) PLUG / FOUL (CCF)	2.4E-07	2.2E+00	2.8E-07
798	AC2-F	FAILURE OF OFFSITE POWER RECOVERY	8.6E-02	2.0E+00	9.8E-02

Table 19.1-95 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	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)	1.1E-03	5.6E-02	5.1E+01
2	ESWCF3PMBD001ABC-ALL	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RE-START (CCF)	6.0E-05	2.0E-02	3.3E+02
3	SGNBTSWCCF1	PCMS APPLICATION SOFTWARE GROUP1 FAILURE CCF	1.0E-04	1.5E-02	1.5E+02
4	SGNBTSWCCF	PSMS APPLICATION SOFTWARE FAILURE CCF	1.0E-05	1.4E-02	1.4E+03
5	EPSCF3DLADDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO START (CCF)	2.4E-04	1.2E-02	5.1E+01
6	CWSCF3PCBD001ABC-ALL	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RE-START (CCF)	3.3E-05	1.1E-02	3.3E+02
7	EPSCF3DLSRDG-ALL	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN DURING FIRST HOUR OF OPERATION (CCF)	1.8E-04	8.8E-03	5.1E+01
8	EPSCBFO52RAT-ABC	EPS 52/RATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	4.6E-03	8.9E+02
9	EPSCBFO52UAT-ABC	EPS 52/UATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	4.6E-03	8.9E+02
10	EPSCF3DLLRDG-12	EPS CLASS 1E GTG A,B,C FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION (CCF)	5.1E-04	4.1E-03	9.2E+00

Table 19.1-96 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	RTPBTSWCCF	BASIC SOFTWARE FAILURE CCF	1.0E-07	3.7E+04	3.7E-03
2	SWSCF3PMYR001ABC-ALL	EWS-OPP-001A,B,C (ESW PUMP) FAIL TO RUN (CCF)	1.2E-07	1.2E+04	1.5E-03
3	CWSCF3PCYR001ABC-ALL	NCS-RPP-001A,B,C (CCW PUMP) FAIL TO RUN (CCF)	6.7E-08	1.2E+04	8.2E-04
4	CWSCF3RHPF001ABC-ALL	NCS-RHX-001A,B,C (CCW HX) PLUG / FOUL(CCF)	3.6E-08	1.2E+04	4.4E-04
5	CWSCF3RHPF001ABC-12	NCS-RHX-001A,B,C (CCW HX) PLUG / FOUL(CCF)	1.8E-08	2.3E+03	4.2E-05
6	SGNBTSWCCF	PSMS APPLICATION SOFTWARE FAILURE CCF	1.0E-05	1.4E+03	1.4E-02
7	EPSCBFO52RAT-ABC	EPS 52/RATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.9E+02	4.6E-03
8	EPSCBFO52UAT-ABC	EPS 52/UATA,B,C (BREAKER) FAIL TO OPEN (CCF)	5.2E-06	8.9E+02	4.6E-03
9	EPSCF4CBSC52RAT-123	EPS 52/RATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	8.9E+02	2.6E-05
10	EPSCF4CBSC52UAT-123	EPS 52/UATA,B,C,D (BREAKER) SPURIOUS CLOSE (CCF)	2.9E-08	8.9E+02	2.6E-05

Table 19.1-97 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 SAFETY INJECTION PUMP	5.5E-02	5.8E-01	1.1E+01
2	CHIOO02P+RWS-DP3	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP	1.6E-01	2.7E-01	2.4E+00
3	RSSOO02P	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS	2.6E-03	2.4E-01	9.7E+01
4	CHIOO02P	OPERATOR FAILS TO START STANDBY CHARGING PUMP	2.6E-03	2.4E-01	9.5E+01
5	ACWOO02SC	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM	2.2E-02	1.2E-01	6.2E+00
6	HPIOO02S	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP	4.9E-03	9.9E-02	2.1E+01
7	RSSOO02LINE+P	OPERATOR FAILS TO ESTABLISH RHR INJECTION LINE AND START STANBY PUMP	3.8E-03	5.7E-02	1.6E+01
8	CHIOO02RWS-DP3	OPERATOR FAILS TO REFILL RWSAT WATER FROM RWSP	1.6E-01	5.6E-02	1.3E+00
9	CHIOO02P+RWS-DP2	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP	6.8E-02	5.3E-02	1.7E+00
10	EPSOO02RDG	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	4.2E-02	2.9E+00

Table 19.1-98 Human Error RAW of POS 8-1 for LPSD PRA

RANK	Basic Event ID	Basic Event Description	Basic Event Probability	RAW	FV Importance
1	RSSOO02P	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS	2.6E-03	9.7E+01	2.4E-01
2	CHIOO02P	OPERATOR FAILS TO START STANDBY CHARGING PUMP	2.6E-03	9.5E+01	2.4E-01
3	HPIOO02S	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP	4.9E-03	2.1E+01	9.9E-02
4	RSSOO02LINE+P	OPERATOR FAILS TO ESTABLISH RHR INJECTION LINE AND START STANBY PUMP	3.8E-03	1.6E+01	5.7E-02
5	LOAOO02LC	OPERATOR FAILS TO ISOLATE THE LEAKAGE TRAIN OF RHR SYSTEM	2.6E-03	1.6E+01	3.8E-02
6	HPIOO02S-DP2	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP	5.5E-02	1.1E+01	5.8E-01
7	ACWOO02SC	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM	2.2E-02	6.2E+00	1.2E-01
8	RWSOO04XV051	MISALIGNMENT OF RWS-VLV-051 AFTER TEST OR MAINTENANCE	8.0E-04	3.9E+00	2.3E-03
9	EPSOO02RDG	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS	2.1E-02	2.9E+00	4.2E-02
10	CHIOO02P+RWS-DP3	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP	1.6E-01	2.4E+00	2.7E-01

Table 19.1-99 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	EPSDLLRDGP1	EPS A-AAC GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.8E-02	3.4E-02	2.9E+00
2	CHIPMBD001A	CVS-RPP-001A (A-CHI PUMP) FAIL TO START	2.0E-03	2.3E-02	1.2E+01
3	EPSDLLRDGB	EPS B-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	1.0E-02	1.6E+00
4	EPSDLADDGP1	EPS A-AAC GTG FAIL TO START	4.7E-03	9.0E-03	2.9E+00
5	CHIPMAD001A-R	CVS-RPP-001A (A-CHI PUMP) FAIL TO RE-START	1.5E-03	7.9E-03	6.2E+00
6	EPSDLLRDGA	EPS A-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	7.0E-03	1.4E+00
7	CVCAVCD024B	RHS-AOV-024B FAIL TO CLOSE	1.2E-03	6.9E-03	6.7E+00
8	CVCAVCD024C	RHS-AOV-024C FAIL TO CLOSE	1.2E-03	6.9E-03	6.7E+00
9	EPSDLLRDGC	EPS C-CLASS 1E GTG FAIL TO LOAD AND RUN AFTER FIRST HOUR OF OPERATION	1.7E-02	6.2E-03	1.4E+00
10	EPSSEFFDGP1	EPS A-AAC GTG SEQUENCER FAIL TO OPERATE	2.9E-03	5.5E-03	2.9E+00

Table 19.1-100 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	ACWCVEL306A	NCS-VLV-306A EXTERNAL LEAK LARGE	4.8E-08	2.3E+03	1.1E-04
2	ACWMVEL316A	NCS-MOV-316A EXTERNAL LEAK LARGE	2.4E-08	2.3E+03	5.6E-05
3	CWSPNELCCWB	NCS CWS TRAIN B PIPING EXTERNAL LEAK LARGE	1.1E-06	2.3E+03	2.5E-03
4	CWSPNELCCWA	NCS CWS TRAIN A PIPING EXTERNAL LEAK LARGE	8.8E-07	2.3E+03	2.0E-03
5	CWSPNELCCWA1	NCS CWS A1-HEADER LINE PIPING EXTERNAL LEAK LARGE	8.2E-07	2.3E+03	1.9E-03
6	CWSRIEL001B1	NCS-RHX-001B (B-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	2.3E+03	1.7E-03
7	CWSRIEL001A1	NCS-RHX-001A (A-CCW HX) TUBE EXTERNAL LEAK LARGE	7.2E-07	2.3E+03	1.7E-03
8	CWSPMEL001B	NCS-RPP-001B (B-CCW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.3E+03	4.5E-04
9	CWSPMEL001A	NCS-RPP-001A (A-CCW PUMP) EXTERNAL LEAK LARGE	1.9E-07	2.3E+03	4.5E-04
10	HPIXVEL119B	NCS-VLV-119B EXTERNAL LEAK LARGE	7.2E-08	2.3E+03	1.7E-04

Table19.1-101 Important Operator Actions in POS 8-1

No	System	Operator Action Description
1	ALTERNATE COMPONENT COOLING WATER SYSTEM	OPERATOR FAILS TO ESTABLISH THE ALTERNATE CCWS BY FIRE SUPPRESSION SYSTEM
2	CHEMICAL AND VOLUME CONTROL SYSTEM	OPERATOR FAILS TO START STANDBY CHARGING PUMP
3	CHEMICAL AND VOLUME CONTROL SYSTEM	OPERATOR FAILS TO START STANDBY CHARGING PUMP AND REFILL RWSAT WATER FROM RWSP
4	CHEMICAL AND VOLUME CONTROL SYSTEM	OPERATOR FAILS TO REFILL RWSAT WATER FROM RWSP
5	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	OPERATOR FAILS TO CONNECT THE ALTERNATE AC POWER SOURCE TO CLASS 1E BUS
6	HIGH HEAD INJECTION SYSTEM	OPERATOR FAILS TO START STANDBY SAFETY INJECTION PUMP
7	RESIDUAL HEAT REMOVAL SYSTEM	OPERATOR FAILS TO ISOLATE THE LEAKAGE TRAIN OF RHR SYSTEM
8	RESIDUAL HEAT REMOVAL SYSTEM	OPERATOR FAILS TO ESTABLISH RHR INJECTION LINE AND START STANBY PUMP
9	RESIDUAL HEAT REMOVAL SYSTEM	OPERATOR FAILS TO RE-START THE RHR PUMPS WHEN THE LOOP EVENT OCCURS

Table19.1-102 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.

Table19.1-103 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.

Table19.1-104 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.

Table19.1-105 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.

Table19.1-106 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.

Table19.1-107 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.

Table19.1-108 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.

Table19.1-109 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.

Table19.1-110 Important SSCs of each System in POS 8-1 (Sheet 1 of 2)

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 HEAT REMOVAL SYSTEM	RHR PUMP SUCTION MOTOR OPERATED ISOLATION VALVES (RHS-MOV-001A,B,C, 002A,B,C) RHR PUMP (A,B,C) RHR LINE CONTAINMNET ISOLATION MOTOR OPERATED VALVES (RHS-MOV-021A,B,C) RCS COLD LEG INJECTION LINE MOTOR OPERATED VALVES (RHS-MOV-026A,B,C)	RHR D-train is outage.
3	HEAT REMOVAL via SGs	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 VOLUME CONTROL TANK DISCHARGE LINE MOTOR OPERATED VALVES (CVS-LCV-121B,C) CHARGING PUMP RWAT SUCTION ISOLATION VALVES MOTOR OPERATED (CVS-LCV-121D,E, F, G) REFUELING WATER STORAGE AUXILIARY TANK SUCTION LINE MANUAL VALVE FAIL TO OPEN (CVS-VLV-591) REFUELING WATER AUXILIARY TANK	Charging pump B is outage
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) CLASS 1E 6.9KV BUS INCOMING CIRCUIT BREAKER (52/UATA,B,C) AAC GAS TURBINE GENERATOR (GTG P1,2)	GTG D-train is outage.

Table19.1-110 Important SSCs of each System in POS 8-1 (Sheet 2 of 2)

No	System	Description	Remarks
7	EMERGENCY ELECTRIC POWER SUPPLY SYSTEM	CLASS 1E GAS TURBINE GENERATOR (GTG A,B,C) CLASS 1E 6.9KV BUS INCOMING CIRCUIT BREAKER (52/UATA,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 (NCS-MOV-321B, 322B, 324B, 325B) CHARGING PUMP COOLING LINE ISOLATION MOTOR OPERATED VALVES (NCS-MOV-316B)	

Table19.1-111 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 HEAT 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: A,B,C,D trains.	
3	HEAT REMOVAL via SGs	MOTOT DRIVEN EFW PUMP C MAIN STEAM DEPRESSURIZATION VALVES C, D	This system is unavailable in POS 8-1 because SGs are 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 charging pump, 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: A,B,C,D trains.	

Table19.1-112 Differences of Important SSCs between POS 4-1 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEAT 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: A,B,C,D trains.	
2	HEAT REMOVAL via SGs	MOTOT DRIVEN EFW PUMP C MAIN STEAM DEPRESSURIZATION VALVES C, D	This system is unavailable in POS 8-1 because SGs are 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 pumps 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: 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 4-1: A,B,C,D trains.	

Table19.1-113 Differences of Important SSCs between POS 4-2 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEAT 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: A,B,C,D trains.	
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 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: 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 4-2: A,B,C,D trains.	

Table19.1-114 Differences of Important SSCs between POS 4-3 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEAT 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: A,B,C,D trains.	
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 pumps 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: 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 4-3: A,B,C,D trains.	

Table19.1-115 Differences of Important SSCs between POS 8-2 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEAT 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	This system is unavailable in POS 8-1 because the RCS is not atmospheric pressure. But it is available in POS 8-2.
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.	

Table19.1-116 Differences of Important SSCs between POS 8-3 and POS 8-1

No	System	Description	Remarks
1	RESIDUAL HEAT 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	HEAT REMOVAL via SGs	MOTOR DRIVEN EFW PUMP B MAIN STEAM DEPRESSURIZATION VALVES A, B, C, D	This system is unavailable in POS 8-1 because SGs are 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.	

Table19.1-117 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 HEAT 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	HEAT REMOVAL via SGs	MOTOR DRIVEN EFW PUMP B MAIN STEAM DEPRESSURIZATION VALVES A, B, C, D	This system is unavailable in POS 8-1 because SGs are 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.	

Table19.1-118 Differences of Important SSCs between POS 11 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 HEAT 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	HEAT REMOVAL via SGs	MOTOR DRIVEN EFW PUMP B MAIN STEAM DEPRESSURIZATION VALVES	This system is unavailable in POS 8-1 because SGs are 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.	

Table 19.1-119 Key Insights and Assumptions (Sheet 1 of 23)

Key Insights and Assumptions	Dispositions
Design features and insights	
1. High Head Safety Injection System	
- The high head safety injection system consists of four independent and dedicated SI pump trains.	6.3.2.1.1
- 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.	6.3.2.1.1
2. Accumulator System	
- There are four accumulators, one supplying each reactor coolant cold leg.	6.3.2.1.2
- 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.	6.3.2.1.2
3. Chemical and Volume Control System	
- The charging pumps are arranged in parallel with common suction and discharge headers. Each pump provides full capability for normal makeup.	9.3.4.2.6
- Charging injection is provided by the CVCS. One CVCS charging pump is capable of maintaining normal RCS inventory with small system leak if the leakage rate is less than that from a break of a pipe 3/8 inch in inside diameter.	9.3.4.2.7.4
- Normally, one charging pump is operating and takes suction from the VCT, supplies charging flow to the RCS and seal water to the reactor coolant pumps.	9.3.4.2.6
- The pump can take suction from the VCT, the reactor makeup control system, the refueling water storage auxiliary tank and the spent fuel pit.	9.3.4.2.6
- During normal operation, the VCT water level is controlled by automatic makeup. In case the automatic makeup fails to actuate and the water level in the VCT decreases, low VCT water level is detected and actuates a low-low level signal that opens the stop valves in the refueling water storage auxiliary tank supply line, and closes No. 1 and No. 2 stop valves in the VCT outlet to provide emergency makeup.	9.3.4.5.4.1

Table 19.1-119 Key Insights and Assumptions (Sheet 2 of 23)

Key Insights and Assumptions	Dispositions
4. Containment Spray System / Residual Heat Removal System	
- The containment spray system (CSS) and the residual heat removal system (RHRS) share major components which are containment spray/residual heat removal (CS/RHR) pumps and heat exchangers.	6.2.2
- The CSS/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.	6.2.2 5.4.7.2.1
- 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 during LOCA in conjunction with a fast depressurization of the RCS by using the EFW pumps to remove heat through the SGs and by manually opening the MSRVs especially in high RCS pressure sequences, (3) RHR operation for long term core cooling, (4) heat removal function for long term C/V cooling, (5) providing water to flood the reactor cavity and (6) fission product removal. During plant shutdown, RHRS provides function to remove decay heat from the RCS.	3.2.2 6.2.5 5.4.7.1
- The RHRS is designed and equipped with pressure relief valves to prevent RHRS over-pressurization and low temperature over-pressurization.	5.4.7.1
- Two motor operated valves in series on the RHR suction line with power lockout capability during normal power operation minimize the probability of RCS pressure entering the RHR system. Even if both these valves are opened during normal power operation, the RHR system is designed to discharge the RCS inventory to the in-containment RWSP. The RHRS is designed to prevent an interfacing system LOCA by having a design rating of 900 lb. The RHR 900 lb. design rated system can withstand the full RCS pressure.	6.3.1.4

Table 19.1-119 Key Insights and Assumptions (Sheet 3 of 23)

Key Insights and Assumptions	Dispositions
- The RHR system is used to provide core cooling when the RCS must be partially drained to allow maintenance or inspection of the reactor head, SGs, or reactor coolant pump seals.	5.4.7.2.3.6
- During mid-loop operation, if the water level of RCS drops below the mid-loop level, low pressure letdown lines are isolated automatically. This interlock is useful to prevent loss of reactor coolant inventory.	5.4.7.2.3.6
5. Refueling Water Storage Pit	
- The RWSP is located on the lowest floor inside the containment. The coolant and associated debris from a pipe or component rupture (LOCA), and the containment spray drain into the RWSP through transfer pipes.	6.3.2.2.5 6.3.2.2.6
- Four independent sets of ECC/CS strainers located in the RWSP. The strainer design includes redundancy, a large surface area to account for potential debris blockage and maintain safety performance, corrosion resistance, and a strainer hole size to minimize downstream effects.	
6. Reactor Trip System	
- Reactor trip signal is provided by the reactor protection system (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.	7.2.1
- One channel of sensor is allowed to be unlimitedly bypassed. One train of reactor trip breaker is allowed to be unlimitedly bypassed.	16.3.3
- Each train of the RPS consists of two separate digital controllers to achieve defense-in-depth through functional diversity. Each functionally diverse digital controller within a train can initiate a partial reactor trip signal.	7.2.1.9

Table 19.1-119 Key Insights and Assumptions (Sheet 4 of 23)

Key Insights and Assumptions	Dispositions
7. Engineered Safety Function System	
- There are four redundant engineered safety function (ESF) trains. Within each train, ESF actuation system (ESFAS) and signal logic system (SLS) controllers are redundant.	7.3.1.8
- All ESF systems are automatically initiated from signals that originate in the RPS. Manual actuation of ESF systems is carried out through a diverse signal path that bypasses the RPS.	7.3.1.9
8. Diverse Actuation System	
- The diverse actuation system (DAS) provides monitoring, control and actuation of safety and non-safety systems required to cope with abnormal plant conditions concurrent with a CCF that disables all functions of the PSMS and PCMS.	7.8
- DAS design consists of conventional equipment that is totally diverse and independent from the MELTAC platform of the PSMS and PCMS. Therefore, a software CCF in the digital safety and non-safety systems, would not affect the DAS.	7.8.2.2
- DAS hardware for anticipated transient without scram (ATWS) mitigation functions – Reactor trip, turbine trip, and EFW actuation, is diverse from the reactor trip hardware used in the PSMS. The reactor trip is actuated by tripping the non-safety CRDM motor-generator set.	7.8.1.2.1 7.8.2.2
- The DAS is electrically and physically isolated from the PSMS.	7.8.2.3
9. Emergency Feed Water System	
- EFWS consists of two motor-driven pumps and two steam turbine-driven pumps with two emergency feedwater pits.	10.4.9.2
- Each EFW pump discharge line connects with a tie line with a motor-operated isolation valve. During normal plant operation (at non-OLM), the discharge tie line isolation valves of each EFW pump discharge tie line are in the closed position to provide separation of four trains. During OLM, the tie line isolation valves of each EFW pump discharge tie line are kept in the open position.	10.4.9.2
- Upon detection of a water level increase of the SG, the EFW isolation valves and EFW control valves are automatically closed.	10.4.9.2

Table 19.1-119 Key Insights and Assumptions (Sheet 5 of 23)

Key Insights and Assumptions	Dispositions
- The motor-operated EFW isolation valves and EFW control valves are provided in each EFW pump discharge line to close automatically to terminate the flow to the affected SG.	10.4.9.2
- The common suction line from each EFW pit is connected by a tie line with two normally closed manual valves. When the two EFW pumps taking suction from the same pit are not available (OLM of one EFW pump and the single failure of other EFW pump), the tie line connections to EFW pits need to be established.	10.4.9.2
- The demineralized water storage tank provides a backup source for EFWS. The manual valves from the demineralized water storage tank to the EFW pumps are normally closed.	
10. Reactor Coolant System High Point Vents	
- 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 occurs.	5.4.12.2
- 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.	5.4.12.2
11. Main Steam Supply System 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.	10.3
12. Component Cooling Water System	
- The CCWS consists of two independent subsystems. One subsystem consists of trains A & B, and the other subsystem consists of trains C & D, for a total of four trains.	9.2.2.2
- The CCWS is designed to withstand leakage in one train without loss of the system's safety function.	9.2.2.1.1
- Two motor operated valves are located at the CCW outlet of the RCP thermal barrier Hx and close automatically upon a high flow rate signal at the outlet of this line in the event of in-leakage from the RCS through the thermal barrier Hx, and prevents this in-leakage from further contaminating the CCWS.	9.2.2.2.1.5

Table 19.1-119 Key Insights and Assumptions (Sheet 6 of 23)

Key Insights and Assumptions	Dispositions
- CCWS supplies cooling water to containment fan cooler unites to when performing alternate CV cooling during severe accident conditions. The cooling water system is switched from the non-essential chilled water system to CCW system to supply the cooling water to the containment fan cooler units.	9.4.6.2.1
- In the case of loss of CCW, a non-essential chilled water system or a fire suppression system is able to connect to the CCWS in order to cool the charging pump and maintain RCP seal water injection.	
13. Essential Service water system	
The ESWS is arranged into four independent trains (A, B, C, and D). Each train consists of one ESWP, two 100% strainers in the pump discharge line, one 100% strainer upstream of the CCW HX, one CCW HX, one essential chiller unit, and associated piping, valves, instrumentation and controls.	9.2.1.2.1 COL19.2(3) COL19.2(4)
14. Onsite Electric Power System	
- The onsite Class 1E electric power systems comprise four independent and redundant trains, each with its own power supply, buses, transformers, and associated controls.	8.3.1.1.2.1
- One independent Class 1E GTG is provided for each Class 1E train.	8.3.1.1.2.1
- Non-Class 1E 6.9kV permanent buses P1 and P2 are also connected to the non-Class 1E A-AAC GTG and B-AAC GTG, respectively. The loads which are not safety-related but require operation during LOOP are connected to these buses.	8.3.1.1.1
- In the event of SBO, power to one Class 1E 6.9kV bus can be restored manually from the AAC GTG.	8.3.1.1.2.4
- 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.	8.4.1.3
- The non-safety GTG can be started manually when connecting to the class 1E bus in the event of SBO.	8.4.1.3
- Power to the shutdown buses can be restored from the AAC sources within 60 minutes	8.4.1.3

Table 19.1-119 Key Insights and Assumptions (Sheet 7 of 23)

Key Insights and Assumptions	Dispositions
- Power to the shutdown buses can be restored from the AAC sources within 60 minutes	8.4.1.3
- The GTG does not need cooling water system. Cooling of GTG is achieved by air ventilation system	9.5.5
- GTG combustion air intake and exhaust system for each of the four GTGs supply combustion air of reliable quality to the gas turbine and exhausts combustion products from the gas turbine to the atmosphere. The air intake also provides ventilation/cooling air to the GTG assembly.	9.5.8
15. RCP seal	
- RCP seal can keep its integrity for at least one hour without water cooling.	8.4.2.1.2
- If loss of seal injection should occur, CCW continues to provide flow to the thermal barrier heat exchanger; which cools the reactor coolant. The pump is able to maintain safe operating temperatures and operate safely long enough for safe shutdown of the pump.	5.4.1.3.3
- If loss of CCW should occur, seal injection flow continues to be provided to the RCP. The pump is designed so that the seal injection flow is sufficient to prevent damage to the seals with a loss of thermal barrier cooling.	5.4.1.3.4
16. Containment System	
- The containment prevents or limits the release of fission products to the environment.	3.1.2.7 3.8.1
- Hydrogen control system that consists of igniters is provided to limit the combustible gas concentration. The igniters start with the ECCS actuation signal and are powered by two non-class 1E buses with non-class 1E GTGs.	6.2.5.2
- 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.	9.4.6.2.1
- 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.	9.5.1.2.2

Table 19.1-119 Key Insights and Assumptions (Sheet 8 of 23)

Key Insights and Assumptions	Dispositions
- 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.	9.5.1.2.2
- A set of drain lines from SG compartment to the reactor cavity is provided in order to achieve reactor cavity flooding. Spray water which flows into the SG compartment drains to the cavity and cools down the molten core after reactor vessel breach.	3.4.1.5.1
- Reactor cavity has a core debris trap area to prevent entrainment of the molten core to the upper part of the containment.	3.8.1 19.2.3.3.4
- Reactor cavity is designed to ensure thinly spreading debris by providing sufficient floor area and appropriate depth.	3.8.1 19.2.3.3.3
- Reactor cavity floor concrete is provided to protect against challenge to liner plate melt through.	3.8.1 19.2.3.3.3
- Main penetrations through containment vessel are isolated automatically with the containment penetration signal even in case of SBO.	6.2.4
17. 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.	19.2.3.3.7
18. Instrumentations for detecting core damage with high reliability are provided.	5.3.3.1
19. Risk significant SSCs are identified for the RAP.	17.4
20. Instrumentation piping are installed at upside of the RV. No penetrations through the RV are located below the top of the reactor core. This minimizes the potential for a loss of coolant accident by leakage from the reactor vessel, allowing the reactor core to be uncovered.	5.3.3.1

Table 19.1-119 Key Insights and Assumptions (Sheet 9 of 23)

Key Insights and Assumptions	Dispositions
Operator actions (At Power)	
1. Operator actions modeled in the PRA are based on symptom oriented procedures. Risk significant operator actions identified in the PRA will be addressed in plant operating procedures including AOP, EOP, etc.	19.2.5 COL 19.3(6) COL 13.5(5) COL 13.5(6) COL 13.5(7) COL 19.3(6)
2. Maintenance procedures indicate to check valve positions from the main control room after outages or testing. Valves that have been aligned in the wrong position will be detected and fixed to the correct position within a short period of time.	19.2.5 COL 19.3(6) COL 13.5(7)
3. In the operational VDU of US-APWR, the layout of controllers & monitoring alignment in each window are different and this feature would make the operator perceive them as different locations.	18.4 19.2.5 COL 19.3(6) COL 13.5(5)
4. In the case of loss of CCW, operators connect a non-essential chilled water system or a fire suppression system to the CCWS in order to cool the charging pump and maintain RCP seal water injection. This operator action is risk important. Activities to minimizes the likelihood of human error in the human factors engineering is important in developing procedures, training and other human reliability related programs.	18.6 19.1.4 COL 13.5(5)
5. When station blackout occurs, operators connect the alternative ac power to class 1E bus in order to recovery emergency ac power. This operator action is risk important. Activities to minimizes the likelihood of human error in the human factors engineering is important in developing procedures, training and other human reliability related programs.	18.6 19.2.5 COL 19.3(6) COL 13.5(6)
6. 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.	19.2.5 COL 19.3(6) COL 13.5(6)

Table 19.1-119 Key Insights and Assumptions (Sheet 10 of 23)

Key Insights and Assumptions	Dispositions
7. 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). In high RCS pressure sequences, a fast depressurization of the RCS by using the EFW pumps to remove heat through the SGs and by manually opening the MSRVs allows alternate core cooling injection using the CS/RHR pumps. 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.	19.2.5 COL 19.3(6) COL 13.5(6)
8. When any two EFW pumps that commonly utilize at EFW pit have failed, operators supply water to operating EFW pumps from alternate EFW pit or demineralized water storage pit in order to ensure the water source.	19.2.5 COL 19.3(6) COL 13.5(6)
9. In the case of failure to isolate failed SG, but success to sufficiently depressurize RCS by secondary side cooling and Safety depressurization valve in SGTR event, operators do RCS pressure control in order to prepare to early RHR cooling in order to ensure long term heat removal. (RCS pressure control means stopping SI safety injection and starting charging pump. RCS pressure under SI injection remains higher for connecting RHR system. Charging pump is back up for failure of RHR cooling after stopping SI injection.)	19.2.5 COL 19.3(6) COL 13.5(6)
10. In the case of above, if operators fail to move RHR cooling after SI injection control, operators start to bleed and feed operation. Operators open safety depressurization valve and start the safety injection pump in order to ensure long term heat removal.	19.2.5 COL 19.3(6) COL 13.5(6)
11. When the main steam isolation valve fail to close in SGTR event, with status signal of this valve, operators try to close this valve in order to stop leakage of RCS coolant from the failed SG.	19.2.5 COL 19.3(6) COL 13.5(6)

Table 19.1-119 Key Insights and Assumptions (Sheet 11 of 23)

Key Insights and Assumptions	Dispositions
12. When the main steam isolation valve fail to close in SGTR event, with SG pressure indication after above operation, operators close turbine bypass stop valves in order to stop leakage of RCS coolant from the failed SG.	19.2.5 COL 19.3(6) COL 13.5(6)
13. In the case of loss of failed SG isolation function in SGTR event, with SG pressure indication after above operation, operators open main steam depressurization valve of intact SG loop in order to promote SG heat removal and to depressurize RCS and move to cool down and recirculation operation.	19.2.5 COL 19.3(6) COL 13.5(6)
14. In the case of loss of secondary side cooling function by emergency feedwater system in transient events including turbine trip, load loss event etc., with emergency feedwater pump flow rate, operators start to recover main feedwater system in order to maintain secondary side cooling.	19.2.5 COL 19.3(6) COL 13.5(6)
15. In the case of loss of SI injection function entirely in LOCA event, with SI flow rate and RCS temperature indication, operators provide secondary side cooling to reduce RCS pressure and temperature by opening the main steam depressurization valves manually and supplying water from the emergency feedwater system in order to enable low pressure injection with containment spray system / residual heat removal system.	19.2.5 COL 19.3(6) COL 13.5(6)
16. In the case of loss of containment spray system function, alternate containment cooling operation is implemented utilizing CV natural recirculation in order to remove heat from CV. This preparation contains CCW pressurization with N2 gas, disconnection heat load of non-safety chiller and CRDM etc. and connection to containment fan cooler units. This operation is implemented when the containment pressure reaches the design pressure.	19.2.5 COL 19.3(6) COL 13.5(6)
17. In the case of leakage of the RWSP water from HHIS piping, CSS/RHR piping or refueling water storage system piping, with drain sump water level – abnormally high, operators close the RWSP suction isolation valves respectively in order to prevent leakage of RWSP water from failed piping.	19.2.5 COL 19.3(6) COL 13.5(6)

Table 19.1-119 Key Insights and Assumptions (Sheet 12 of 23)

Key Insights and Assumptions	Dispositions
18. When the CV isolation signal fail to automatically actuate, with CV pressure abnormally high signal, operators manually actuate the CV isolation signal in order to remove heat from the containment vessel.	19.2.5 COL 19.3(6) COL 13.5(6)
19. When the CCW header tie-line isolation valves fail to automatically close with specific signals which contain SI signal plus UV signal, P signal, and surge tank level low signal, operators manually close these valves in order to separate CCW header.	19.2.5 COL 19.3(6) COL 13.5(5)
20. RCS is depressurized through operating the depressurization valve after onset of core damage and before reactor vessel breach. This operation prevents events due to high pressure melt ejection.	19.2.5 COL 19.3(6) COL 13.5(5)
21. Operation of firewater injection to reactor cavity is implemented to flood reactor cavity in case of containment spray system failure, after onset of core damage and before reactor vessel breach.	19.2.5 COL 19.3(6) COL 19.3(6)
22. When the CCW header tie-line isolation valves fail to automatically close with specific signals which contain SI signal plus UV signal, P signal, and surge tank level low signal, operators manually close these valves in order to separate CCW header.	19.2.5 COL 19.3(6) COL 19.3(6)

Table 19.1-119 Key Insights and Assumptions (Sheet 13 of 23)

Key Insights and Assumptions	Dispositions
Operator actions (LPSD)	19.1.6
1. 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.	19.2.5 COL 19.3(6) COL 13.5(7) 5.4.7.2.3.6
2. When station blackout occurs, operators connect the alternative ac power with alternate gas turbines to class 1E bus in order to recover emergency ac power. This operator action is risk important. Activities to minimizes the likelihood of human error in the human factors engineering is important in developing procedures, training and other human reliability related programs.	18.8 18.9 19.2.5 COL 19.3(6) COL 13.5(7)
3. In the case of loss of CCW/ESW, operators connect the fire suppression system to the CCWS and start the fire suppression pump in order to cool the charging pump and maintain injection to RCS. . This operator action is risk important. Activities to minimizes the likelihood of human error in the human factors engineering is important in developing procedures, training and other human reliability related programs.	18.8 18.9 19.2.5 COL 19.3(6) COL 13.5(7)
4. In the case of loss of decay heat removal functions by RHRS and SGs operators start the charging pump in order to recover water level in the RCS. If water level in the RWSAT, which is the water source of charging pumps, indicates low level the operator will supply RWSP water to the RWSAT by the refueling water recirculation pump. This operator action is risk important. Activities to minimizes the likelihood of human error in the human factors engineering is important in developing procedures, training and other human reliability related programs.	18.8 18.9 19.2.5 COL 19.3(6) COL 13.5(7)
5. In case LOCA occurs in RHR line, operator will perform isolation of the RHR hot legs suction isolation valves and stop leakage of RCS coolant from RHRS where LOCA occurs.	19.2.5 COL 19.3(6) COL 13.5(7)
6. 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.	19.2.5 COL 19.3(6) COL 13.5(7)
7. When over-draining occurs and the automatic isolation valve fails, with RCS water level – low, operators close the valve on the letdown line in order to stop draining.	19.2.5 COL 19.3(6) COL 13.5(7)

Table 19.1-119 Key Insights and Assumptions (Sheet 14 of 23)

Key Insights and Assumptions	Dispositions
8. In the case of loss of decay heat removal functions by RHRS and SGs, operators start the safety injection pump in order to maintain RCS water level. This operator action is risk important. Activities to minimizes the likelihood of human error in the human factors engineering is important in developing procedures, training and other human reliability related programs.	18.8 18.9 19.2.5 COL 19.3(6) COL 13.5(7)
9. In the case of failure of running RHRS, with RHR flow rate – low, operators open the valves on the standby RHR suction line and discharge line and start the standby RHR pump in order to maintain RHR operating.	19.2.5 COL 19.3(6) COL 13.5(7)
10. In the case of leakage of the RWSP water from HHIS piping, CSS/RHR piping or refueling water storage system piping, with drain sump water level – abnormally high, operators close the RWSP suction isolation valves respectively in order to prevent leakage of RWSP water from failed piping.	19.2.5 COL 19.3(6) COL 13.5(7)
11. In the case of failure of running CCWS, with CCW flow rate – low, operators start the standby CCW pump in order to maintain CCWS operating.	19.2.5 COL 19.3(6) COL 13.5(7)
12. In the case of failure of running ESWS, with CCW flow rate – low, operators start the standby ESW pump in order to maintain ESWS operating.	19.2.5 COL 19.3(6) COL 13.5(5)
13. When ESW strainer plugs up, with ESW pump pressure – normal, ESW flow rate – low and differential pressure – significant, operators switch from plugged strainer to standby strainer in order to maintain ESWS operating.	19.2.5 COL 19.3(6) COL 13.5(5)
14. In the case of loss of decay heat removal functions from RHR, with RCS temperature – high or RCS water level – low, operators feed water to SGs by motor-driven EFW pump and open safety depressurization valve in order to remove decay heat from RCS.	19.2.5 COL 19.3(6) COL 13.5(7)
15. In the case of failure of feed or steam line associated with available motor-driven EFW pump during secondary side cooling, operators open the EFW tie-line valves in order to feed water to multiple SGs.	19.2.5 COL 19.3(6) COL 13.5(7)

Table 19.1-119 Key Insights and Assumptions (Sheet 15 of 23)

Key Insights and Assumptions	Dispositions
Operator actions (Severe Accidents)	
1. Operators manually initiate severe accident mitigation systems in accordance with the instructions from the technical support centre staff.	COL 19.3(6)
2. 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.	COL 19.3(6)

Table 19.1-119 Key Insights and Assumptions (Sheet 16 of 23)

Key Insights and Assumptions	Dispositions
LPSD assumptions	
1. Freeze plug may not be used 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.	
2. Hydrogen peroxide addition is adopted instead of aeration because it decreases the duration of the mid-loop operation. As a result, the mid-loop operation is needed only to drain the SG primary side water while being able to maintain a high RCS water level for most of the oxidation operation.	5.4.7.2.3.6
3. Installation of a redundant water narrow level instrument enhances reliability of the mid-loop operation.	5.4.7.2.3.6
4. 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.	19.2.5 COL 19.3(6) COL 13.5(6)
5. When the RCS is mid-loop operation, it is assumed that the reflux cooling with the SGs is effective.	19.2.5 COL 19.3(6) COL 13.5(6)
6. 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. Therefore, potential plugging of the suction strainers due to debris is excluded from the PRA modeling.	6.2.2
7. 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. There are no features that automate the response to loss of RHR.	19.2.5 COL 19.3(6)

Table 19.1-119 Key Insights and Assumptions (Sheet 17 of 23)

Key Insights and Assumptions	Dispositions
8. The time when loss of RHR occur were set to be 12 hours after plant trip, which is the time POS 4 (mid-loop operation) is entered after plant trip, since this condition gives the most severe condition for mid-loop operation from a decay heat perspective. The pressurizer spray-line vent line with 3/4 inch diameter is assumed to be open at the initial condition. One hour after loss of RHR function, the operator is assumed to perform the following actions: - Close pressurizer spray line vent, - Start emergency feed water (EFW) pump, and - Open main steam depressurization valve.	19.2.5 COL 19.3(6) COL 13.5(7)
9. Nitrogen will not be injected in the SG tubes to speed draining in the US-APWR design. The SG tubes will be filled with air during midloop operation.	19.2.5 COL 19.3(6) COL 13.5(7)
10. Operator actions assumed in the PRA will be considered in the shutdown response guideline, which will be developed satisfying NUMRAC 91-06 and following other recent guidelines such as INPO 06-008.	19.2.5 COL 19.3(6) COL 13.5(7)
11. Cleanliness, housekeeping and foreign material exclusion areas are administrative controls and programs to be developed by any applicant referencing the certified US-APWR design for construction and operation	6.2 Table 6.2.2-2 19.2.5 COL 19.3(6) COL 13.5(7)
12. The reactivity insertion event due to boron dilution has been judged to be insignificant to risk because of the following factors: - Strict administrative controls are in place to prevent boron dilution - Boron dilution events are highly recoverable - The consequences of re-criticality are minor unless they continue for very long.	15.4.6.2 19.2.5 COL 19.3(6) COL 13.5(7)
13. Administrative controls ensure the RCS water level, temperature and pressure indication are available during shutdown.	19.2.5 COL 19.3(6) COL 13.5(7)

Table 19.1-119 Key Insights and Assumptions (Sheet 18 of 23)

Key Insights and Assumptions	Dispositions
Seismic insights	
1. Table 19.1-54 provides the list of HCLPFs for US-APWR SSCs. This table demonstrates that the SSC HCLPF values are greater than 1.67 times the design basis SSE although the assessment performed by conservative generic data from EPRI URD. This insight will be certified by the following assessment.	19.1.5.1 Table 19.1-54
- Perform seismic margin assessment using US-APWR plant specific in-structure response and stress analyses. - Conduct plant walkdown to certify the SSCs retain seismic margin under as-built conditions prior to fuel loading.	3.7

Table 19.1-119 Key Insights and Assumptions (Sheet 19 of 23)

Key Insights and Assumptions	Dispositions
Seismic assumptions	
1. 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.	5.4.7.1
2. 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	3.2.1
3. Relay chatter does not occur or does not affect safety functions during and after seismic event.	3.10 Table 19.1-51

Table 19.1-119 Key Insights and Assumptions (Sheet 20 of 23)

Key Insights and Assumptions	Dispositions
Internal fire insights	
1. Fire protection seals are provided for walls, floors, and ceilings, which compose the fire area boundaries divided by four train areas.	9.5.1
2. Turbine building electric rooms are segregated into two groups by qualified fire barriers. This feature is possible to prevent loss of offsite power by a turbine building fire.	9.5.1
3. In case of LOCA or loss of RHR caused by over drain or failure of water level maintain by a fire during LPSD, the flow pathway could be isolated by automatic closing of the low pressure letdown line isolation valve.	5.4.7.2.2.3

Table 19.1-119 Key Insights and Assumptions (Sheet 21 of 23)

Key Insights and Assumptions	Dispositions
Internal fire assumption	
1. All fire doors serving as fire barriers between redundant safety train fire compartments are normally closed.	9.5.1.2.1 COL 9.5(1)
2. For transient combustibles, “three Airline trash bags” has been assumed in each fire compartment.	9.5.1.2.1 COL 9.5(1)
3. Transient combustibles with total heat release capacity of 93,000 Btu (obtained from NUREG/CR-6850, “AppendixG-table-7LBL-Von Volkinburg, Rubbish Bag” Test results) is assumed for Fire ignition source within Containment Vessel.	9.5.1.2.1 COL 9.5(1)
4. The Heat Release Rate of various items as specified in Chapter-11 of NUREG/CR-6850 is used.	9.5.1.2.1 COL 9.5(1)
5. Damage temperature of thermoplastic cables as shown in Appendix-H of NUREG/CR-6850 is used as the target damage temperature.	9.5.1.2.1 COL 9.5(1)
6. Operators are well trained in responding to fire event.	9.5.1.2.1 COL 9.5(1)
7. One of RCS letdown isolation valves and one of RCS vent line isolation valves are locked close by administrative controls	COL 13.5(1) COL 13.5(7)

Table 19.1-119 Key Insights and Assumptions (Sheet 21 of 23)

Key Insights and Assumptions	Dispositions
Internal flood insights	
1. East side and west side of reactor building are physically separated by flood propagation preventive equipment and the connections are kept closed and locked.	3.4.1.3
2. Areas between the reactor building and the turbine building are physically separated by flood propagation prevention equipment.	3.4.1.3
3. The flood barriers that separate the reactor building between east side and west side are important to safety for the operation of the facility. These doors should be monitored and controlled during plant operation and maintenance.	3.4.1.3 19.2.5 COL 19.3(6) COL 19.5(1) COL 13.5(7) (RAI 19-207)

Table 19.1-119 Key Insights and Assumptions (Sheet 23 of 23)

Key Insights and Assumptions	Dispositions
Internal flood assumption	
1. 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.	3.4.1.3
2. 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. East side and west side of reactor building (R/B) are physically separated by flood propagation preventive equipment such as water tight doors. Therefore, flood propagation between east side and west side in the reactor building is not considered.	3.4.1.3 19.2.5 COL 19.3(6) COL 13.5(1) COL 13.5(7)
3. 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.	3.4.1.3
4. Flooding of ESW system can to be isolated within 15 minutes.	
5. Four trains of ESW system have physical separation and flooding in one train does not propagate to other trains.	9.2.1.2.1 COL 9.2(3) COL 9.2(4)
6. 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.	
7. 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.	3.4.1.3
8. The administrative controlled flood barriers that separated the reactor building between the east side and the west side are effective. The other water tight doors may be opened during maintenance.	19.2.5 COL 19.3(6) (RAI 19-50) COL 13.5(1) COL 13.5(7)
9. The outage states of mitigation systems are important for LPSD risk. From the insight of flooding risk, one train of mitigation system on each side in R/B should be available. So that assumed the available safety injection pumps trains A and C are available during POS 8-1. B and D pumps are assumed out of service.	19.2.5 COL 19.3(6) COL 13.5(7)

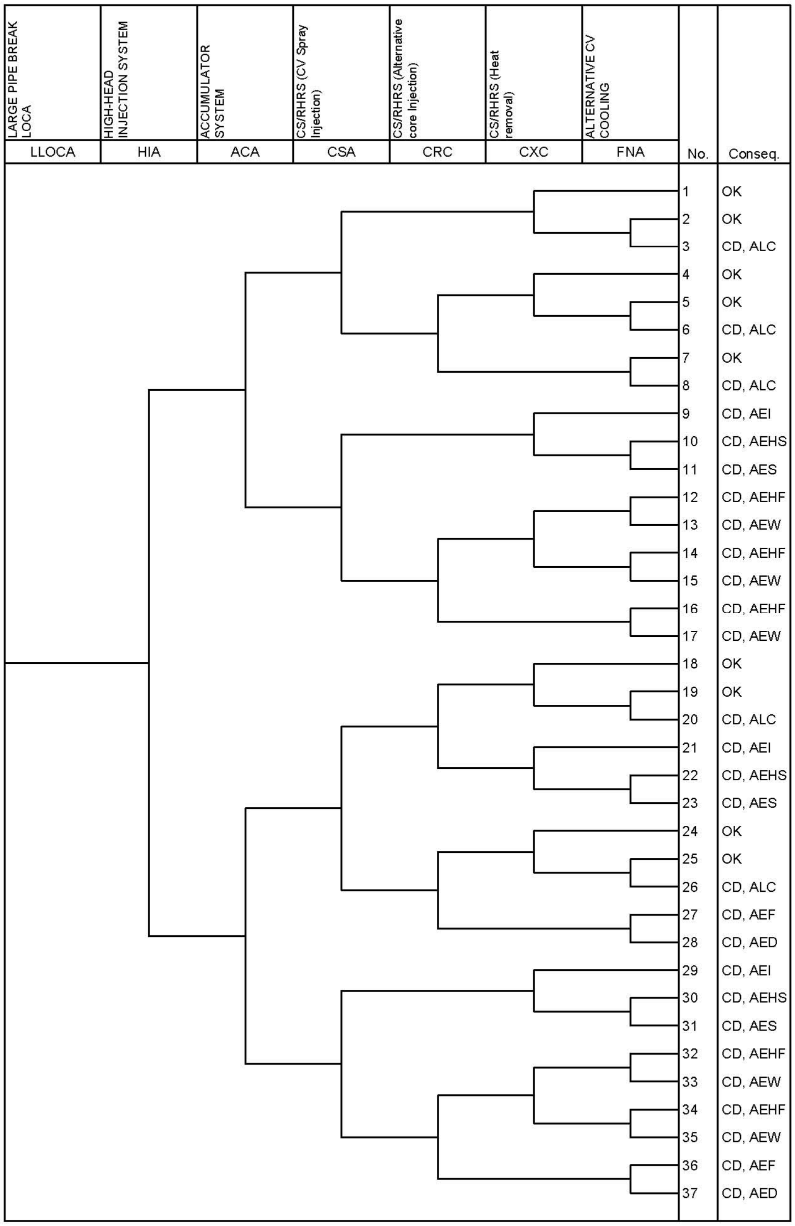


Figure 19.1-1 Event Tree (Sheet 1 of 19) (Large LOCA)

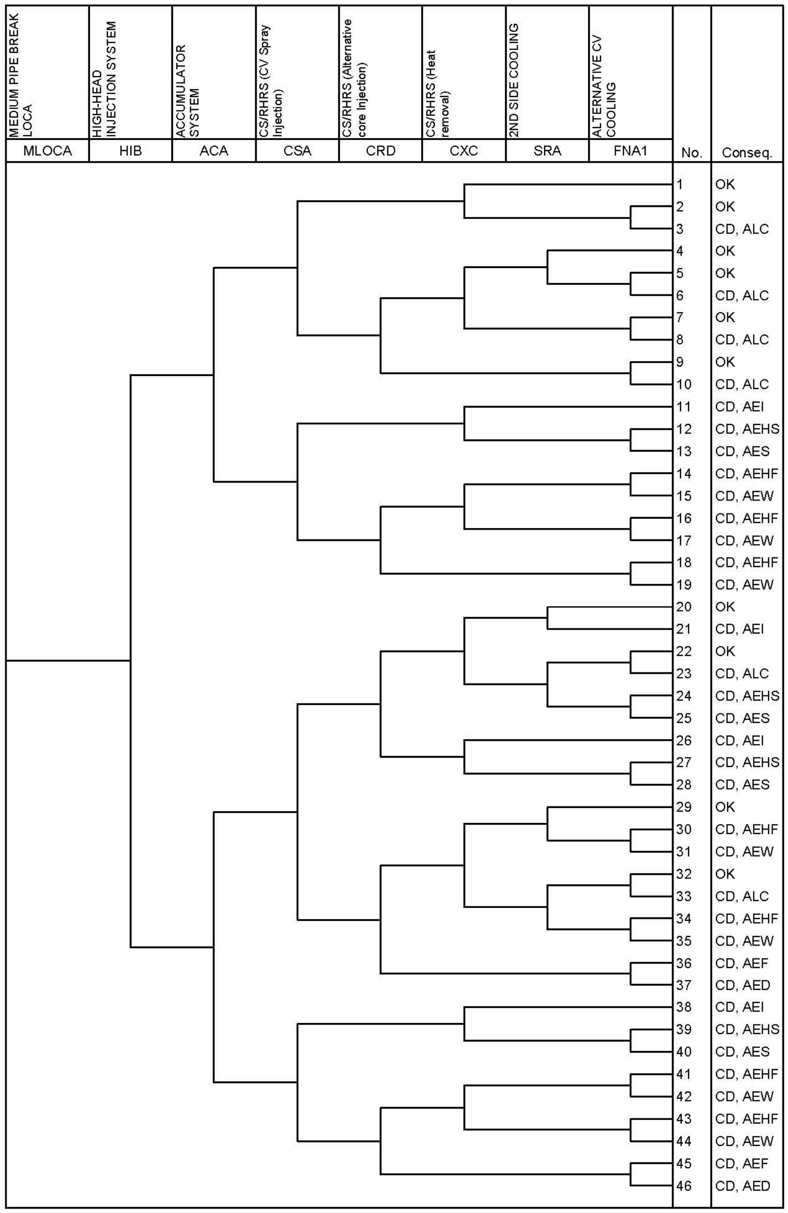


Figure 19.1-1 Event Tree (Sheet 2 of 19) (Medium LOCA)

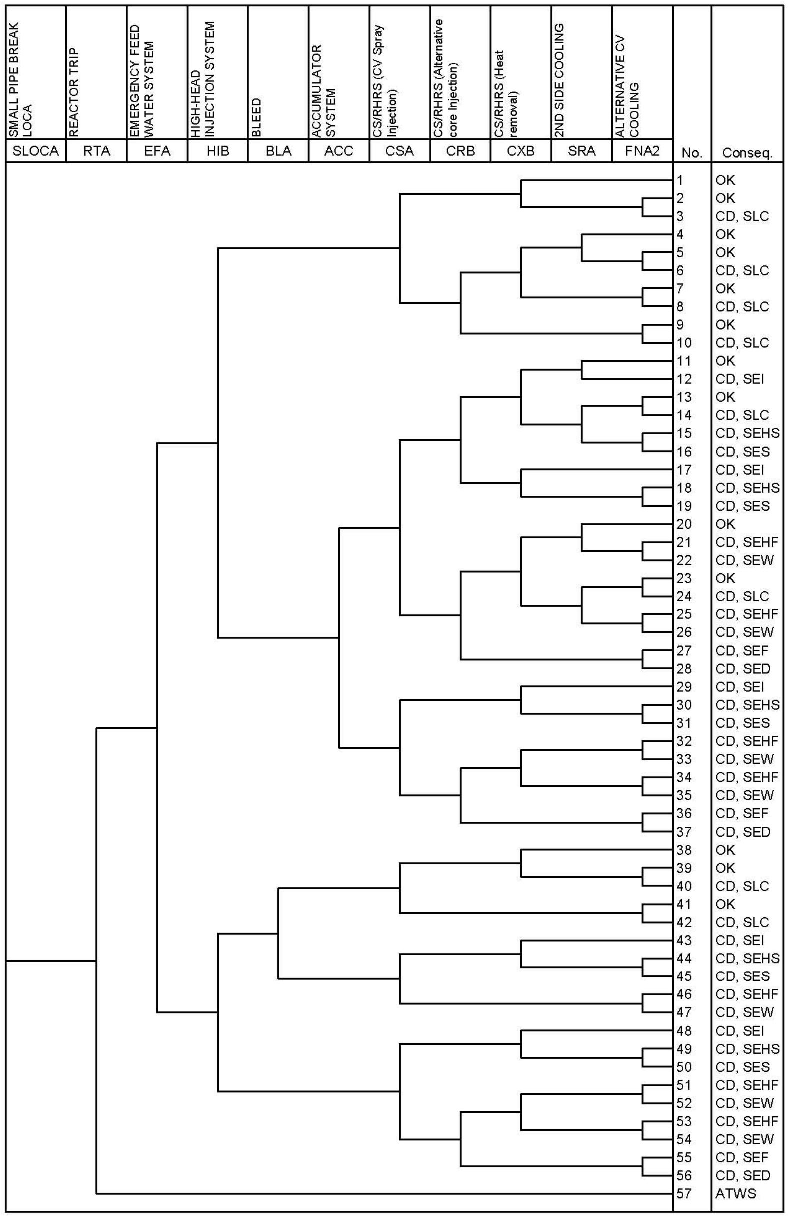


Figure 19.1-1 Event Tree (Sheet 3 of 19) (Small LOCA)

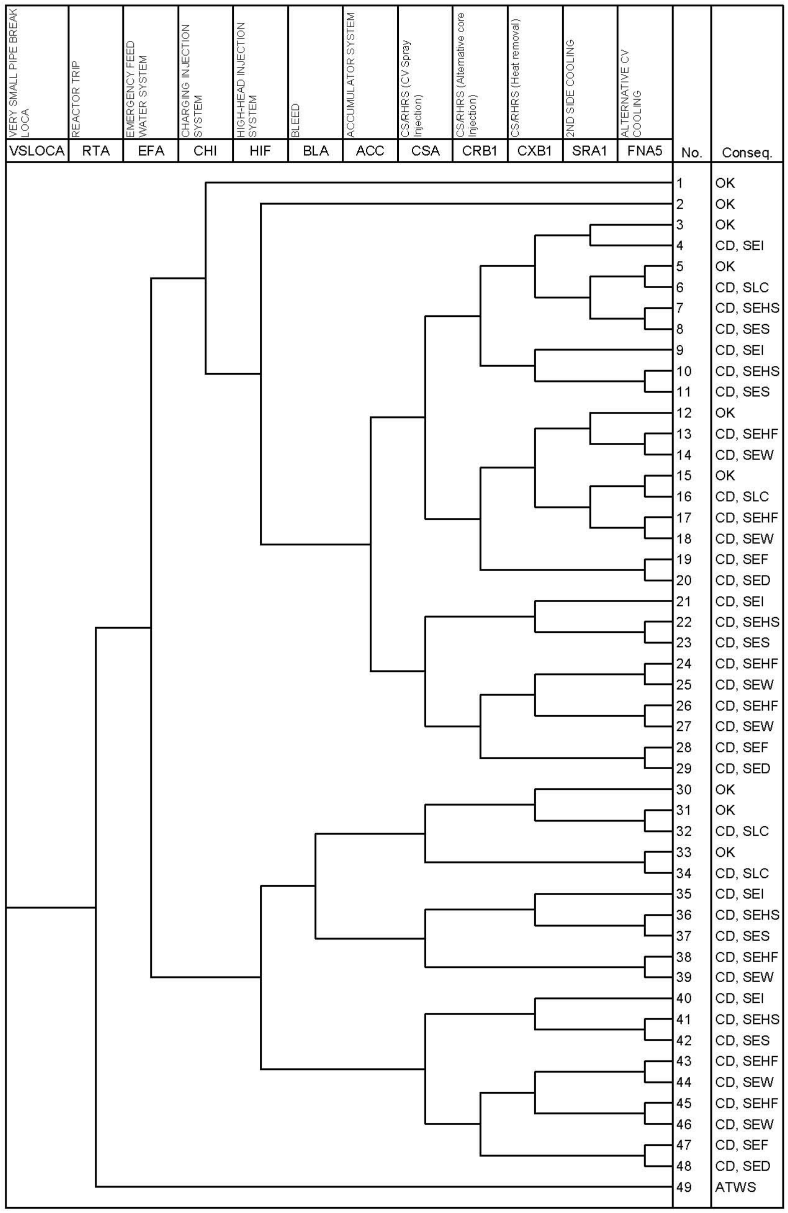


Figure 19.1-1 Event Tree (Sheet 4 of 19) (Very Small LOCA)

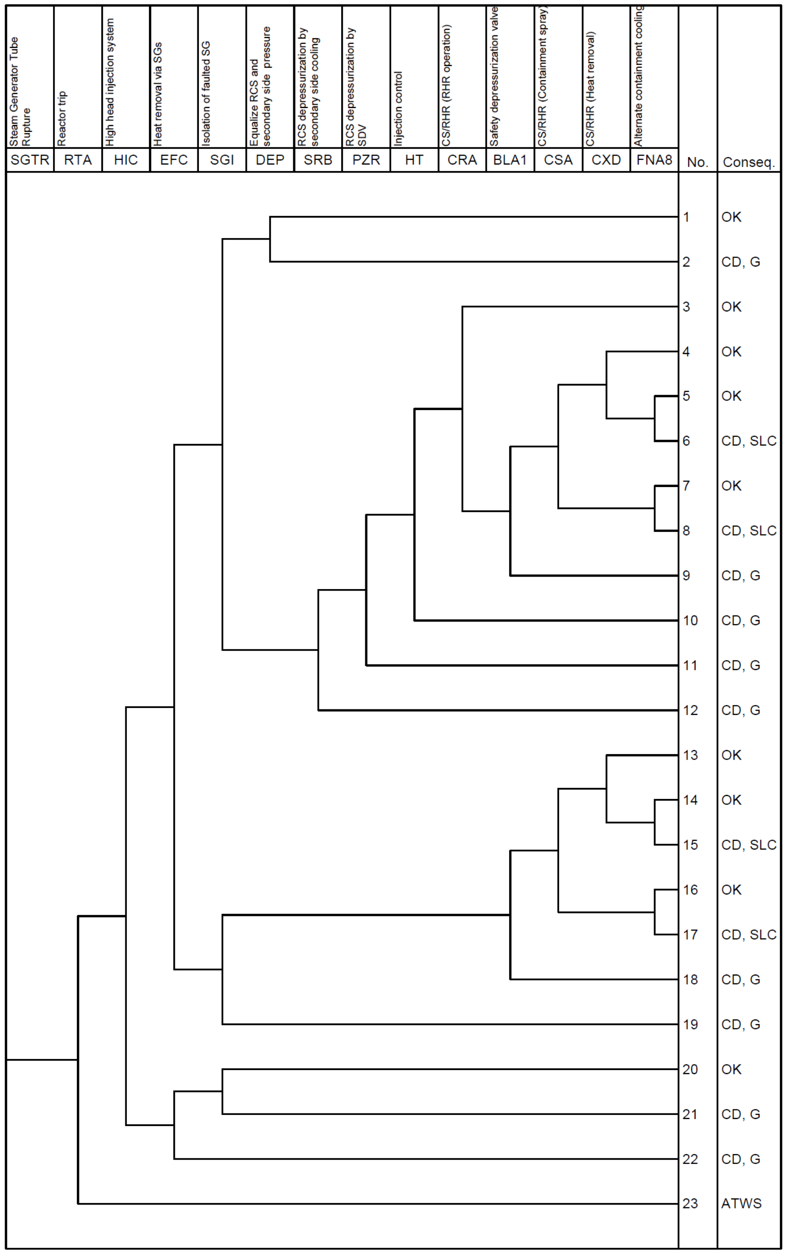


Figure 19.1-1 Event Tree (Sheet 5 of 19) (SGTR)

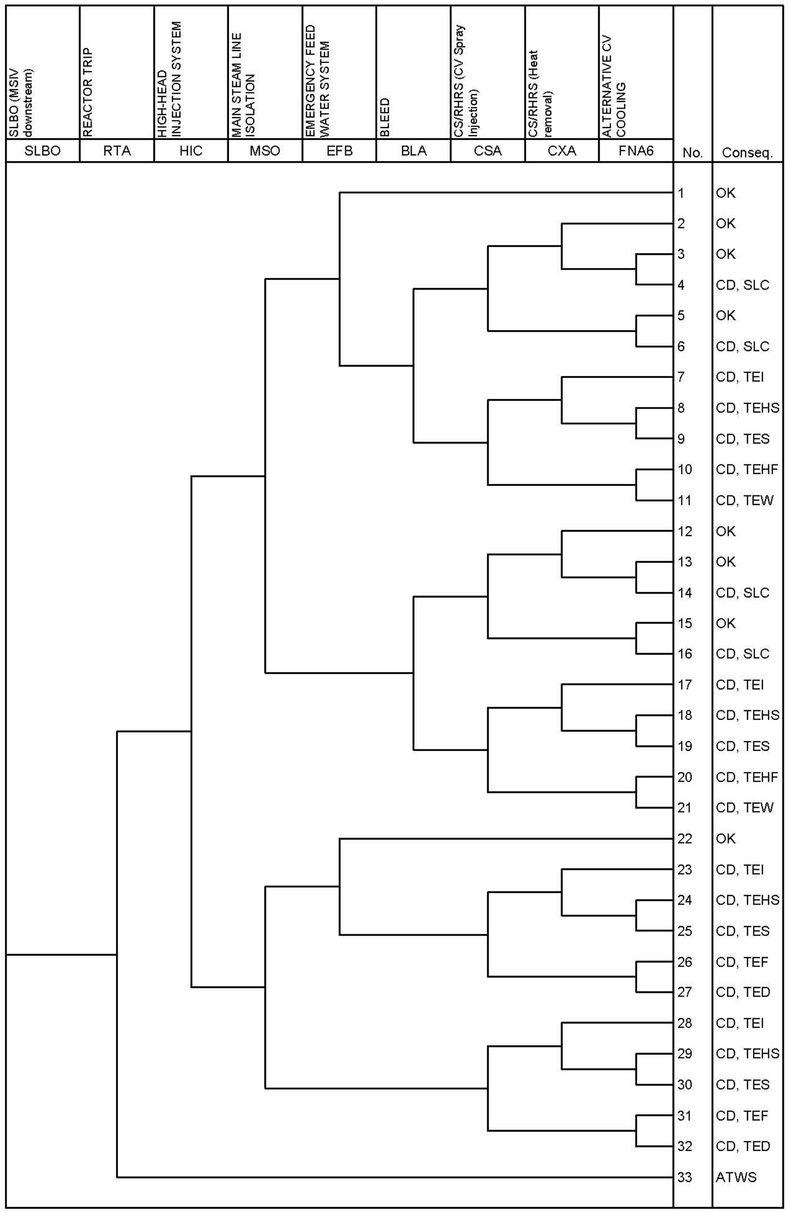


Figure 19.1-1 Event Tree (Sheet 6 of 19) (Steam Line Break Downstream MSIV)

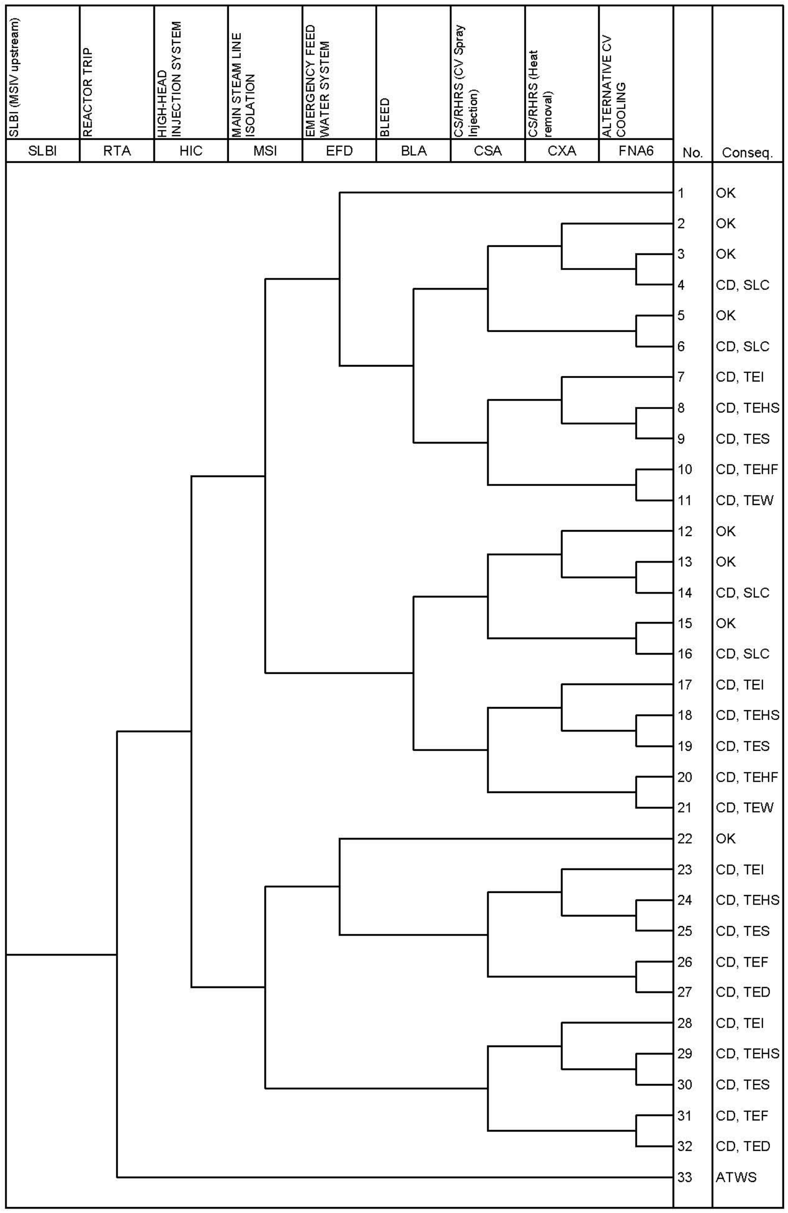


Figure 19.1-1 Event Tree (Sheet 7 of 19) (Steam Line Break Upstream MSIV)

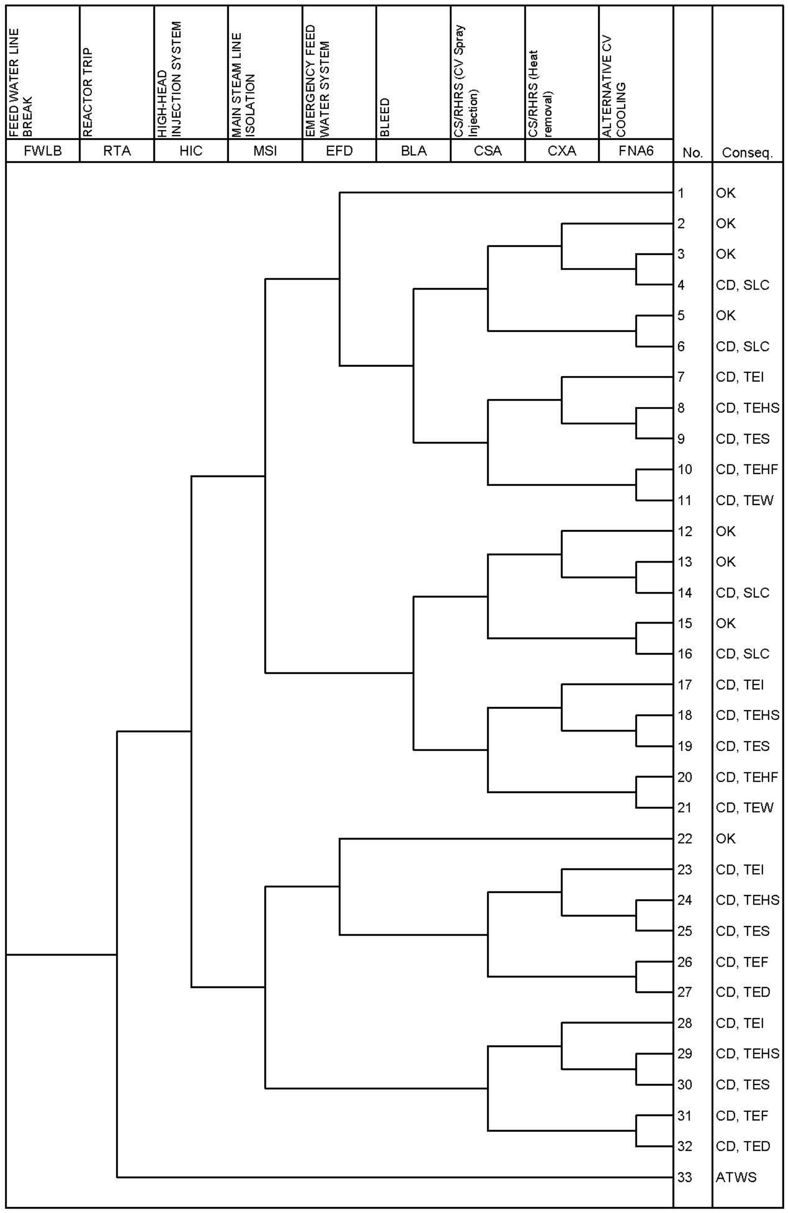


Figure 19.1-1 Event Tree (Sheet 8 of 19) (Feed Water Line Break)

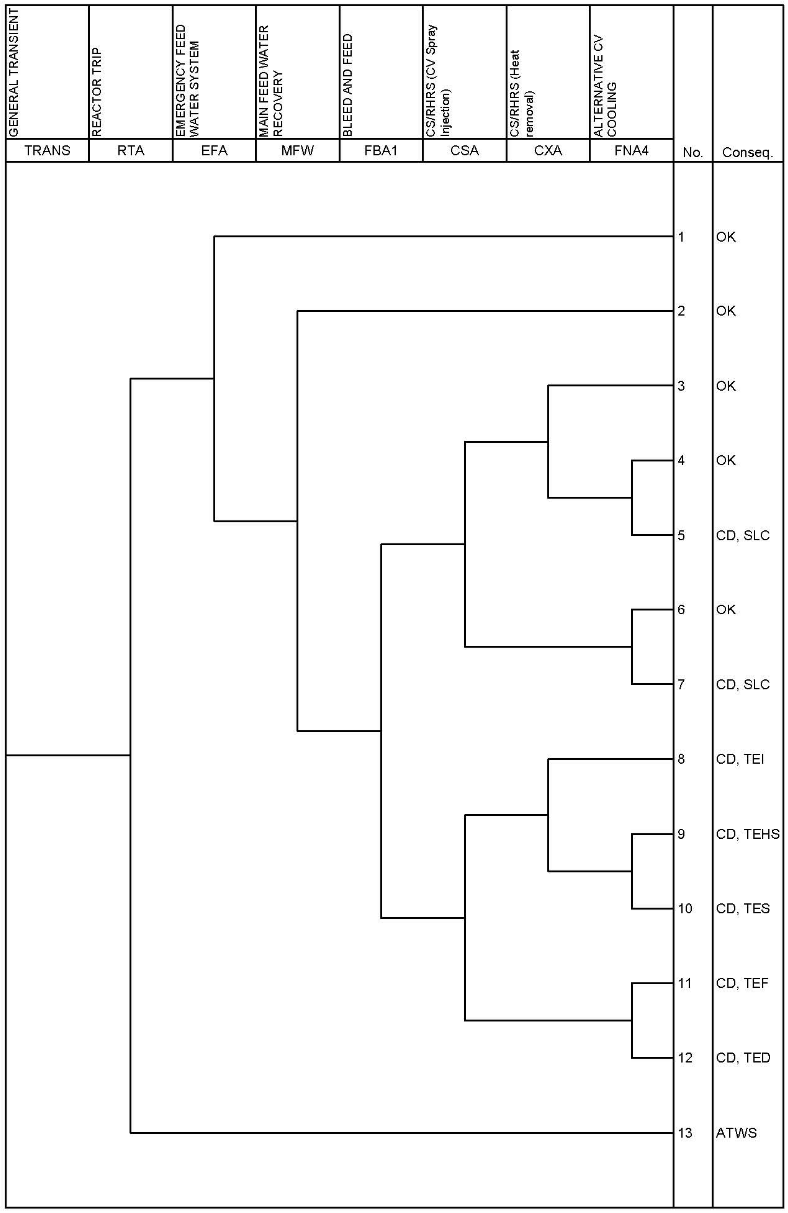


Figure 19.1-1 Event Tree (Sheet 9 of 19) (General Transient)

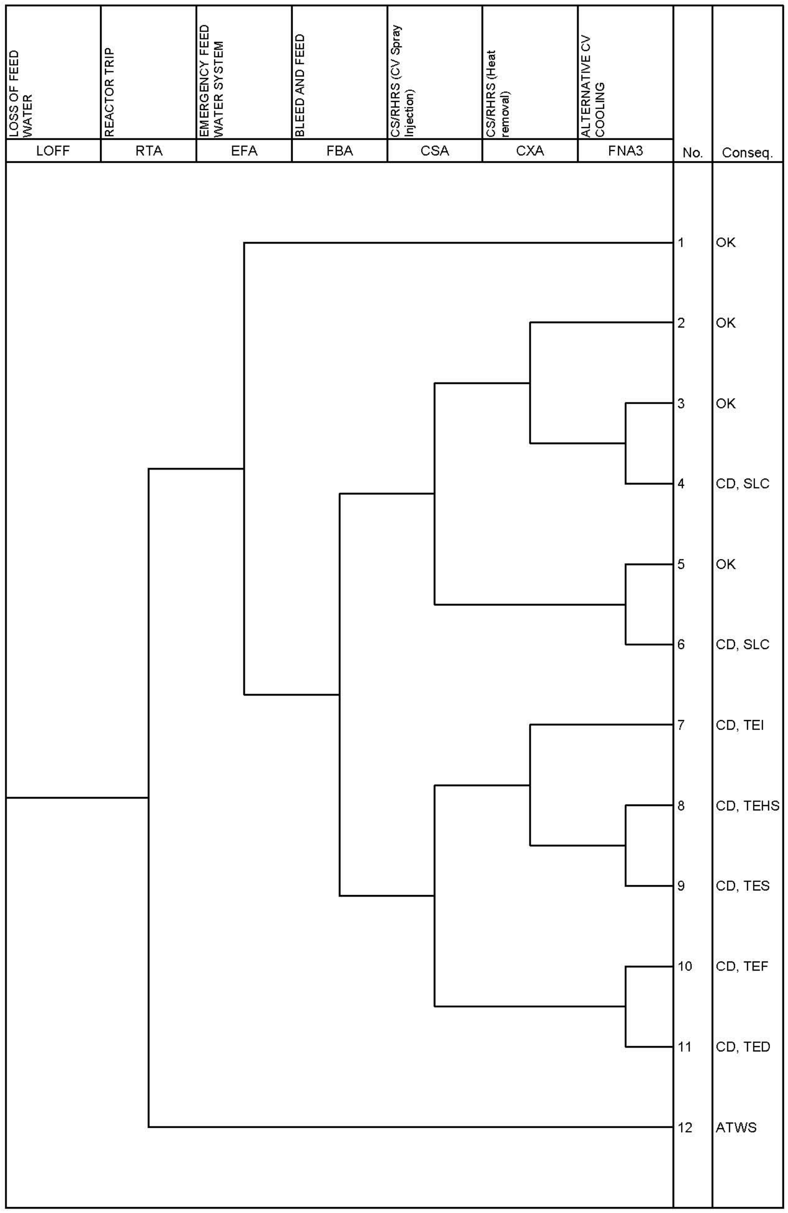


Figure 19.1-1 Event Tree (Sheet 10 of 19) (Loss of Feed Water)

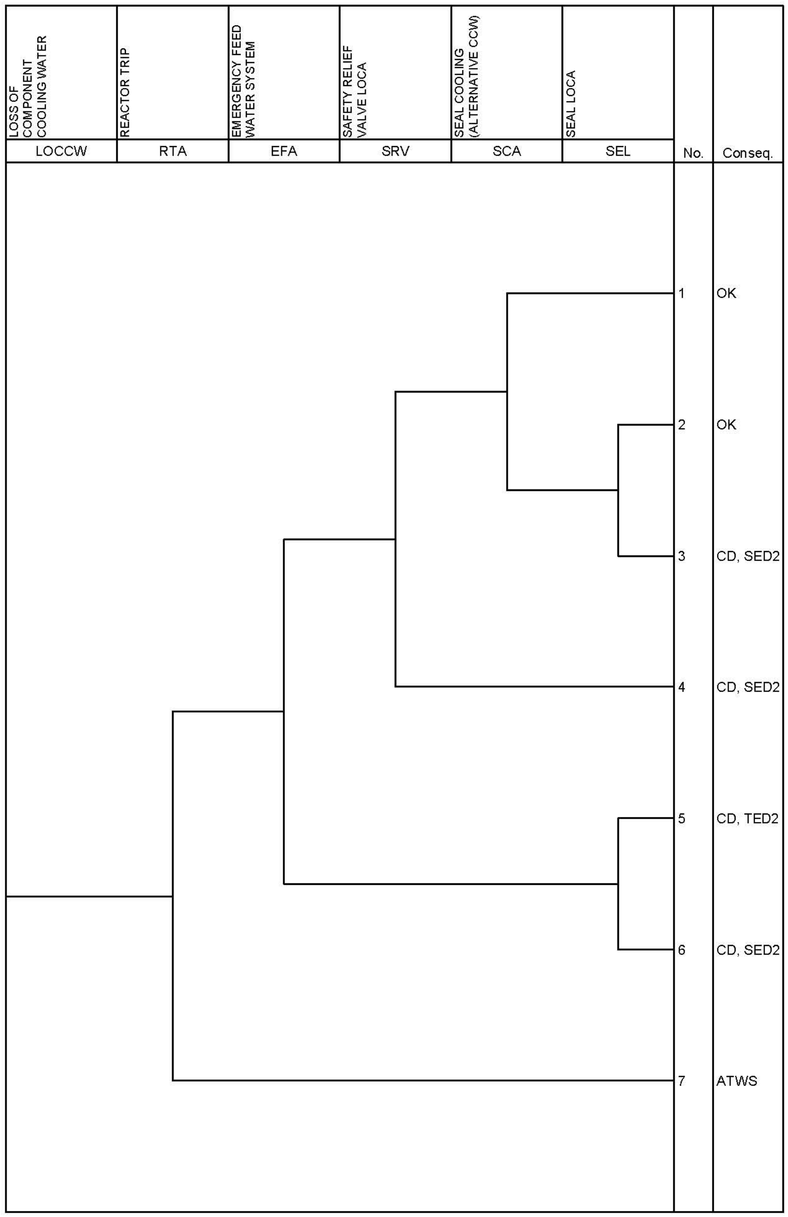


Figure 19.1-1 Event Tree (Sheet 11 of 19) (Loss of Component Cooling Water)

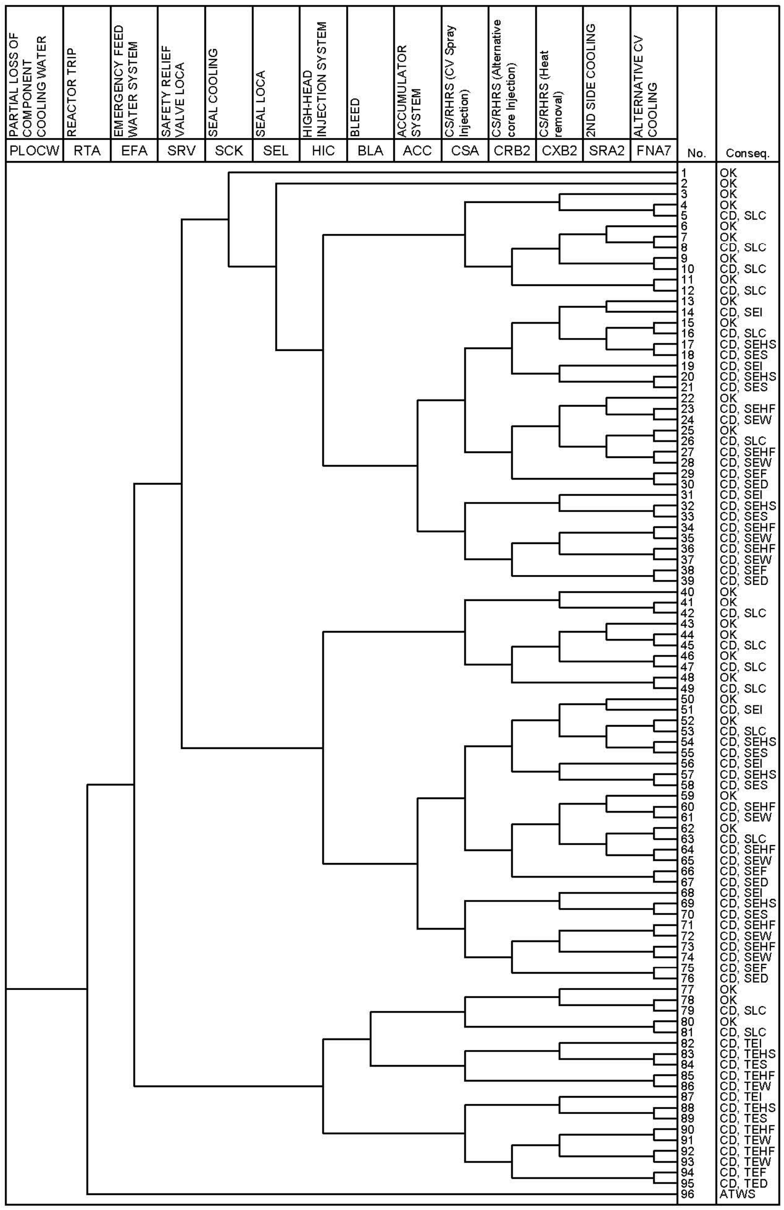


Figure 19.1-1 Event Tree (Sheet 12 of 19)
(Partial Loss of Component Cooling Water)

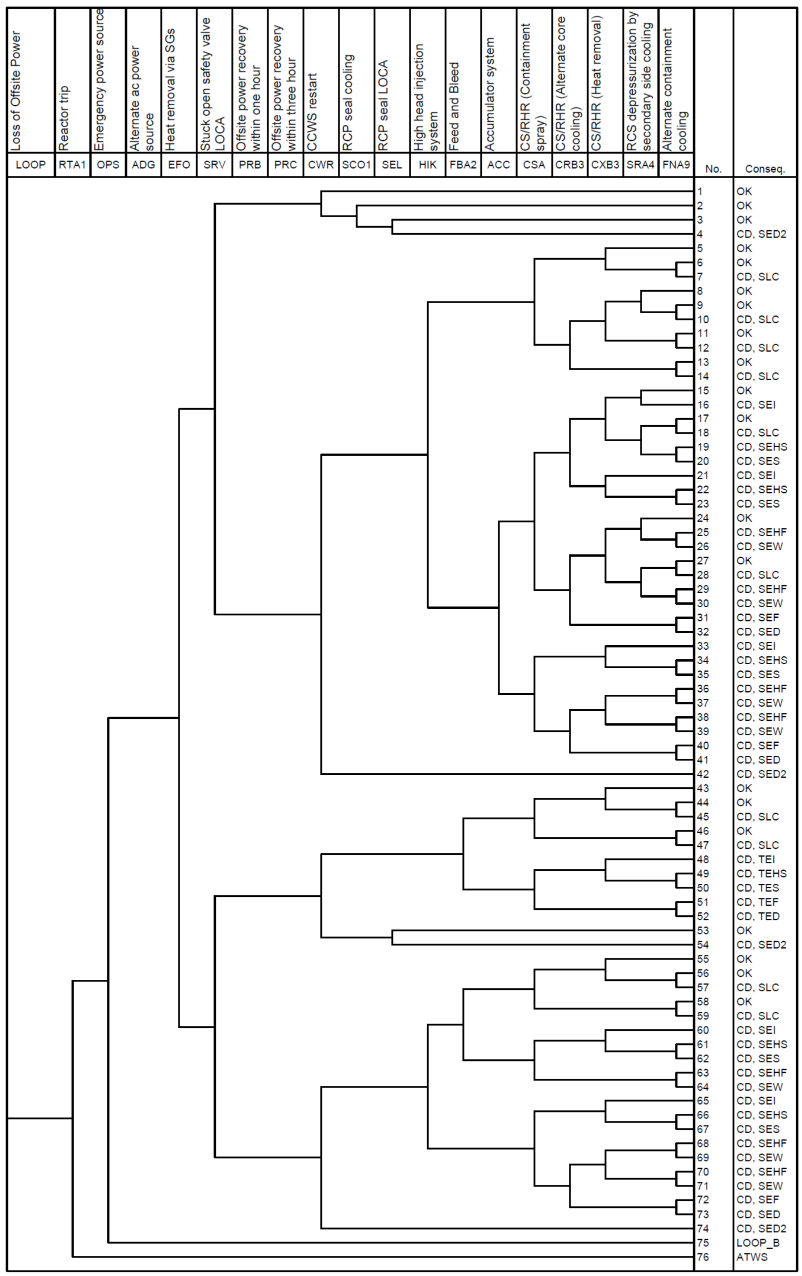


Figure 19.1-1 Event Tree (Sheet 13 of 19) (Loss of Offsite Power [1/4])

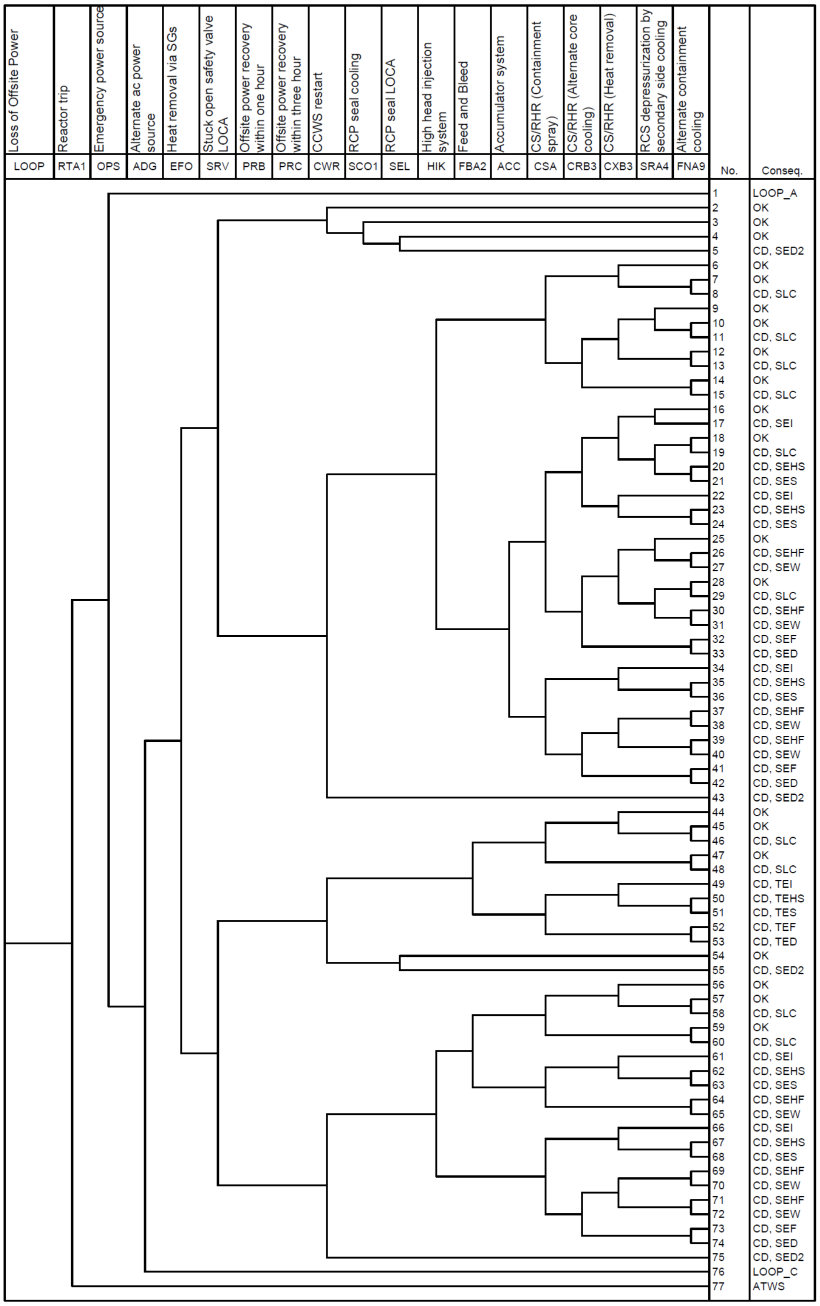


Figure 19.1-1 Event Tree (Sheet 14 of 19) (Loss of Offsite Power [2/4])

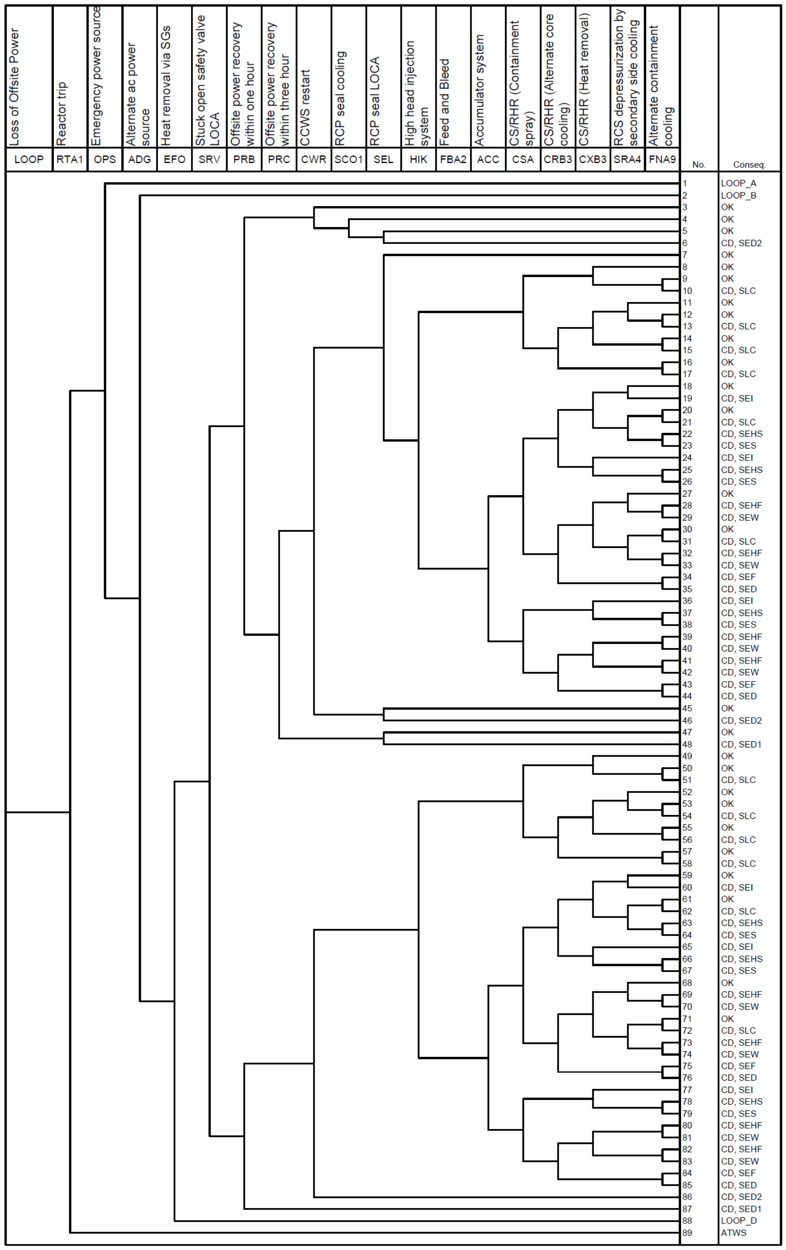


Figure 19.1-1 Event Tree (Sheet 15 of 19) (Loss of Offsite Power [3/4])

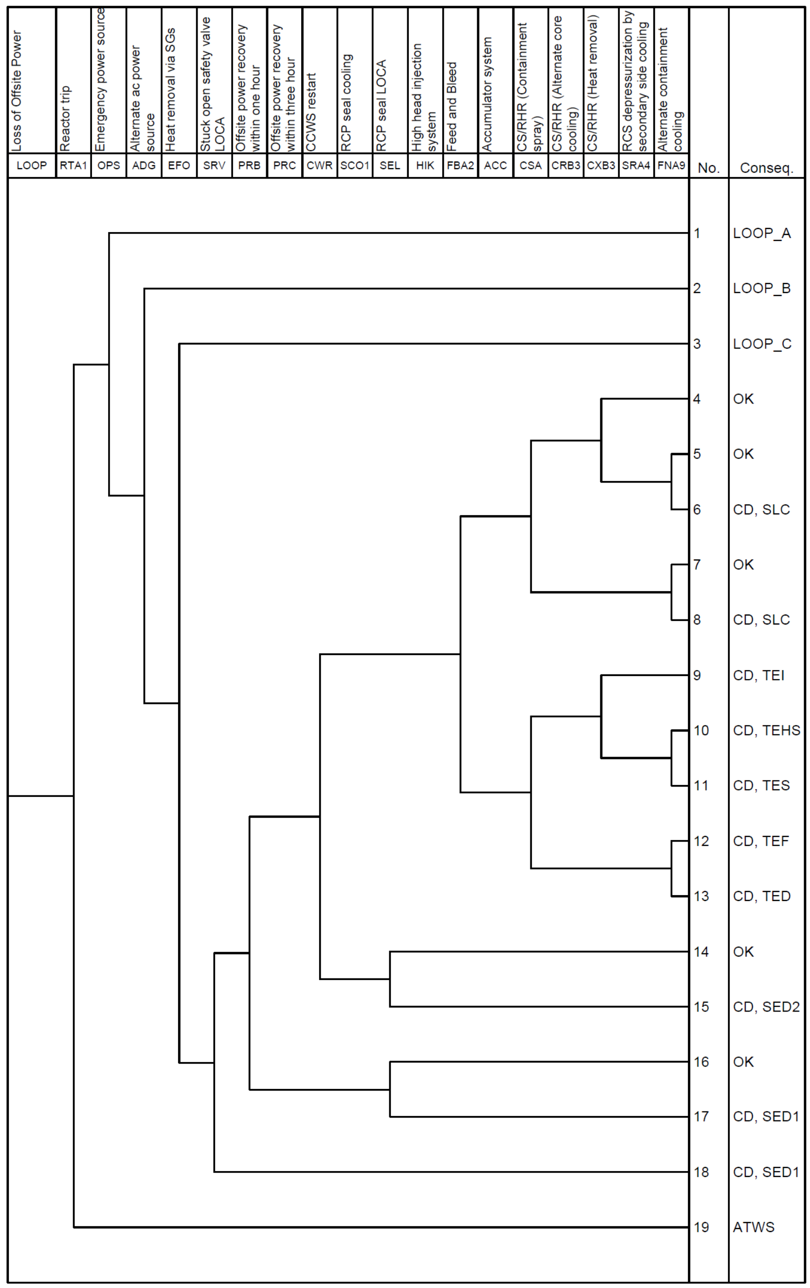


Figure 19.1-1 Event Tree (Sheet 16 of 19) (Loss of Offsite Power [4/4])

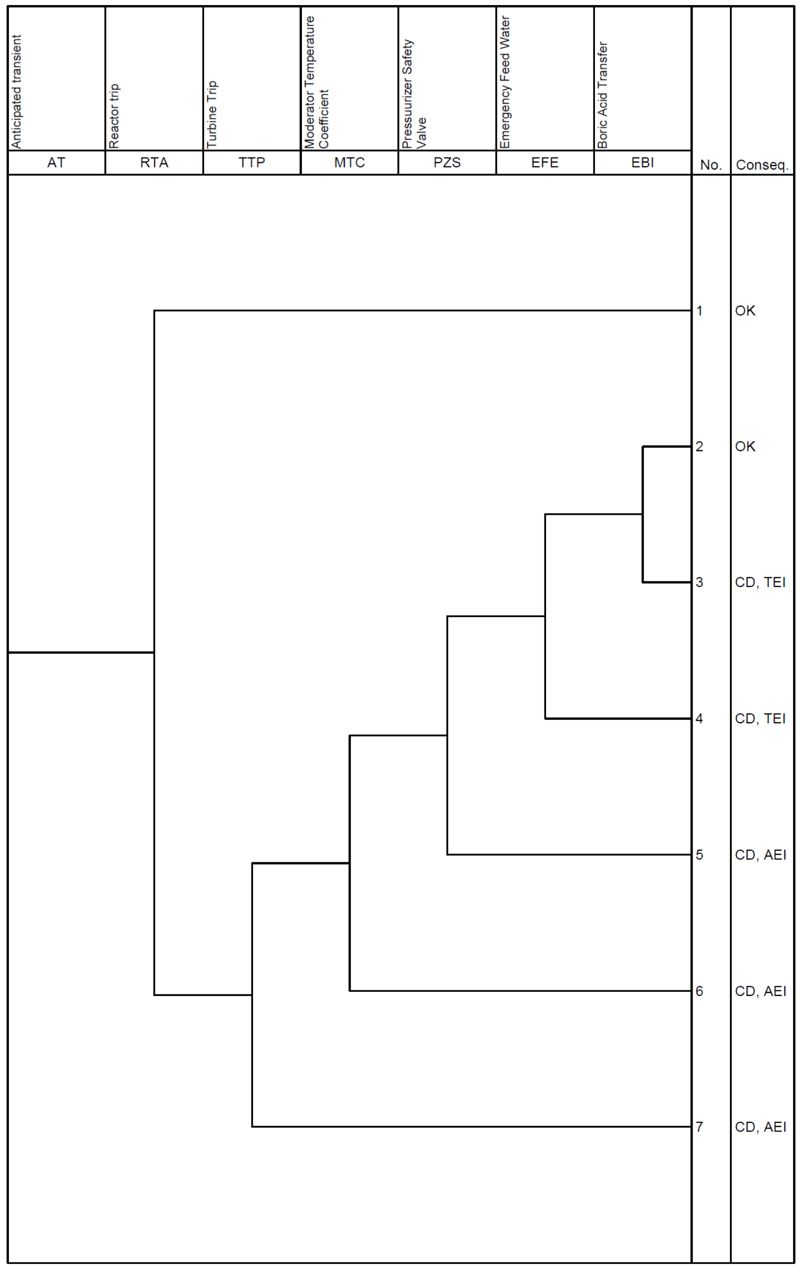


Figure 19.1-1 Event Tree (Sheet 17 of 19) (ATWS)

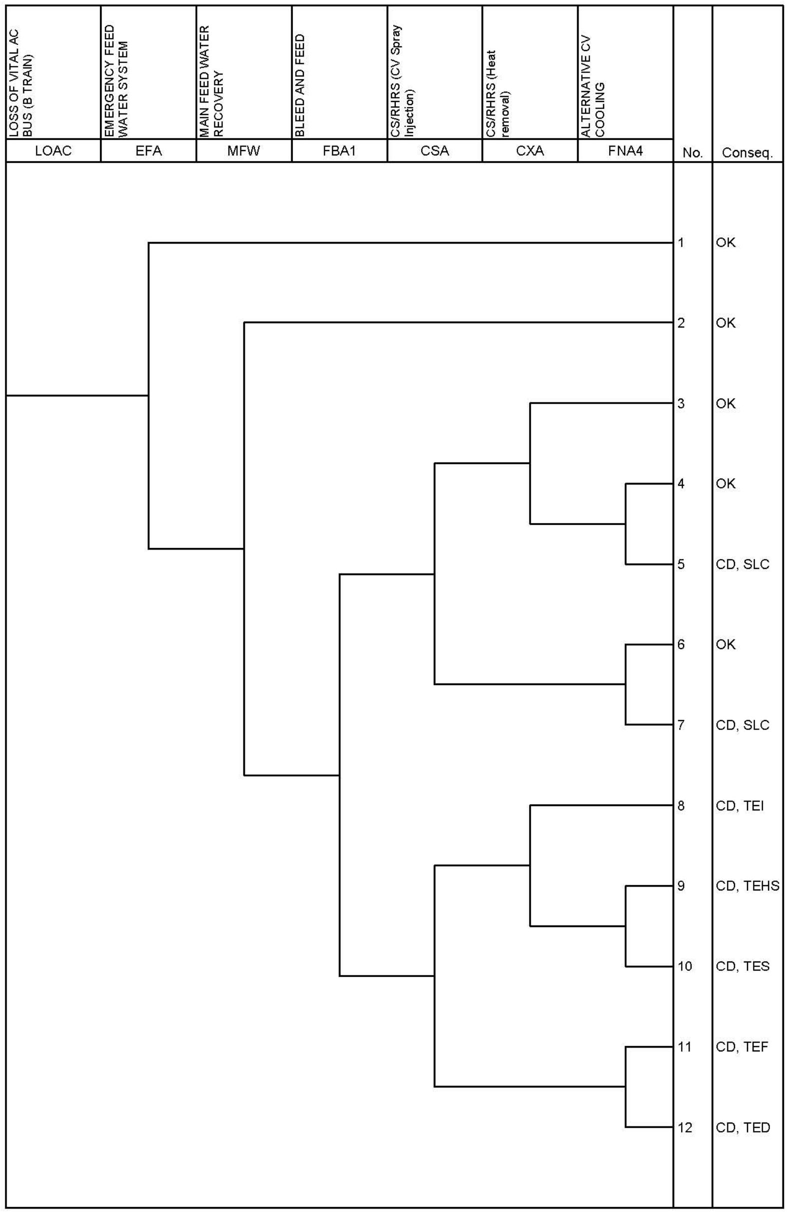


Figure 19.1-1 Event Tree (Sheet 18 of 19) (Loss of Vital AC)

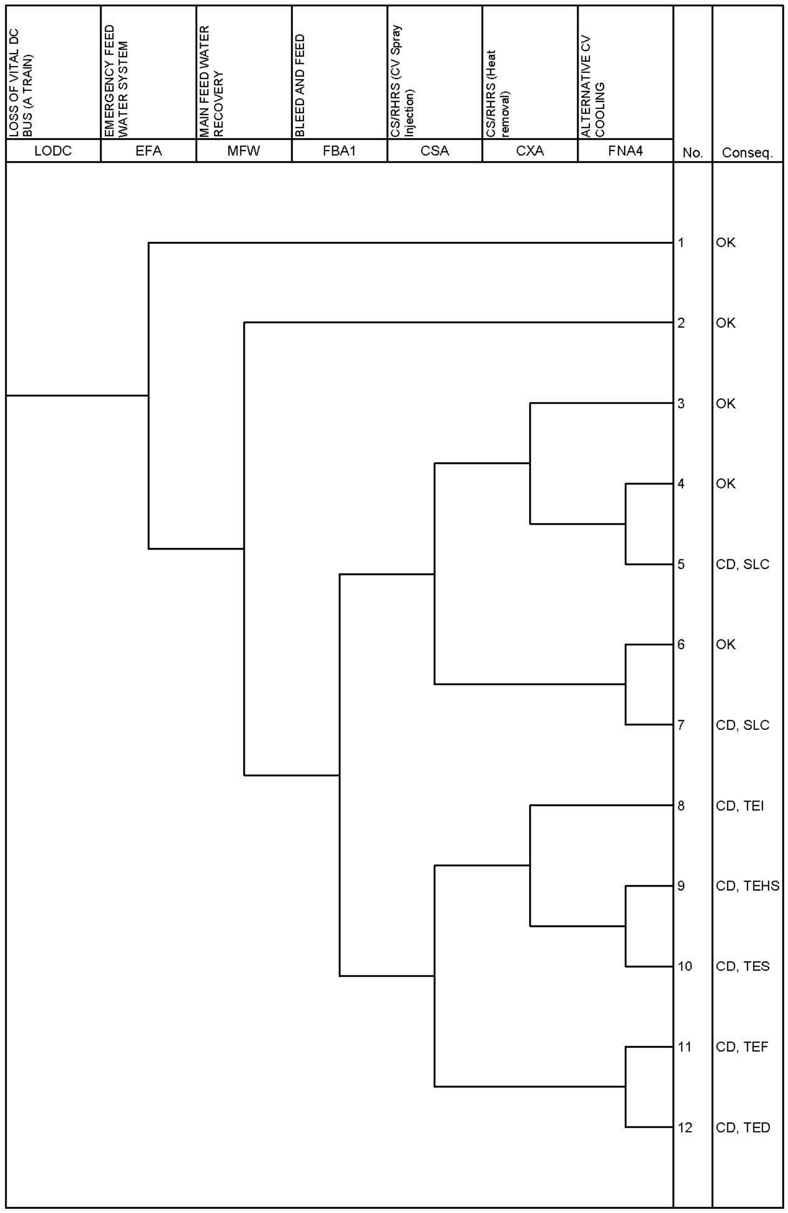


Figure 19.1-1 Event Tree (Sheet 19 of 19) (Loss of Vital DC)

REMARK:
SYSTEM NAME (RCS) OF THE SAFETY INJECTION SYSTEM IS OMITTED FROM THE COMPONENT ID.

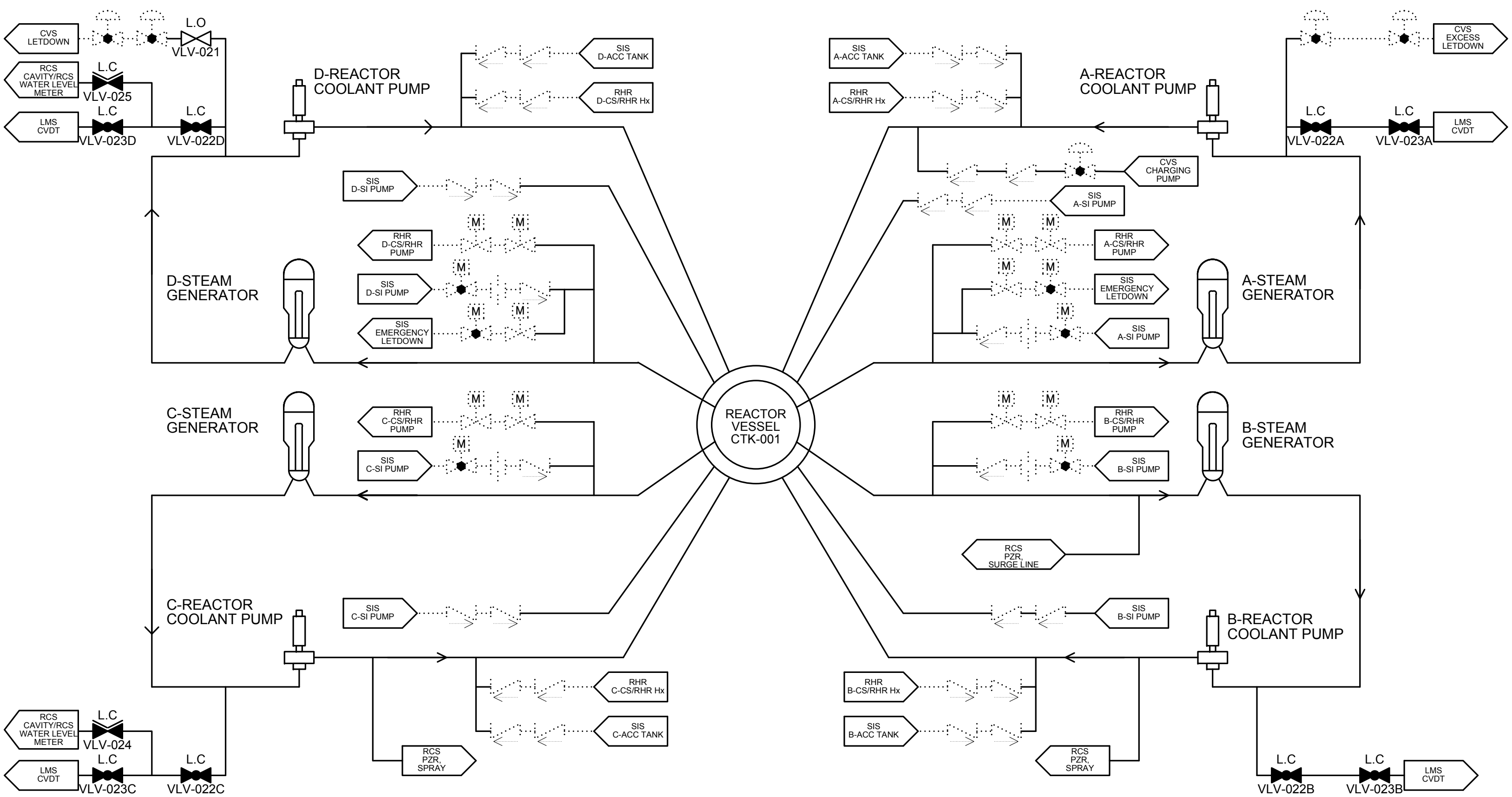


Figure 19.1-2 Simplified System Diagram (Sheet 1 of 42) (Reactor Coolant System)

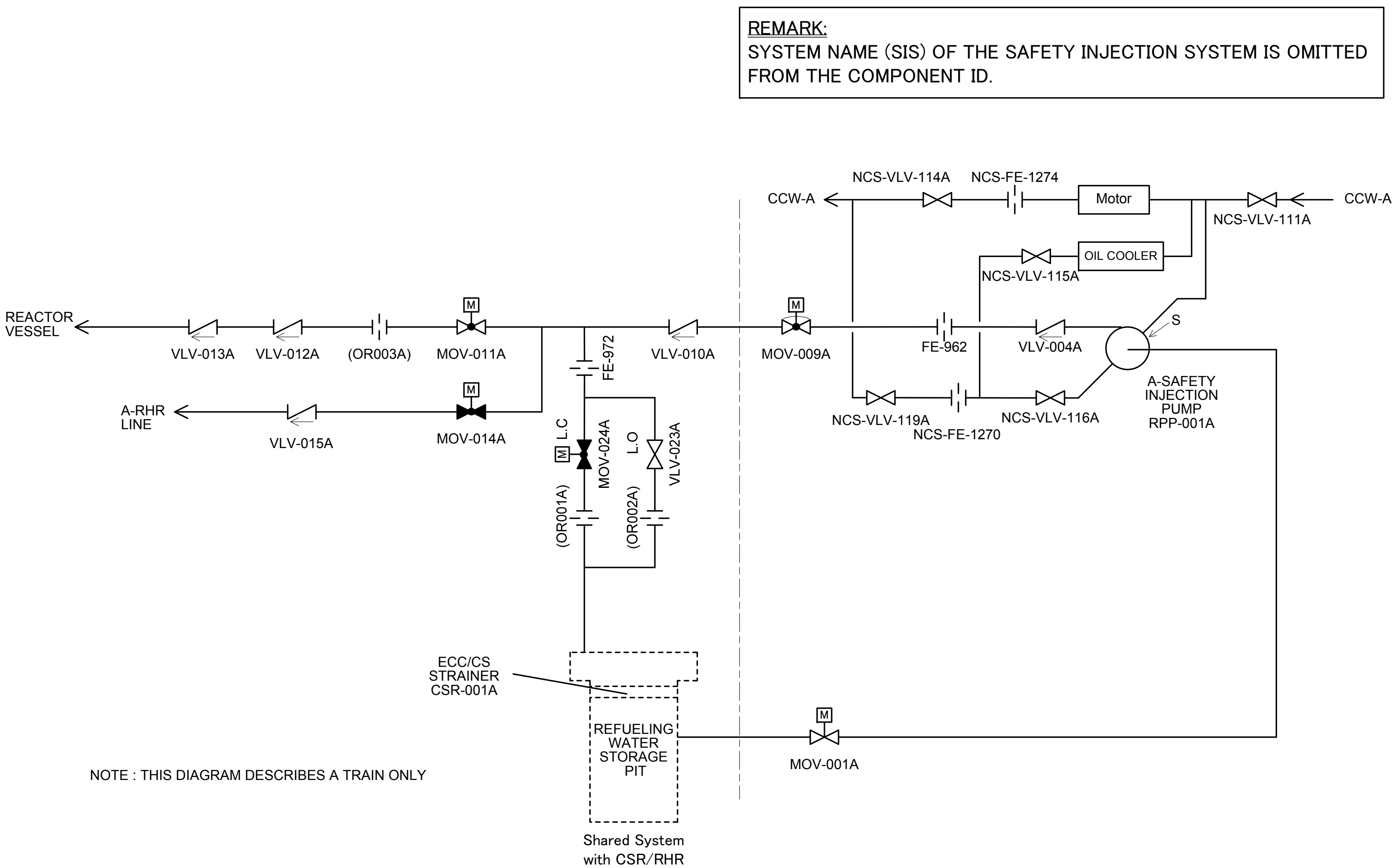


Figure 19.1-2 Simplified System Diagram (Sheet 2 of 42) (Safety Injection System)

REMARK:
SYSTEM NAME (SIS) OF THE SAFETY INJECTION SYSTEM IS OMITTED FROM THE COMPONENT ID.

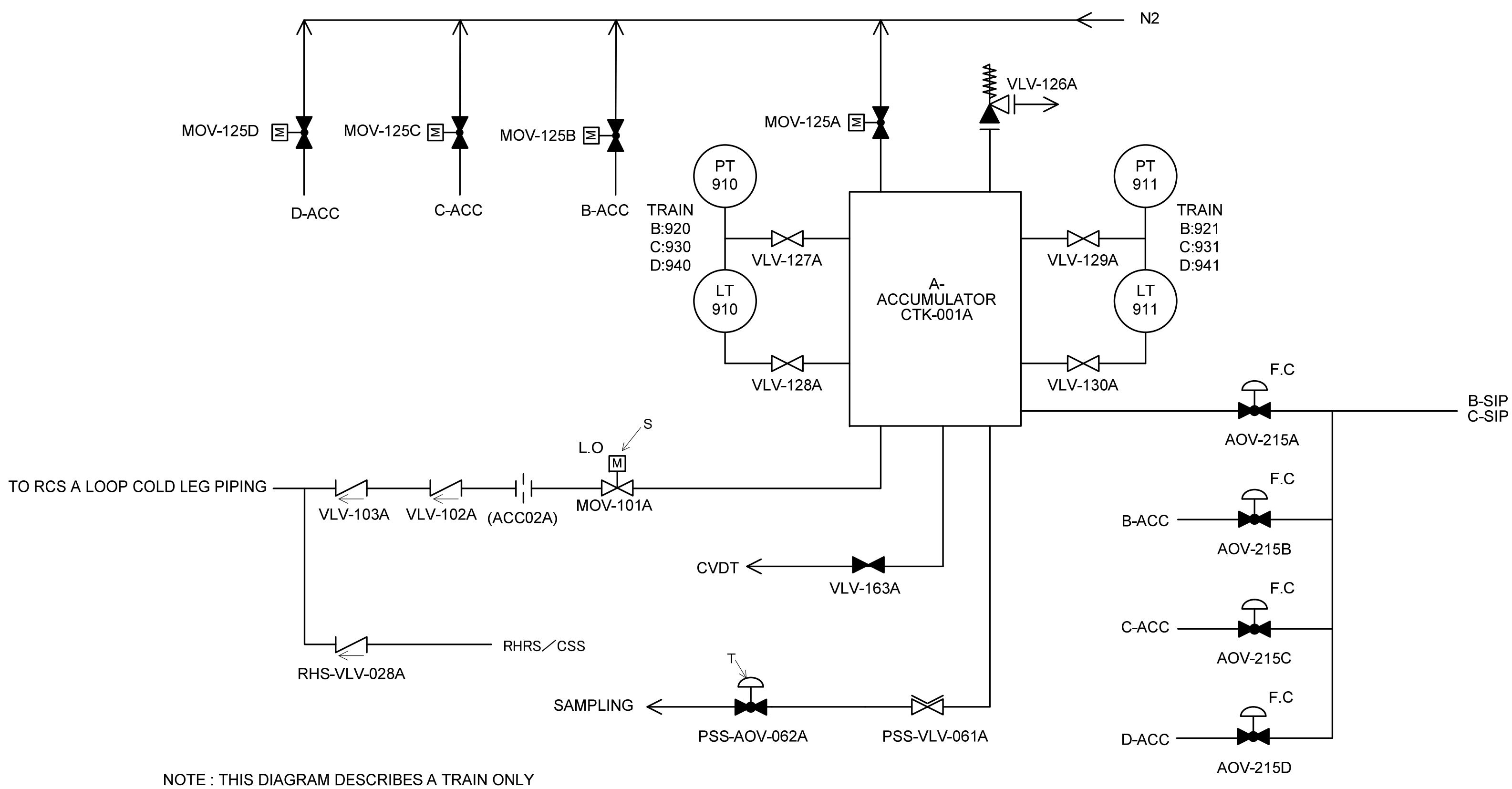


Figure 19.1-2 Simplified System Diagram (Sheet 3 of 42) (Accumulator Injection System)

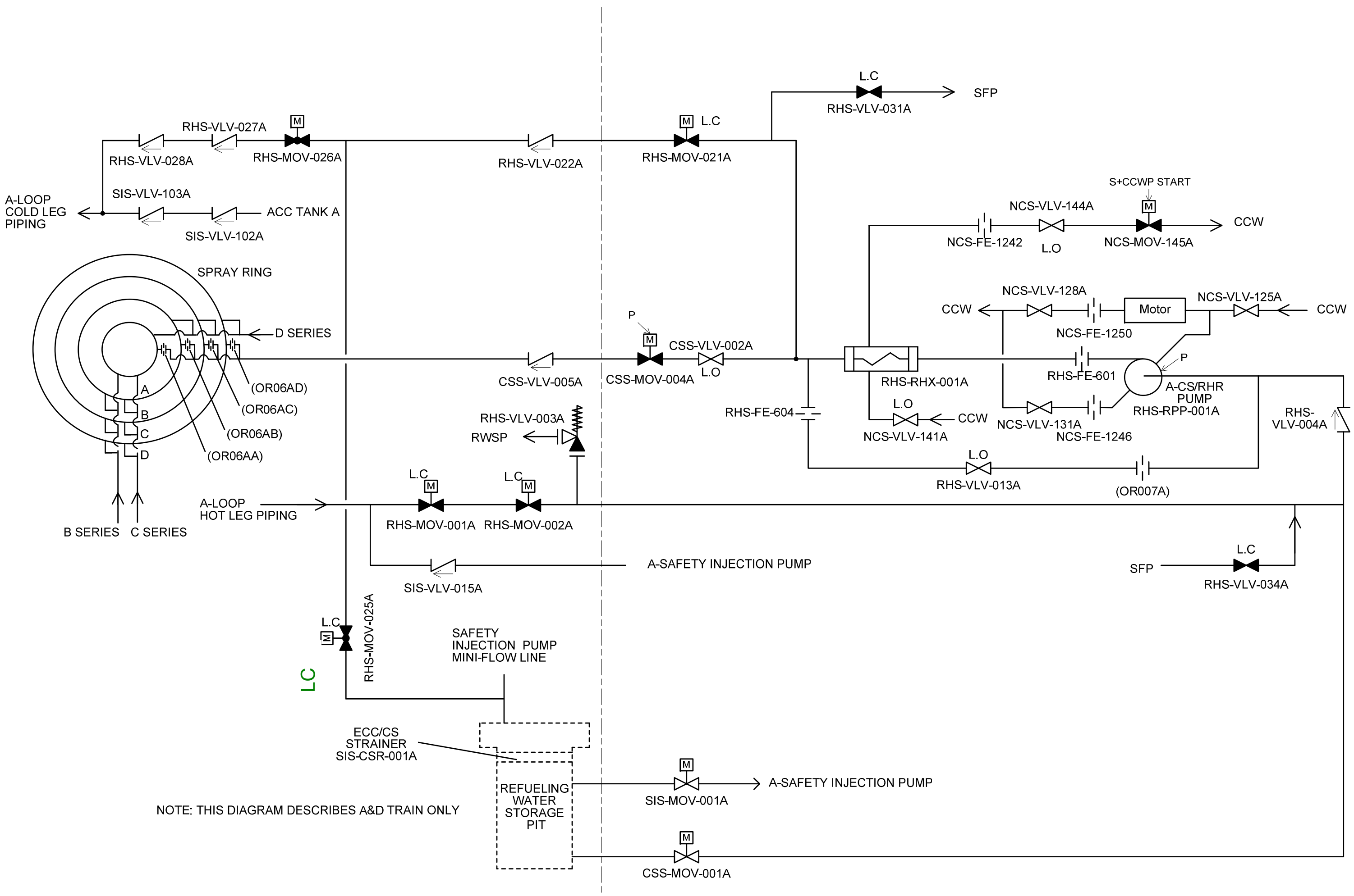


Figure 19.1-2 Simplified System Diagram (Sheet 4 of 42) (Containment Spray System/Residual Heat Removal System [Train A&D])

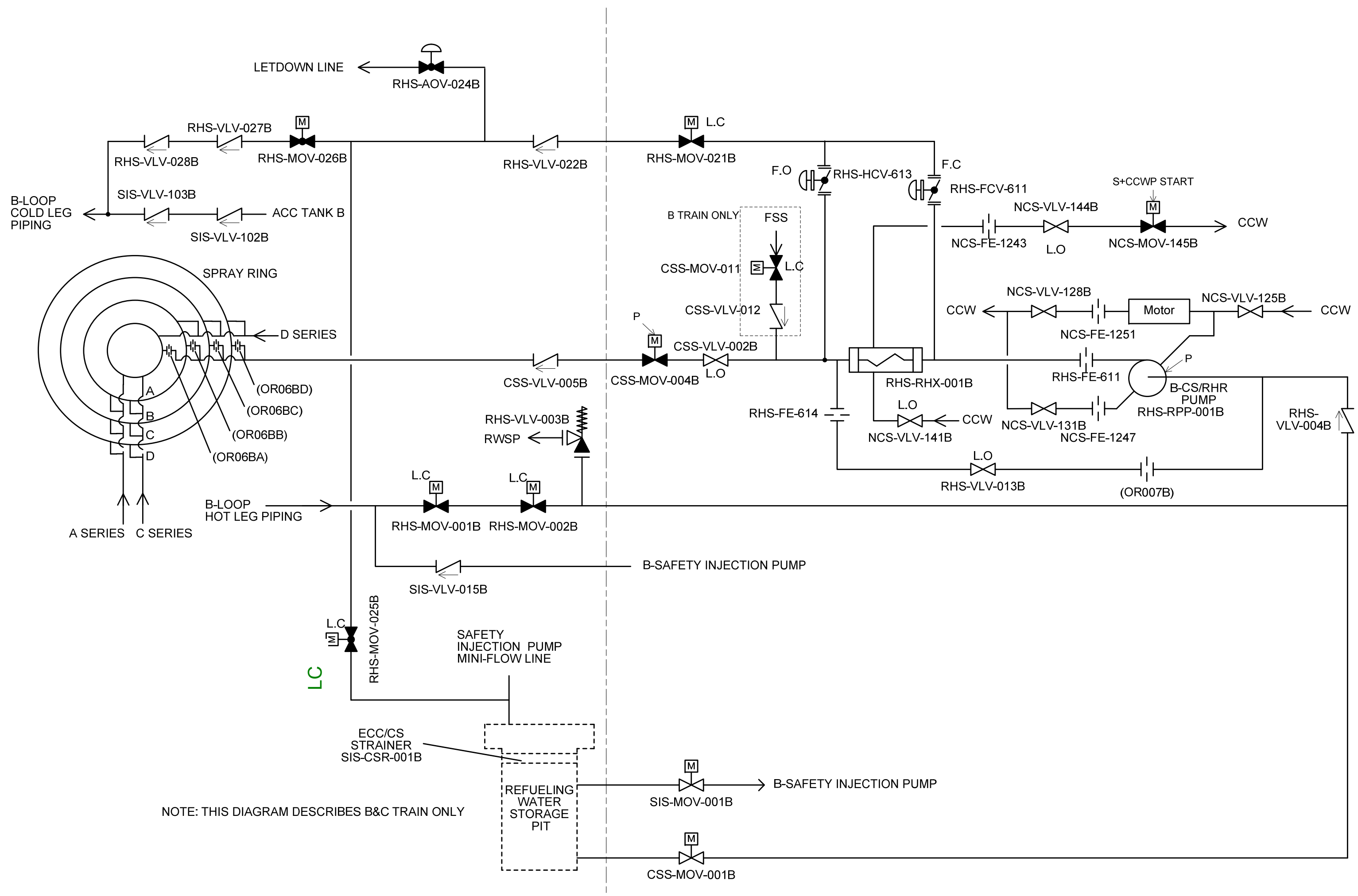


Figure 19.1-2 Simplified System Diagram (Sheet 5 of 42) (Containment Spray System/Residual Heat Removal System [Train C&B])

REMARK:
SYSTEM NAME (CVS) OF THE CHEMICAL AND VOLUME CONTROL SYSTEM IS OMITTED FROM THE COMPONENT ID.

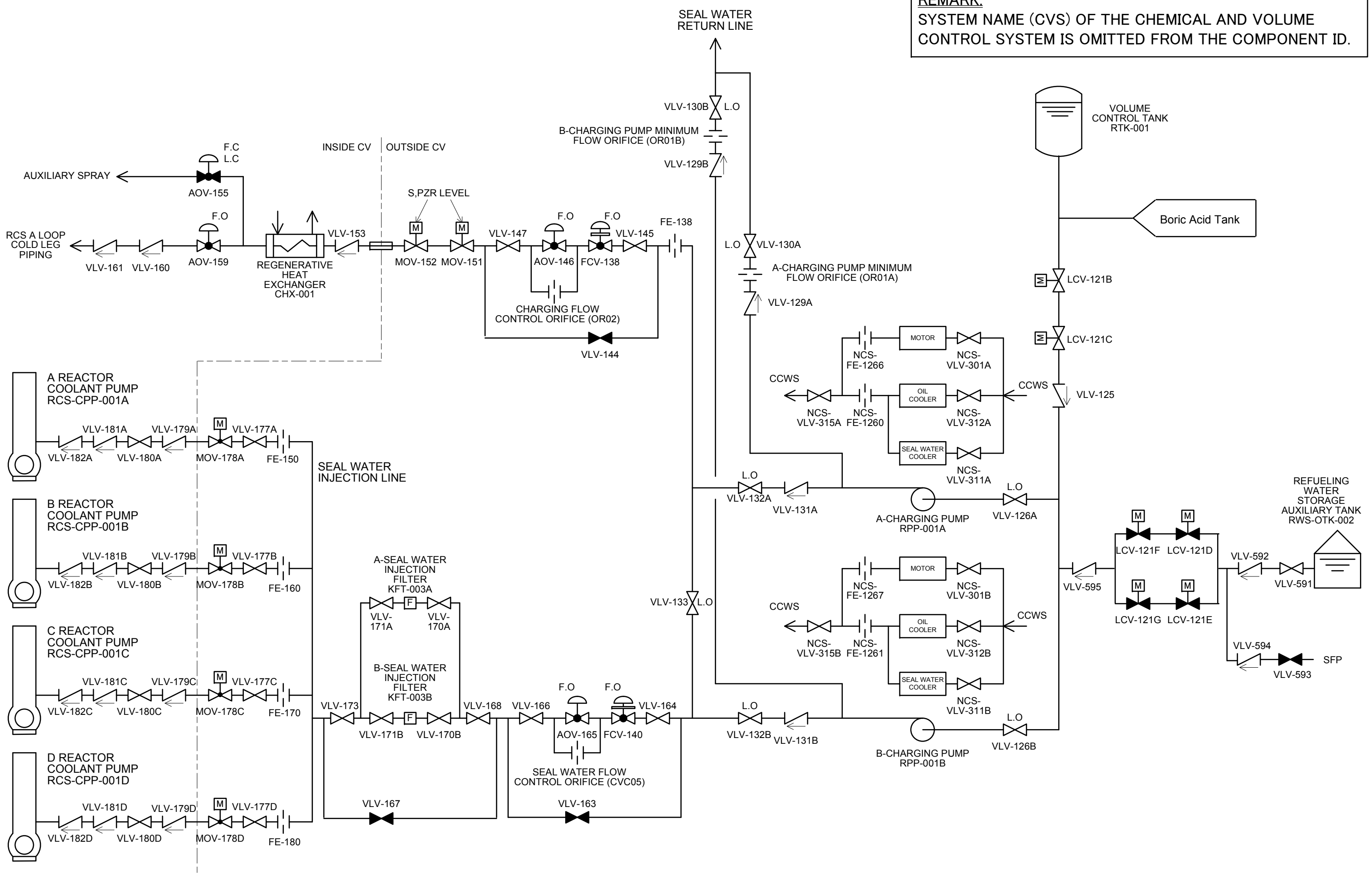


Figure 19.1-2 Simplified System Diagram (Sheet 6 of 42) (Charging Injection System)

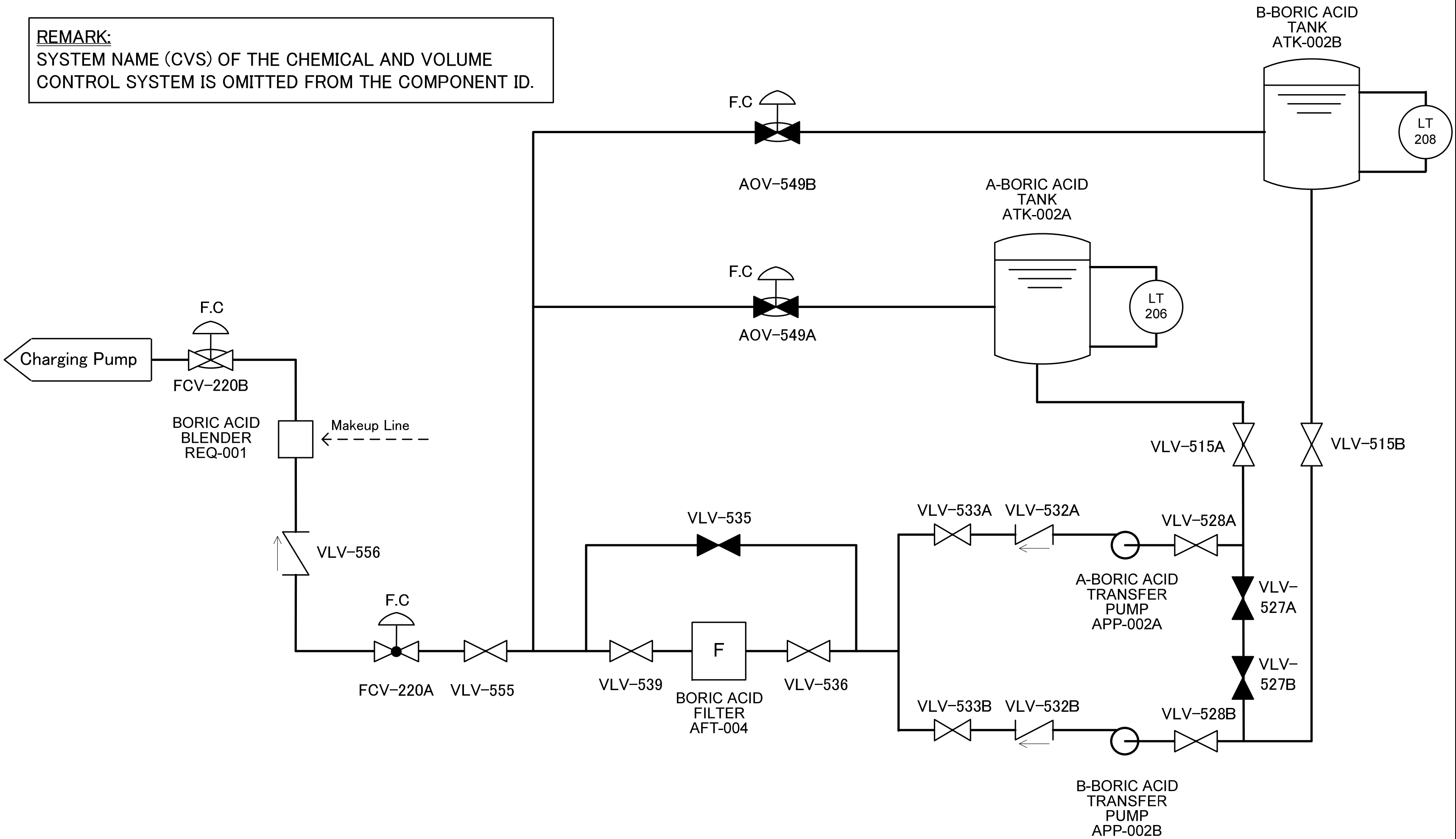


Figure 19.1-2 Simplified System Diagram (Sheet 7 of 42) (Boric Acid Transfer)

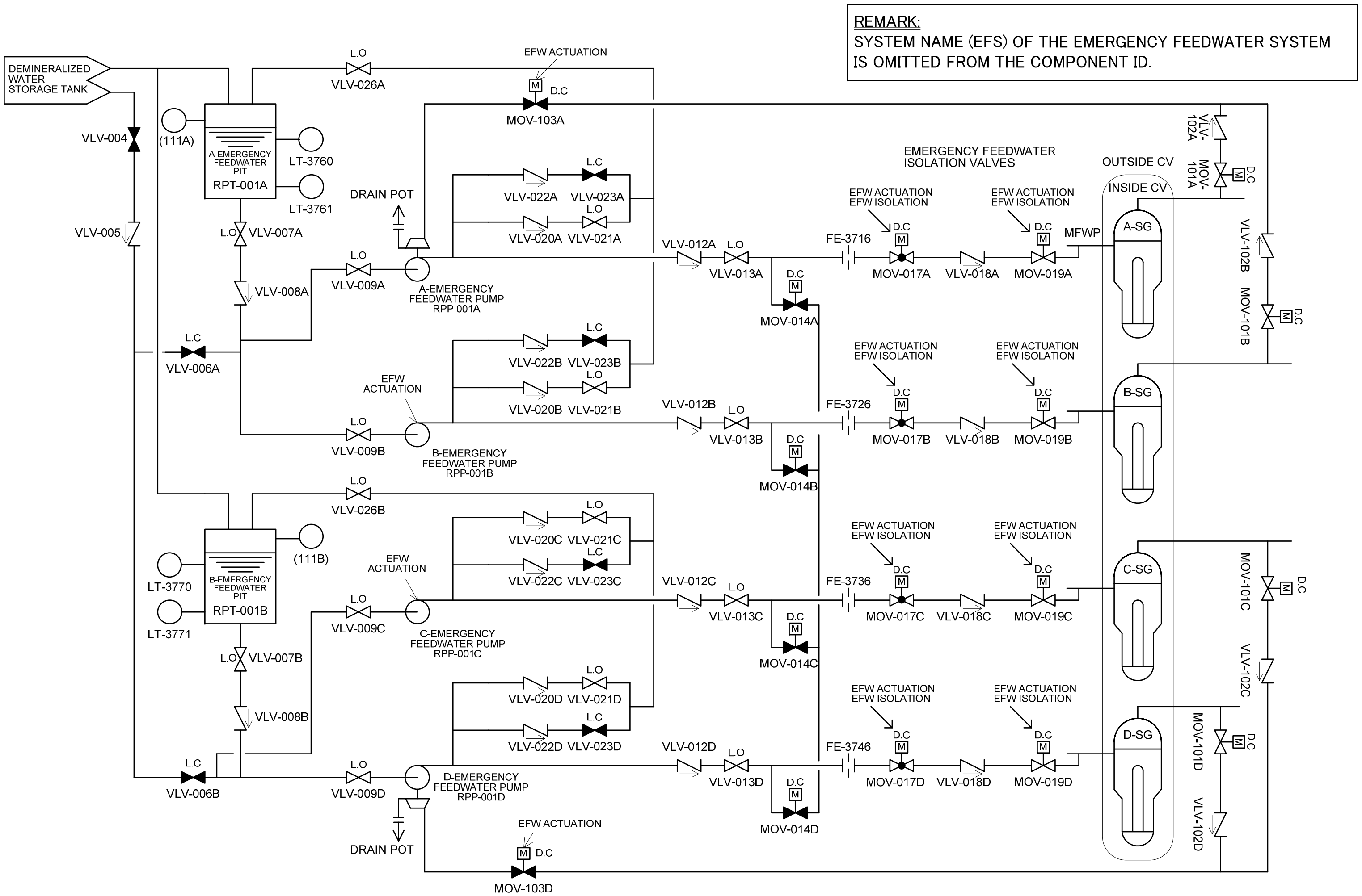


Figure 19.1-2 Simplified System Diagram (Sheet 8 of 42) (Emergency Feedwater System)

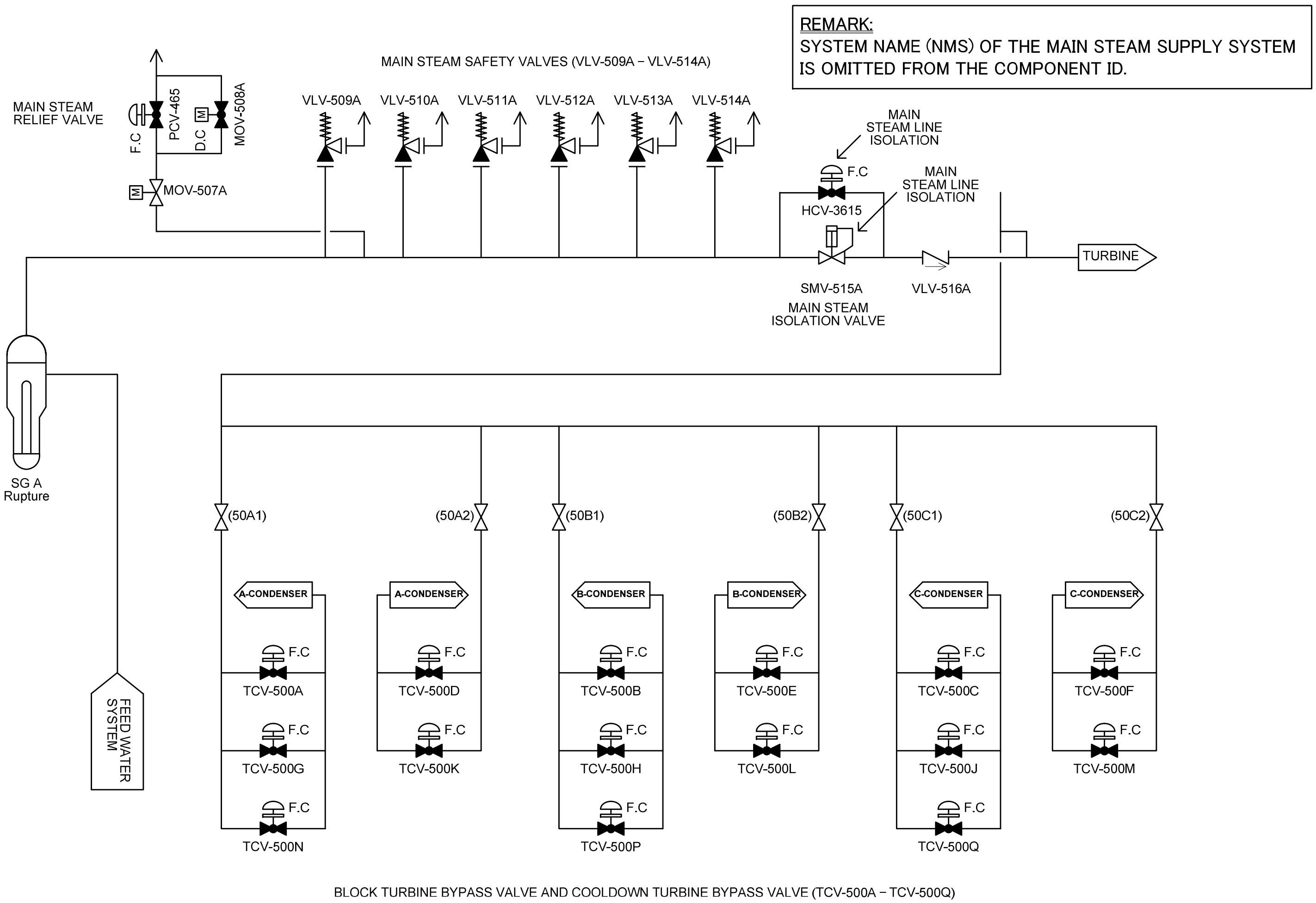


Figure 19.1-2 Simplified System Diagram (Sheet 9 of 42)
(Main Steam Pressure Control System [for Ruptured Steam Generator Isolation])

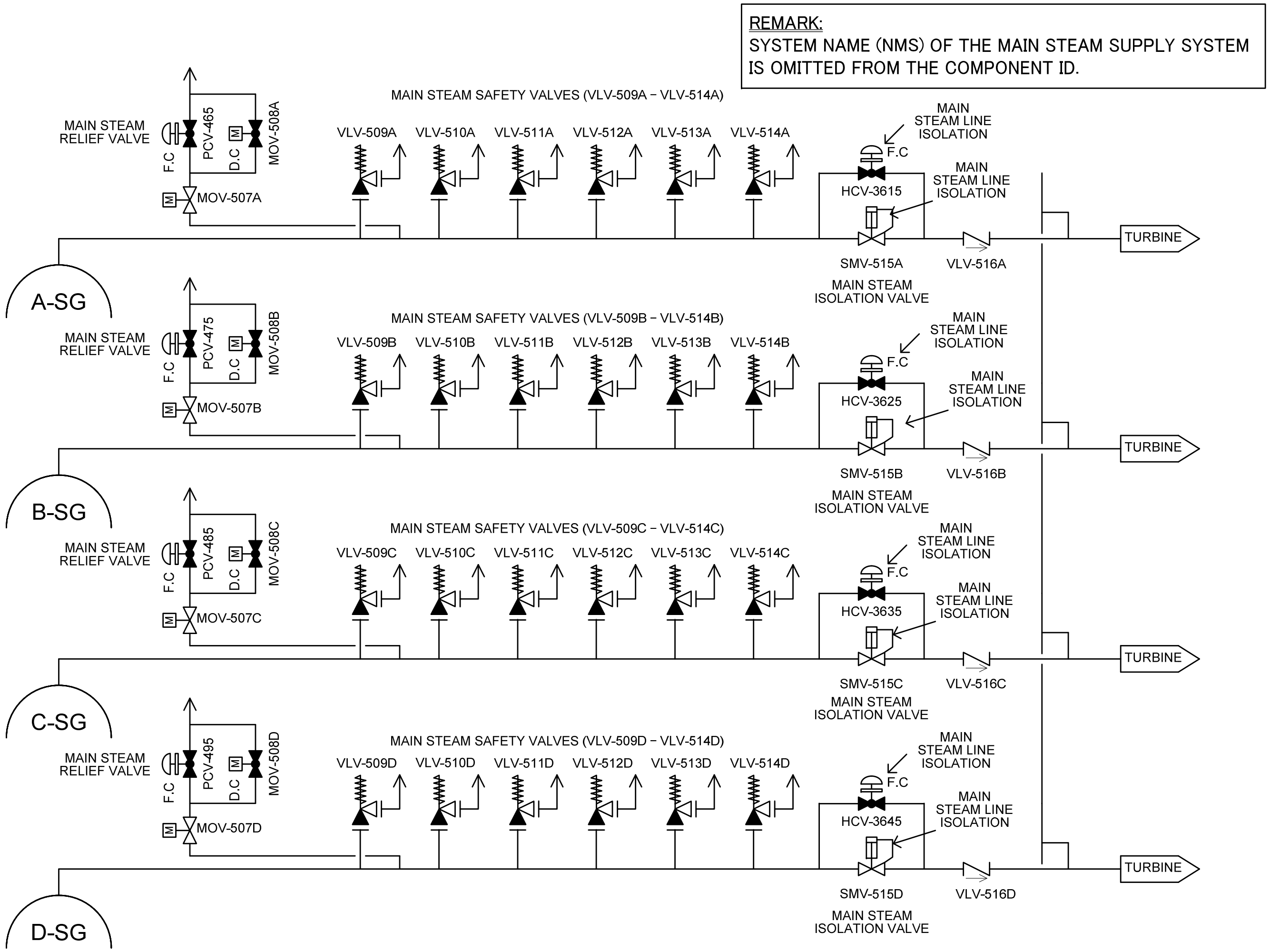


Figure 19.1-2 Simplified System Diagram (Sheet 10 of 42)

(Main Steam Pressure Control System [for Main Steam Relief])

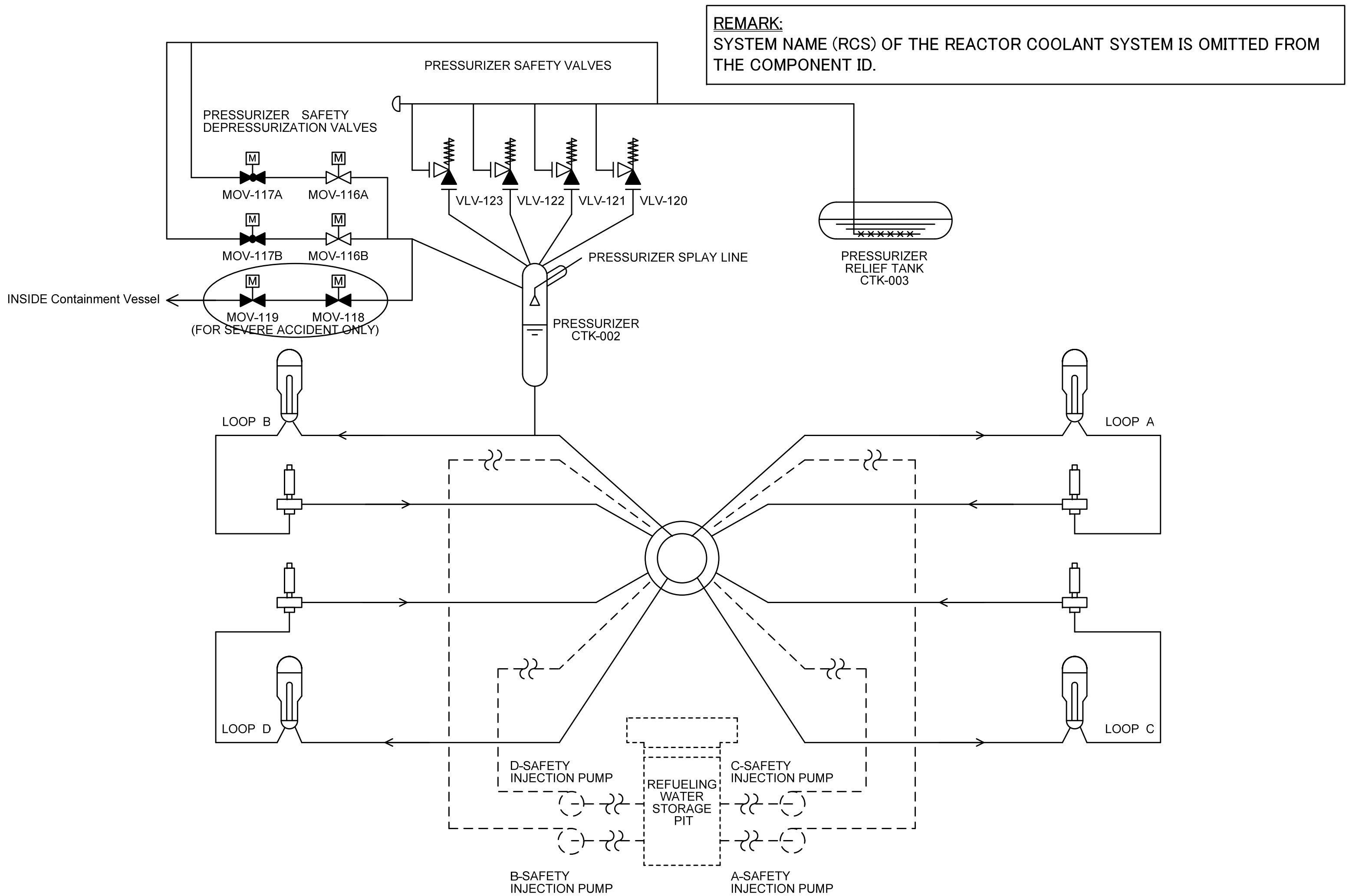


Figure 19.1-2 Simplified System Diagram (Sheet 11 of 42) (Pressurizer Pressure Control System)

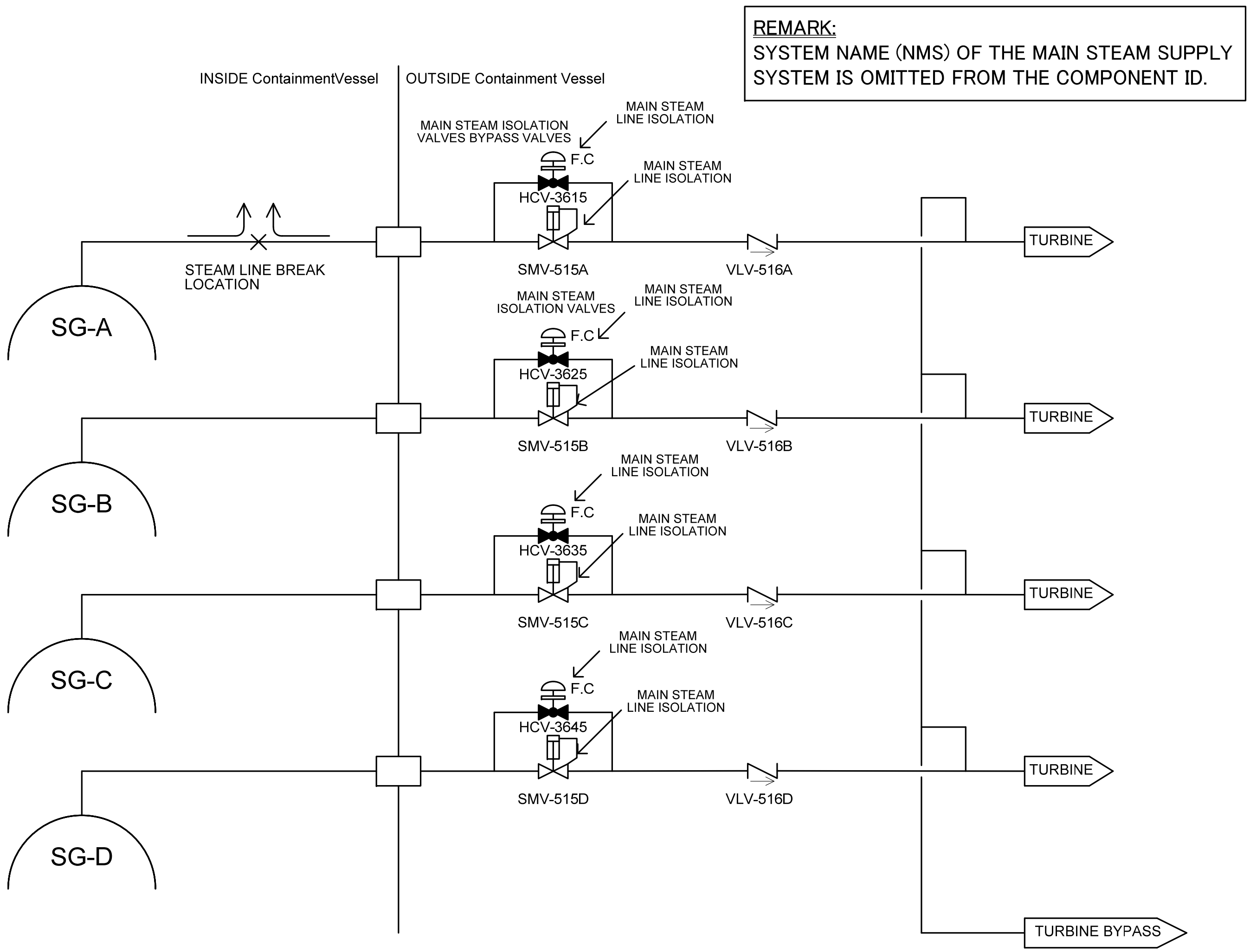


Figure 19.1-2 Simplified System Diagram (Sheet 12 of 42) (Main Steam Isolation System [Steam Line Break inside C/V])

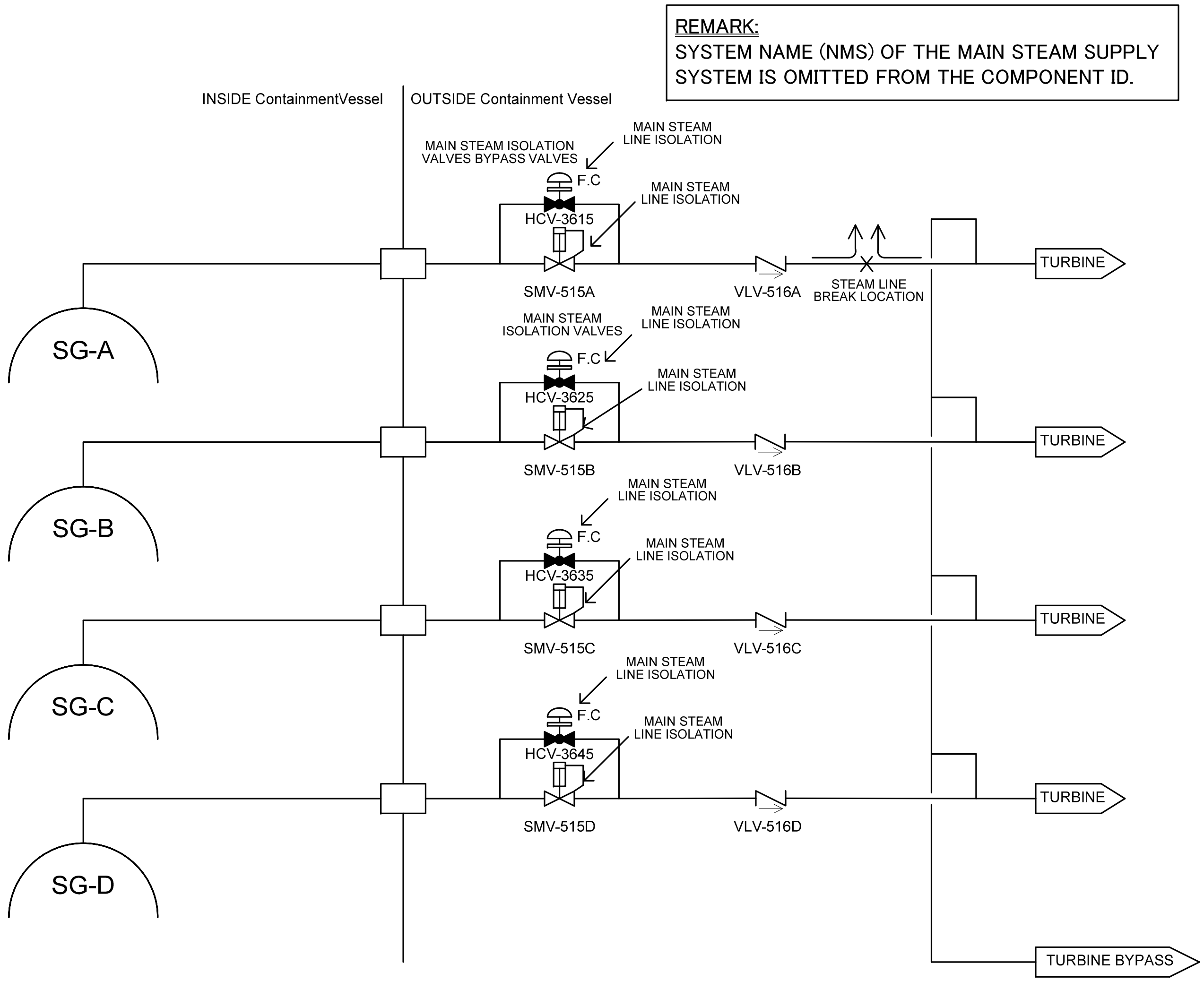


Figure 19.1-2 Simplified System Diagram (Sheet 13 of 42) (Main Steam Isolation System [Steam Line Break outside C/V])

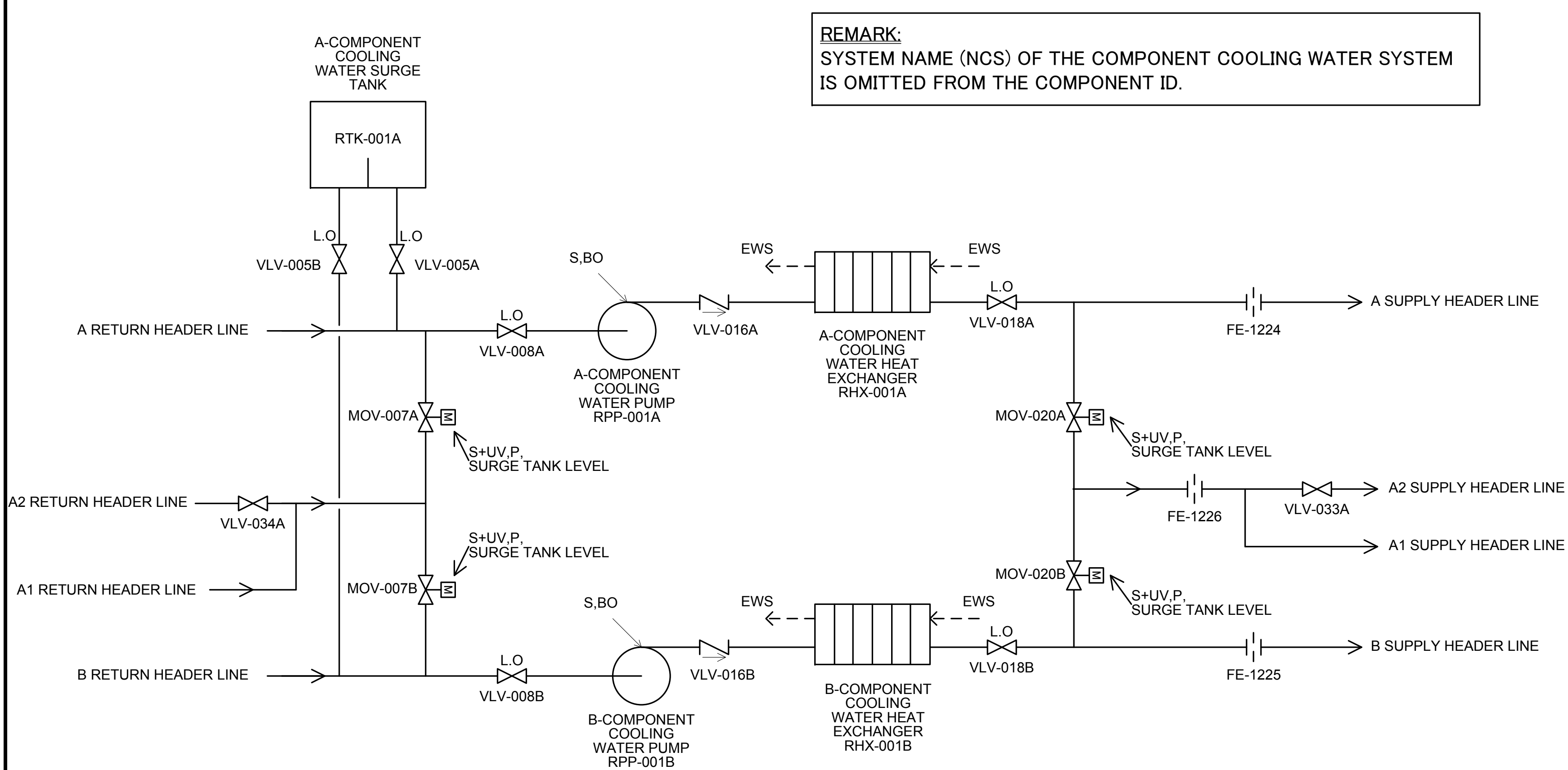


Figure 19.1-2 Simplified System Diagram (Sheet 14 of 42) (Component Cooling Water System [1of5])

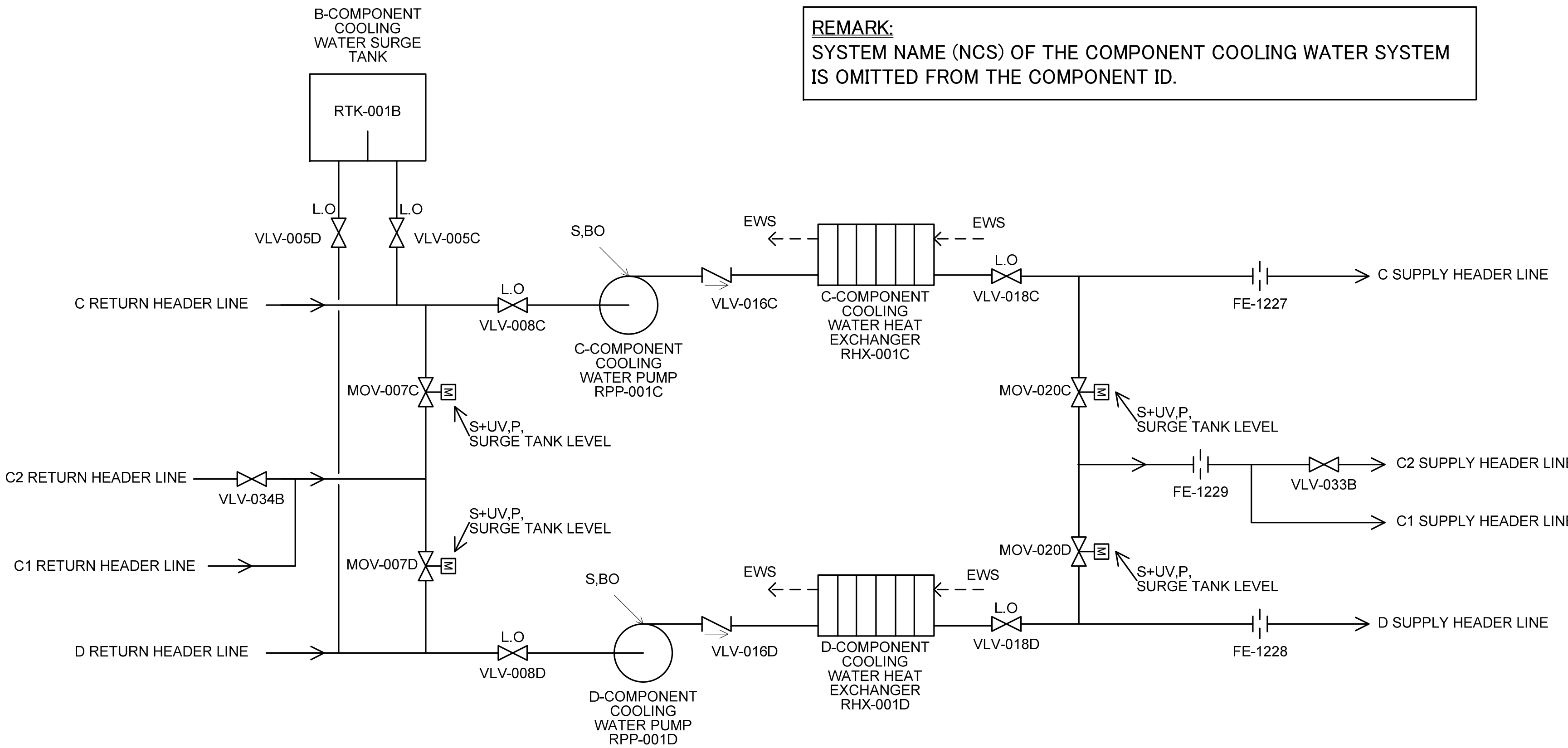


Figure 19.1-2 Simplified System Diagram (Sheet 15 of 42) (Component Cooling Water System [2of5])

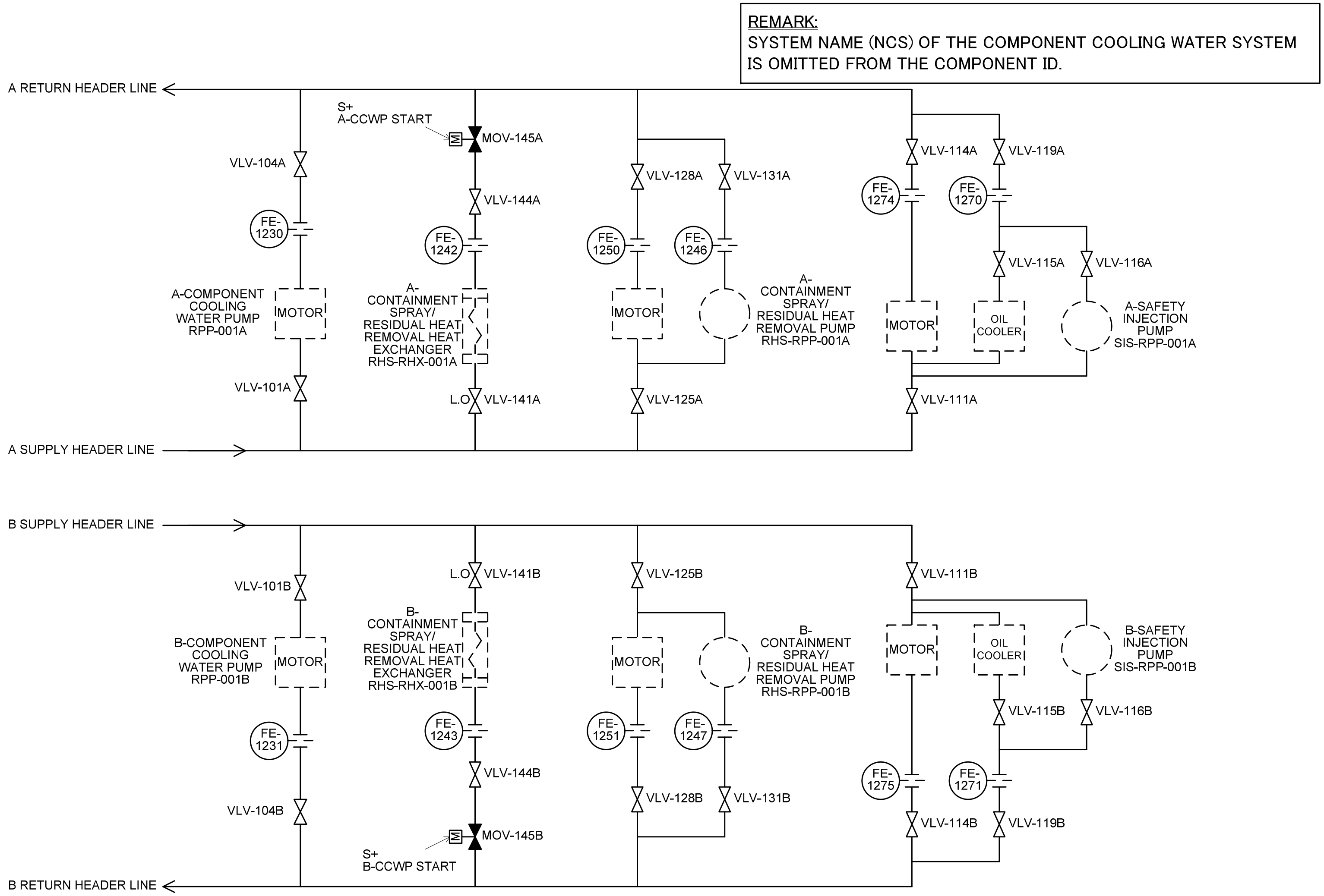


Figure 19.1-2 Simplified System Diagram (Sheet 16 of 42) (Component Cooling Water System [3of5])

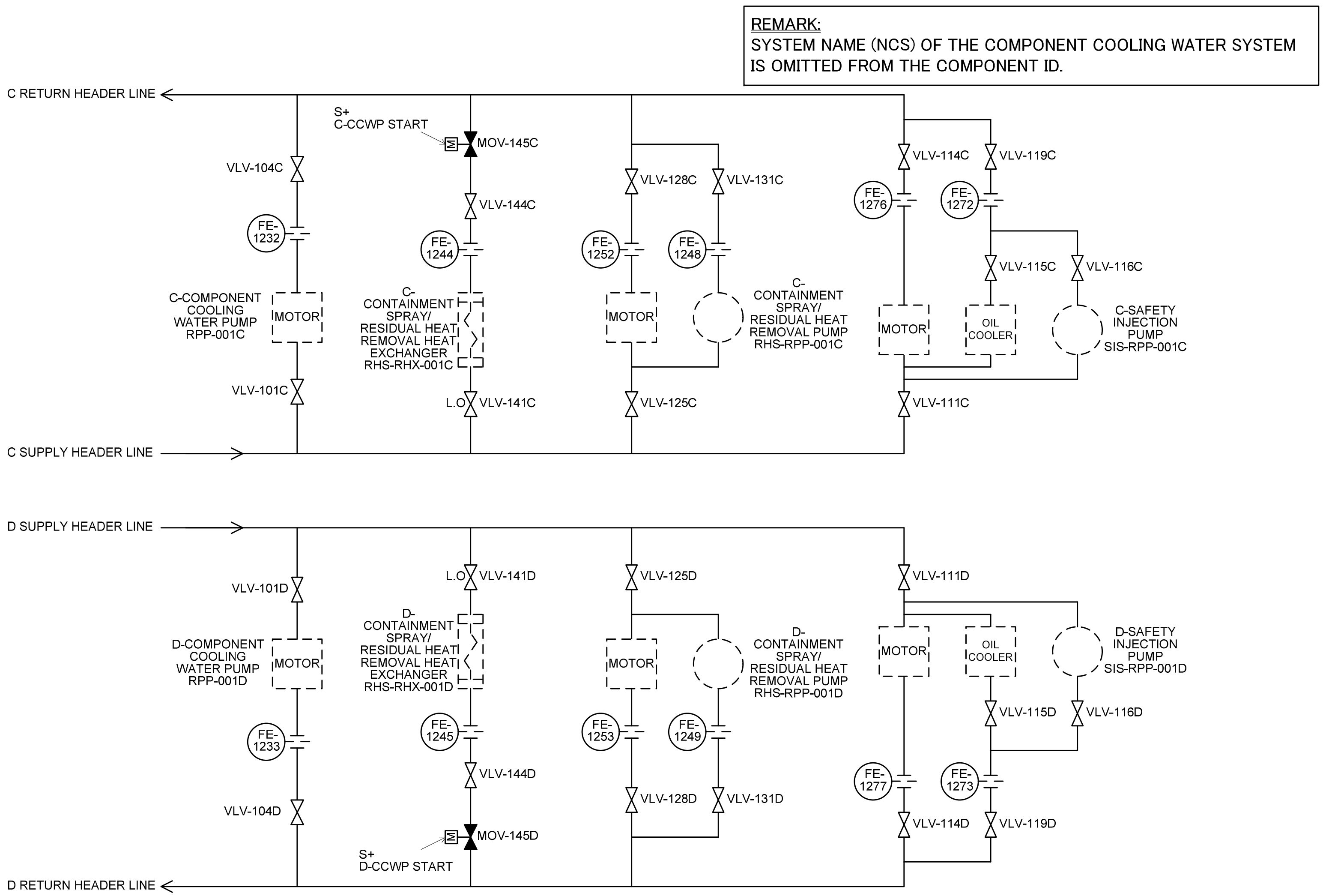


Figure 19.1-2 Simplified System Diagram (Sheet 17 of 42) (Component Cooling Water System [4of5])

REMARK:
SYSTEM NAME (NCS) OF THE COMPONENT COOLING WATER SYSTEM IS OMITTED FROM THE COMPONENT ID.

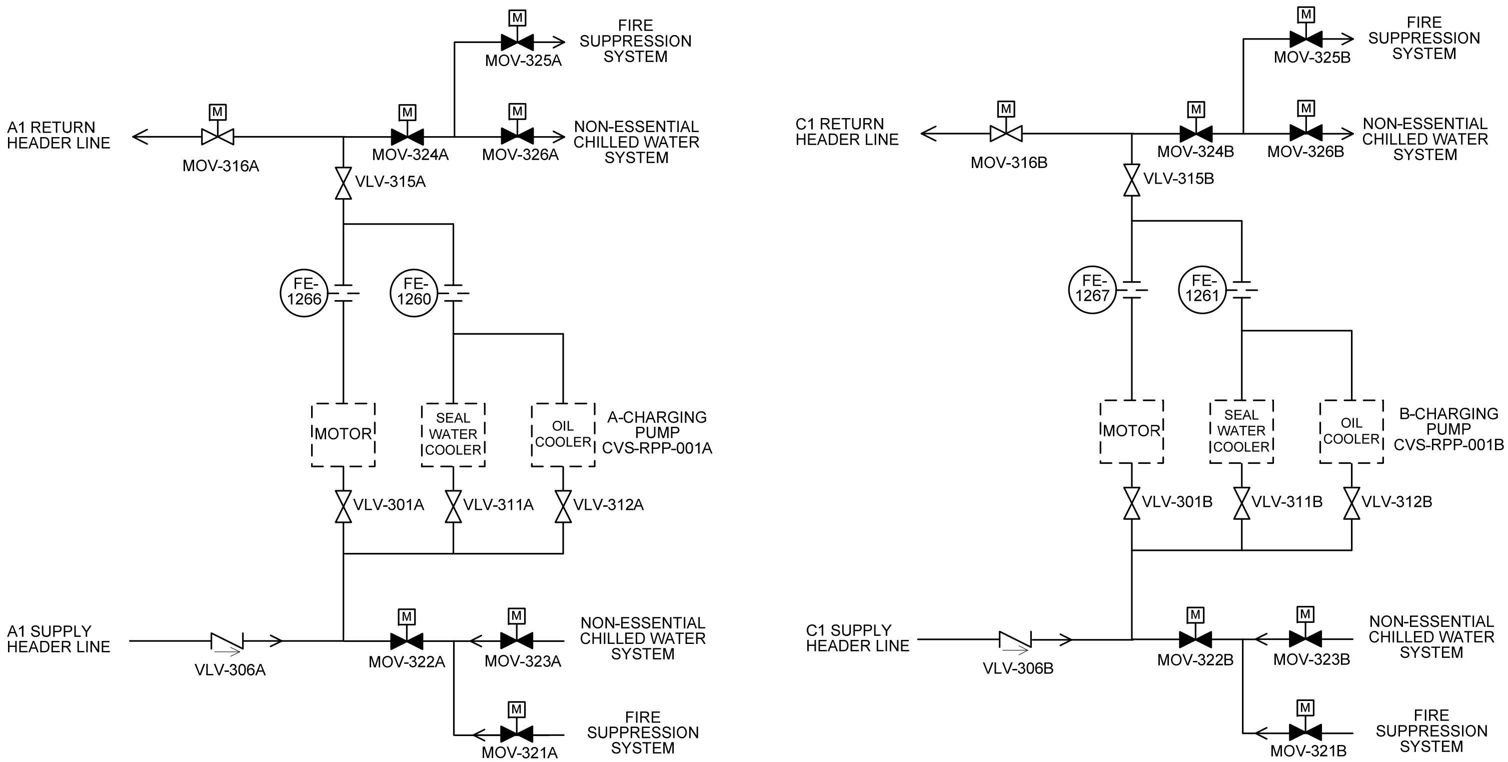


Figure 19.1-2 Simplified System Diagram (Sheet 18 of 42) (Component Cooling Water System [5of5])

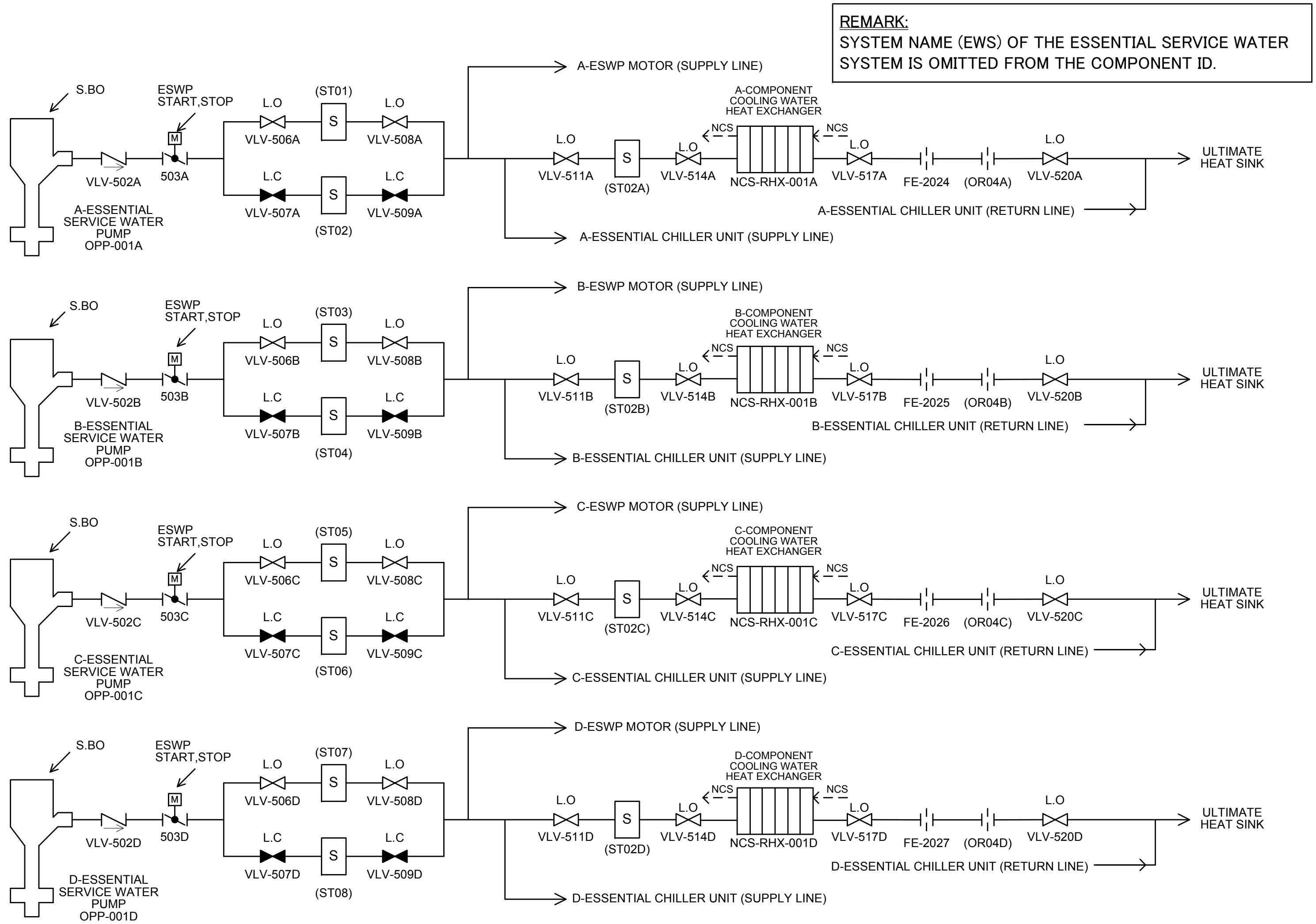


Figure 19.1-2 Simplified System Diagram (Sheet 19 of 42) (Essential Service Water System [1of3])

REMARK:
SYSTEM NAME (EWS) OF THE ESSENTIAL SERVICE WATER SYSTEM IS OMITTED FROM THE COMPONENT ID.

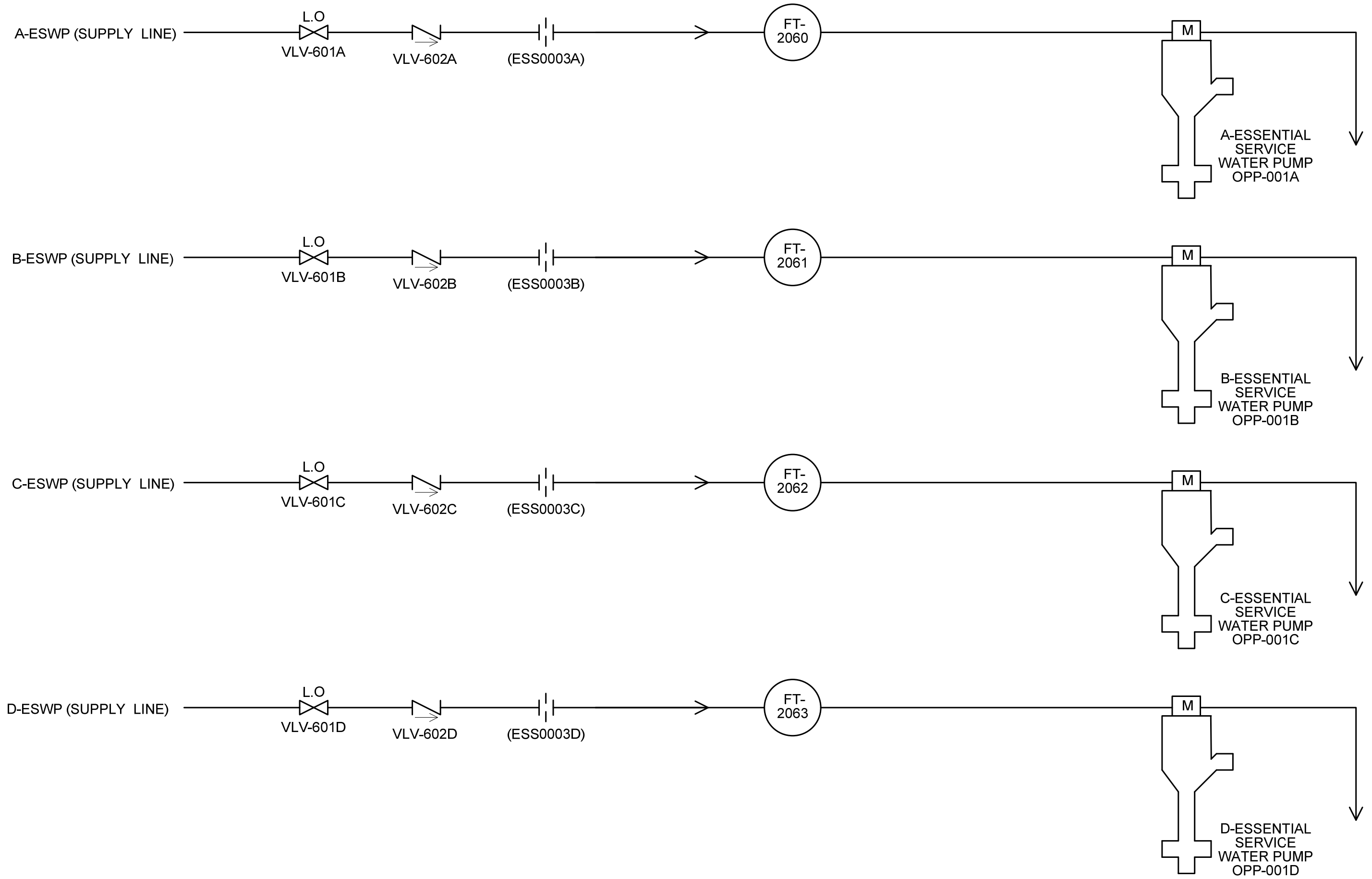


Figure 19.1-2 Simplified System Diagram (Sheet 20 of 42) (Essential Service Water System [2of3])

REMARK:
SYSTEM NAME (EWS) OF THE ESSENTIAL SERVICE WATER SYSTEM IS OMITTED FROM THE COMPONENT ID.

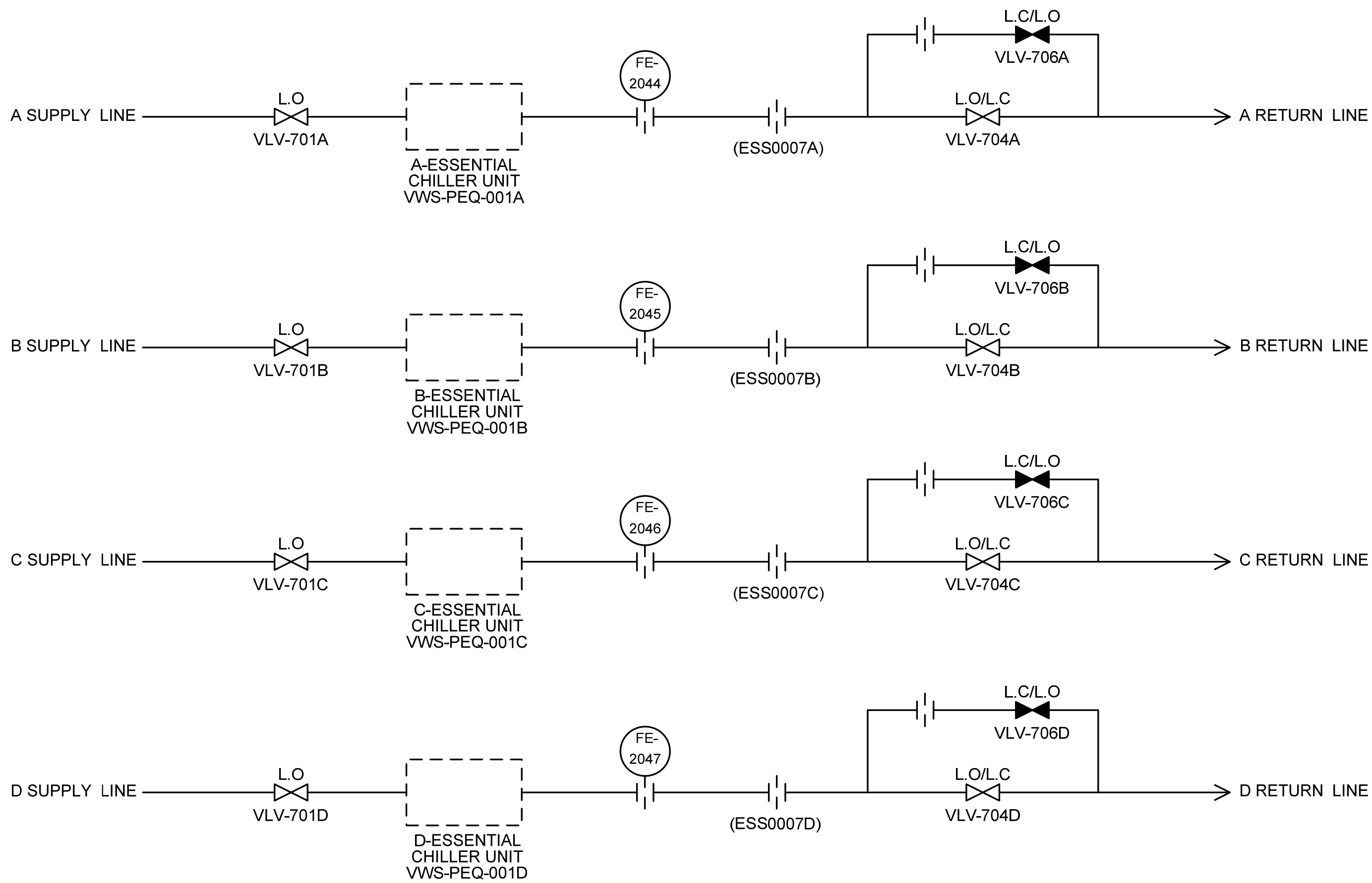


Figure 19.1-2 Simplified System Diagram (Sheet 21 of 42) (Essential Service Water System [3of3])

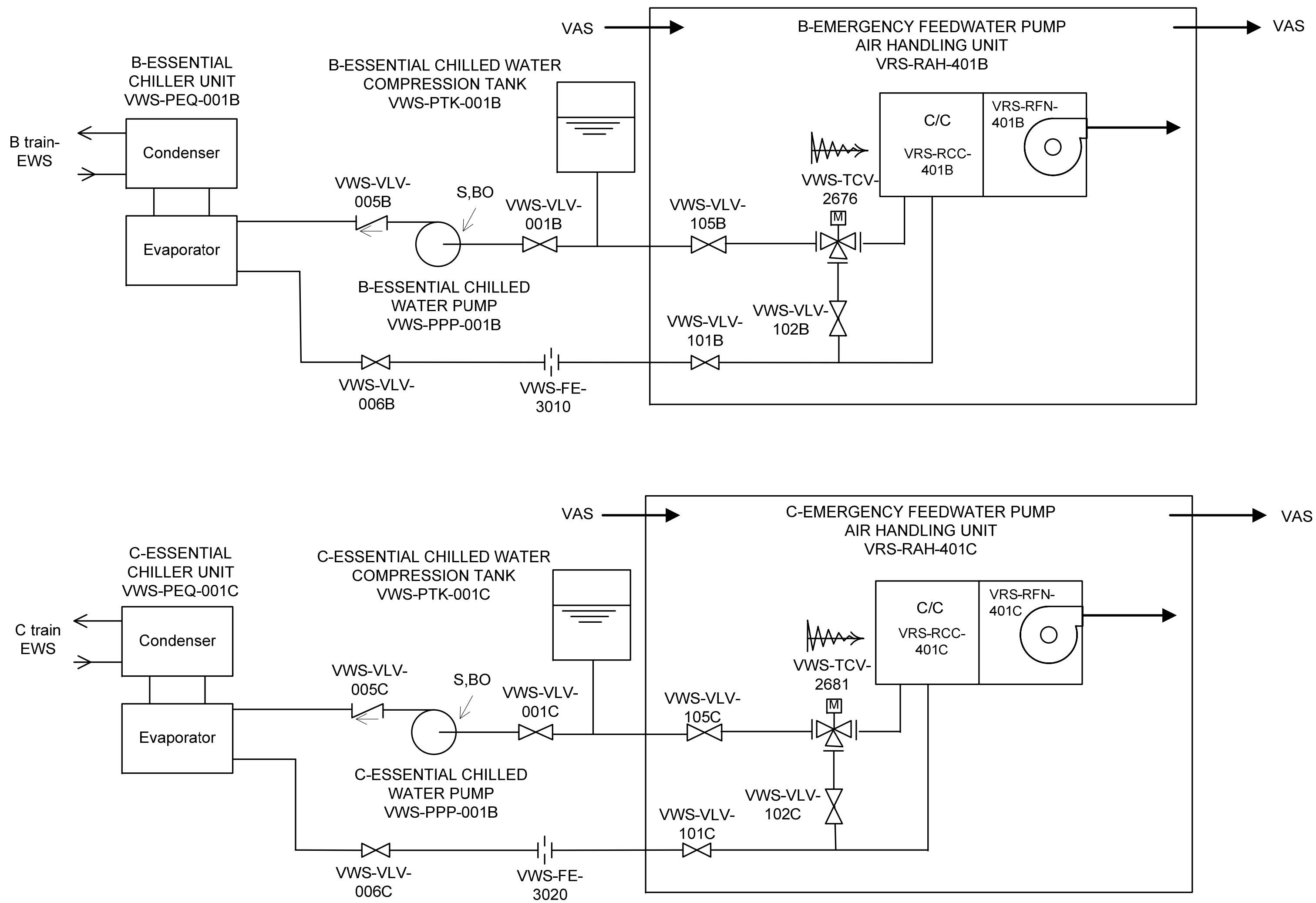


Figure 19.1-2 Simplified System Diagram (Sheet 22 of 42) (Heating, Ventilating and Air Conditioning System)

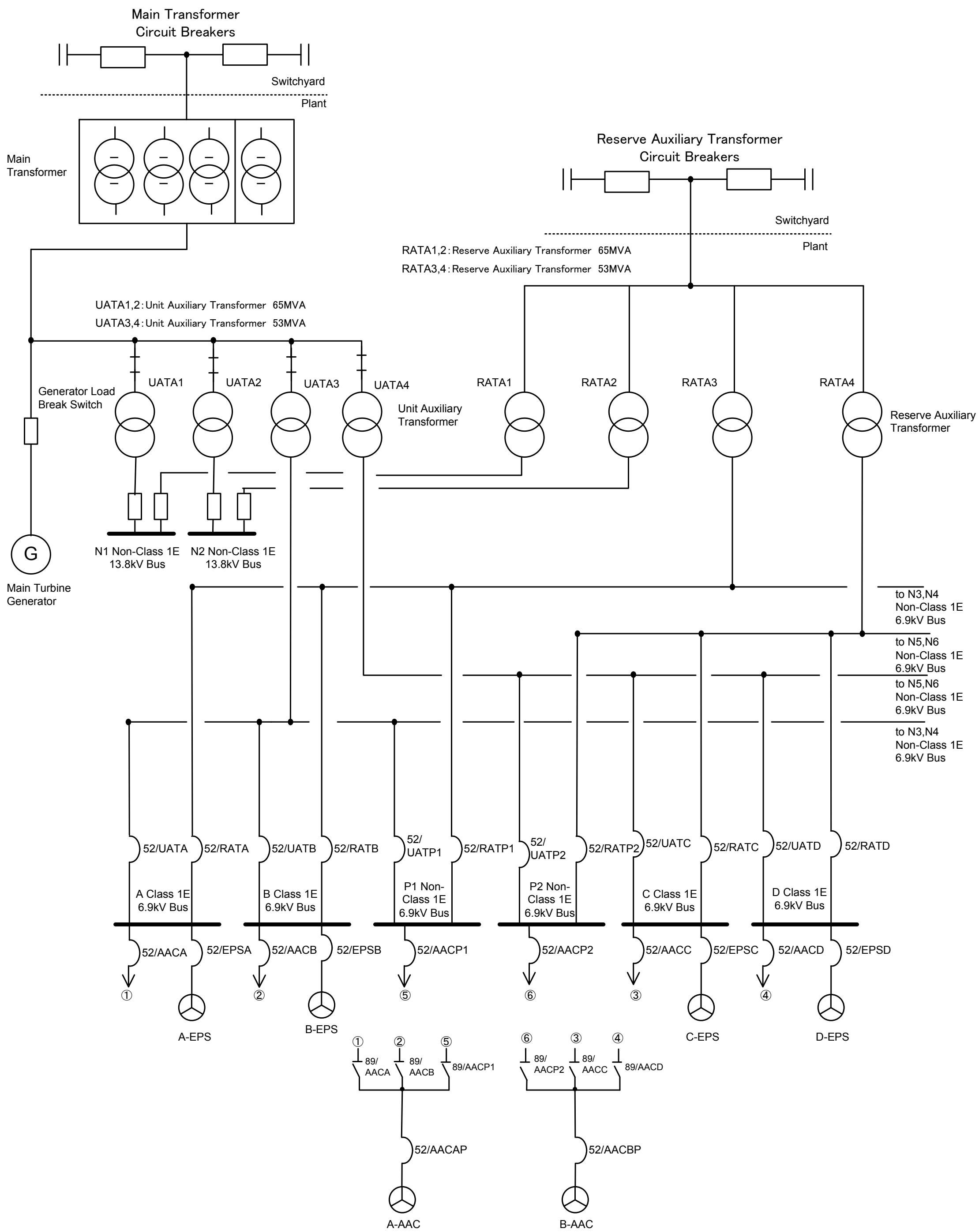


Figure 19.1-2 Simplified System Diagram (Sheet 23 of 42)

(Safety System Electric Bus [1/2])

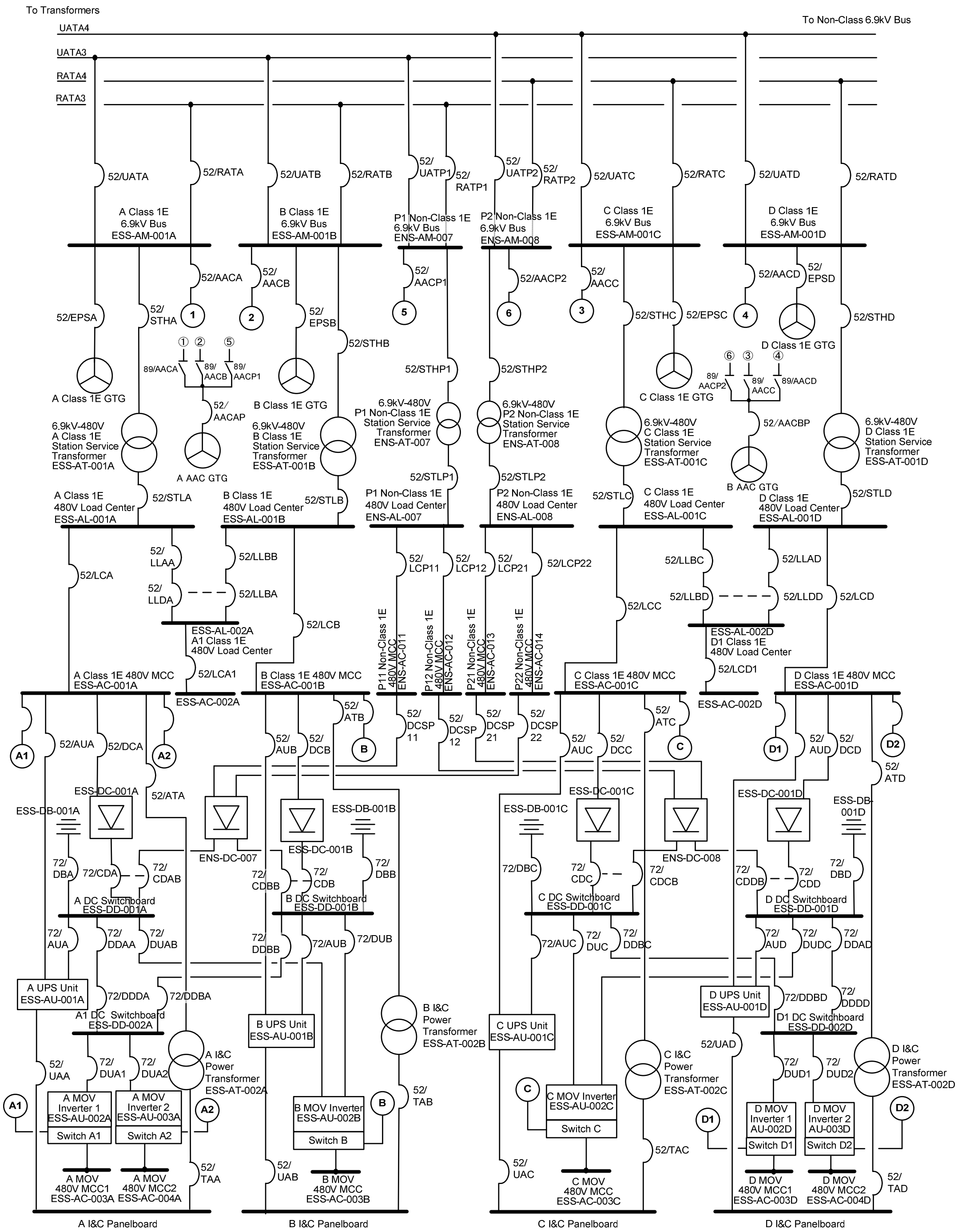


Figure 19.1-2 Simplified System Diagram (Sheet 24 of 42)

(Safety System Electric Bus [2/2])

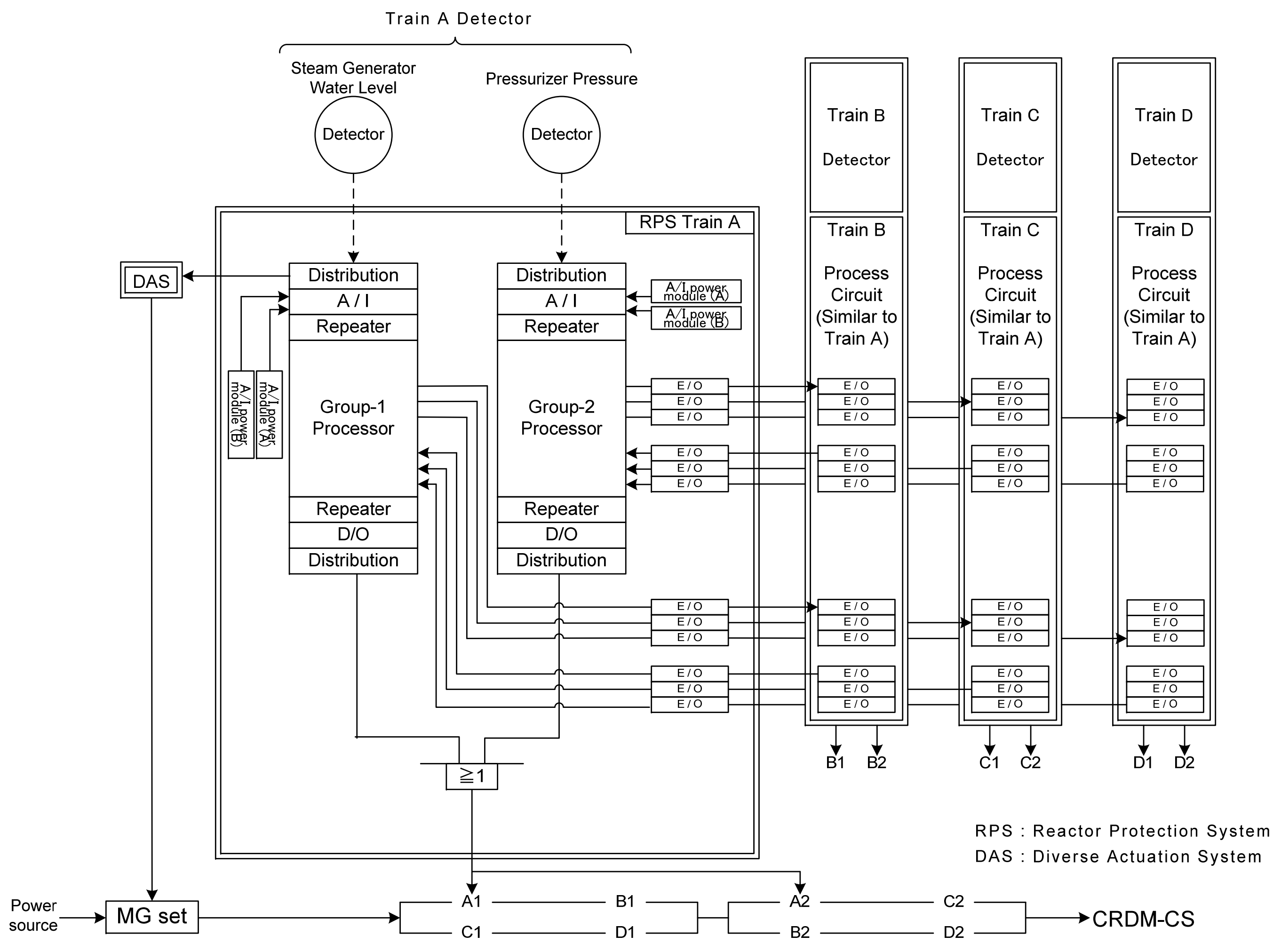


Figure 19.1-2 Simplified System Diagram (Sheet 25 of 42) (Reactor Trip System)

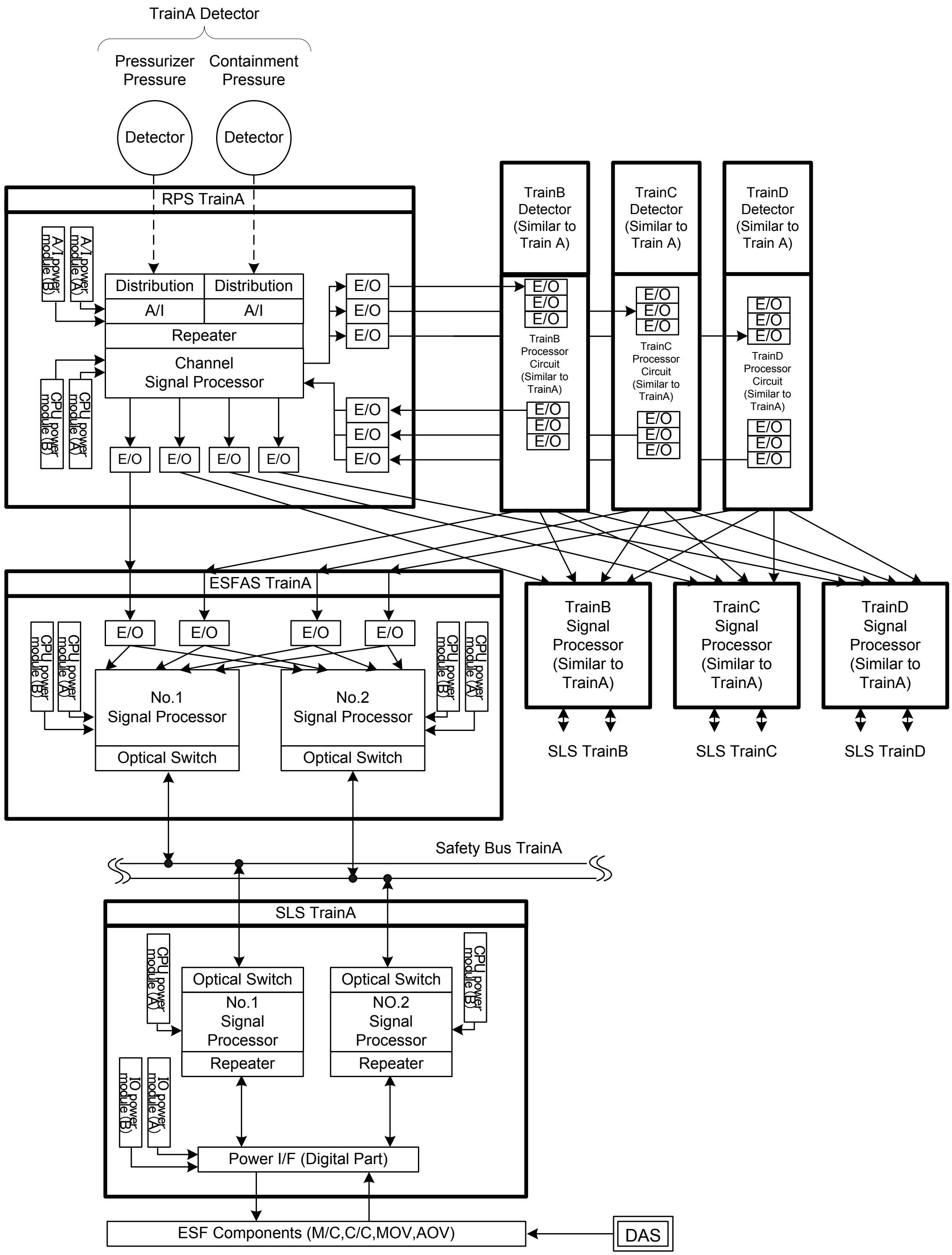


Figure 19.1-2 Simplified System Diagram (Sheet 26 of 42)

(ESF System - ECSS Actuation Signals)

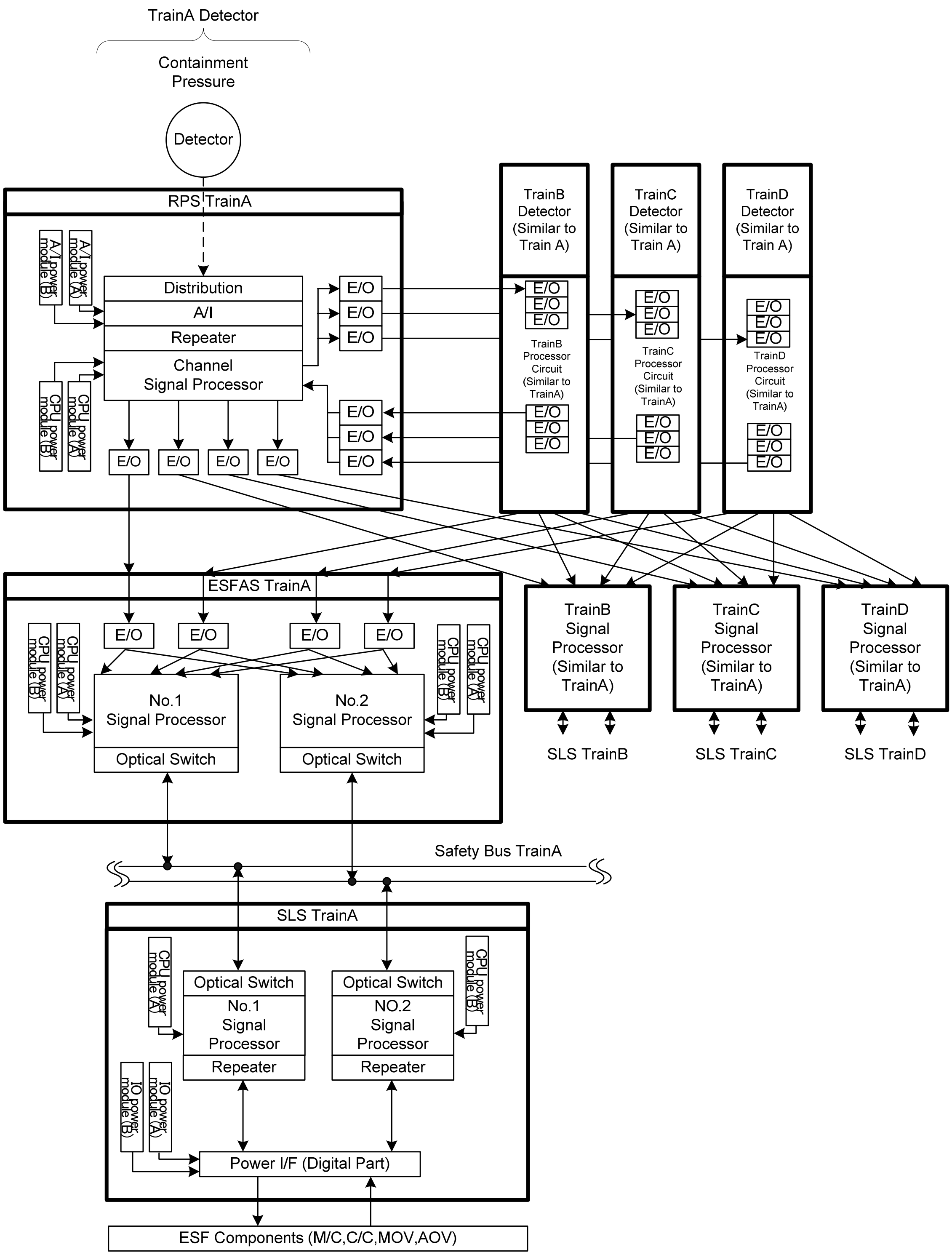


Figure 19.1-2 Simplified System Diagram (Sheet 27 of 42)

(ESF System -Containment Spray Actuation Signals)

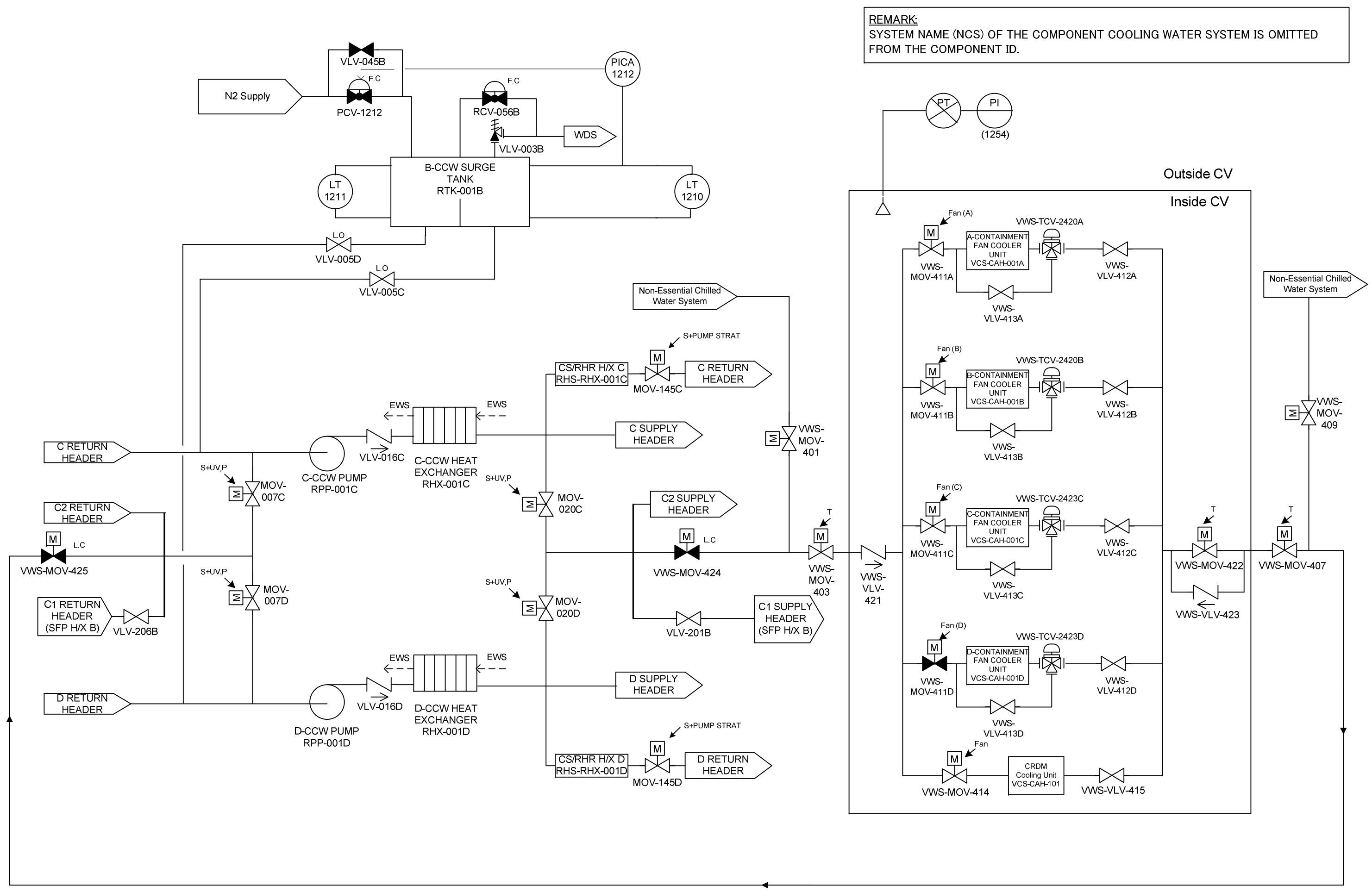


Figure 19.1-2 Simplified System Diagram (Sheet 28 of 42)

(Alternate Containment Cooling by Containment Fan Cooler System - Normal Operation)

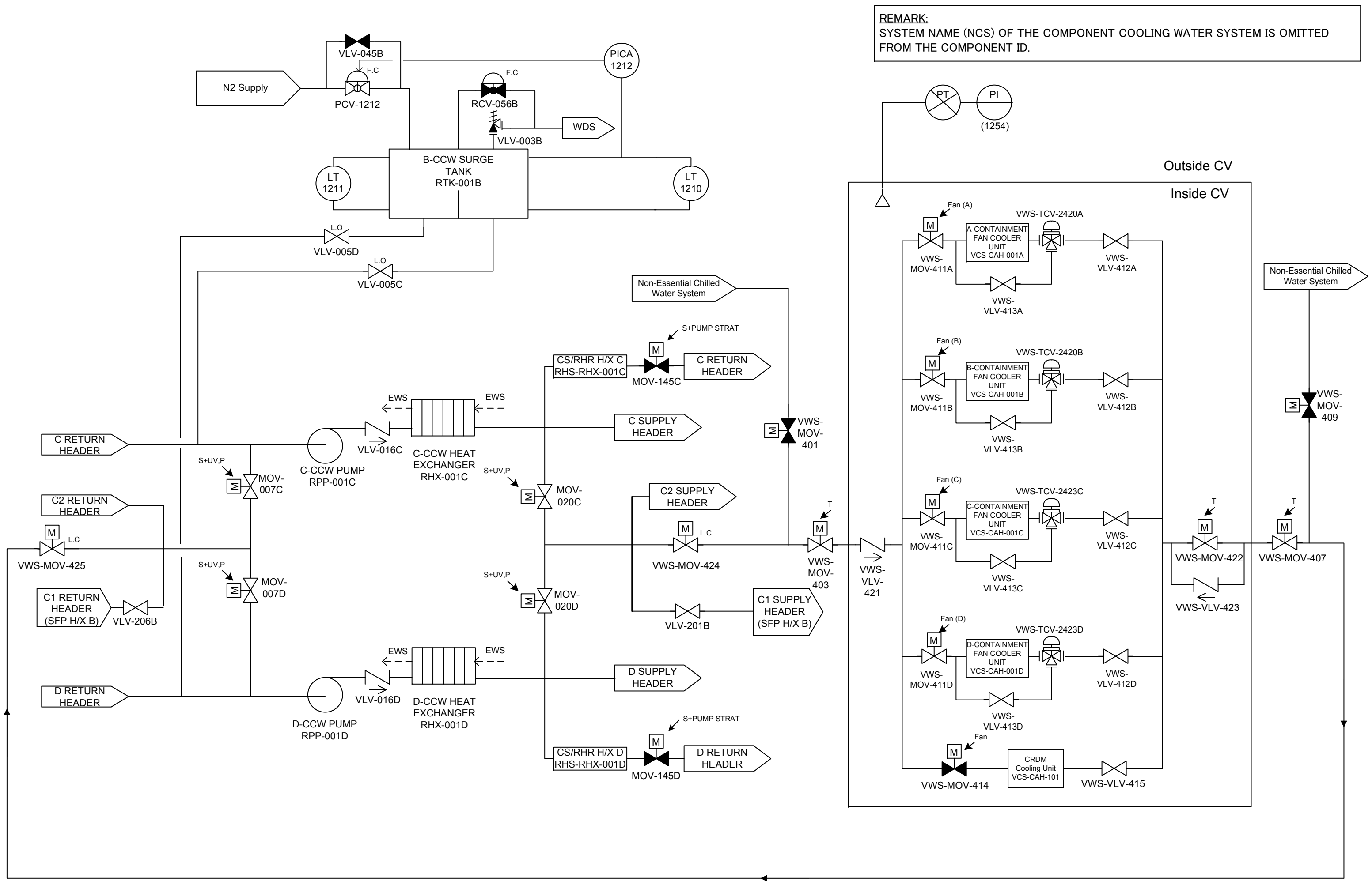


Figure 19.1-2 Simplified System Diagram (Sheet 29 of 42)

(Alternate Containment Cooling by Containment Fan Cooler System - Alternate Containment Cooling Mode)

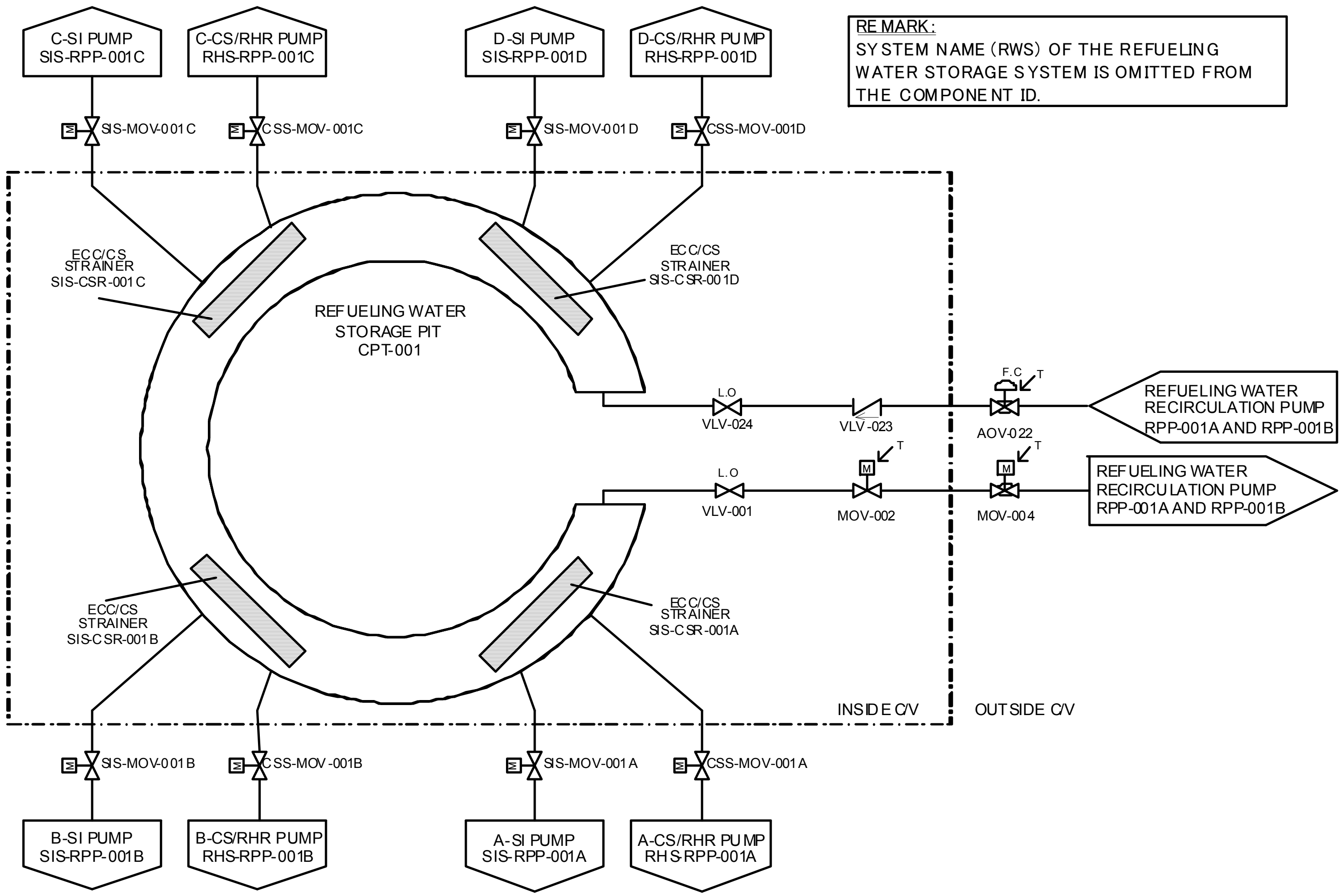


Figure 19.1-2 Simplified System Diagram (Sheet 30 of 42) (Refueling Water Storage Pit) [1of2]

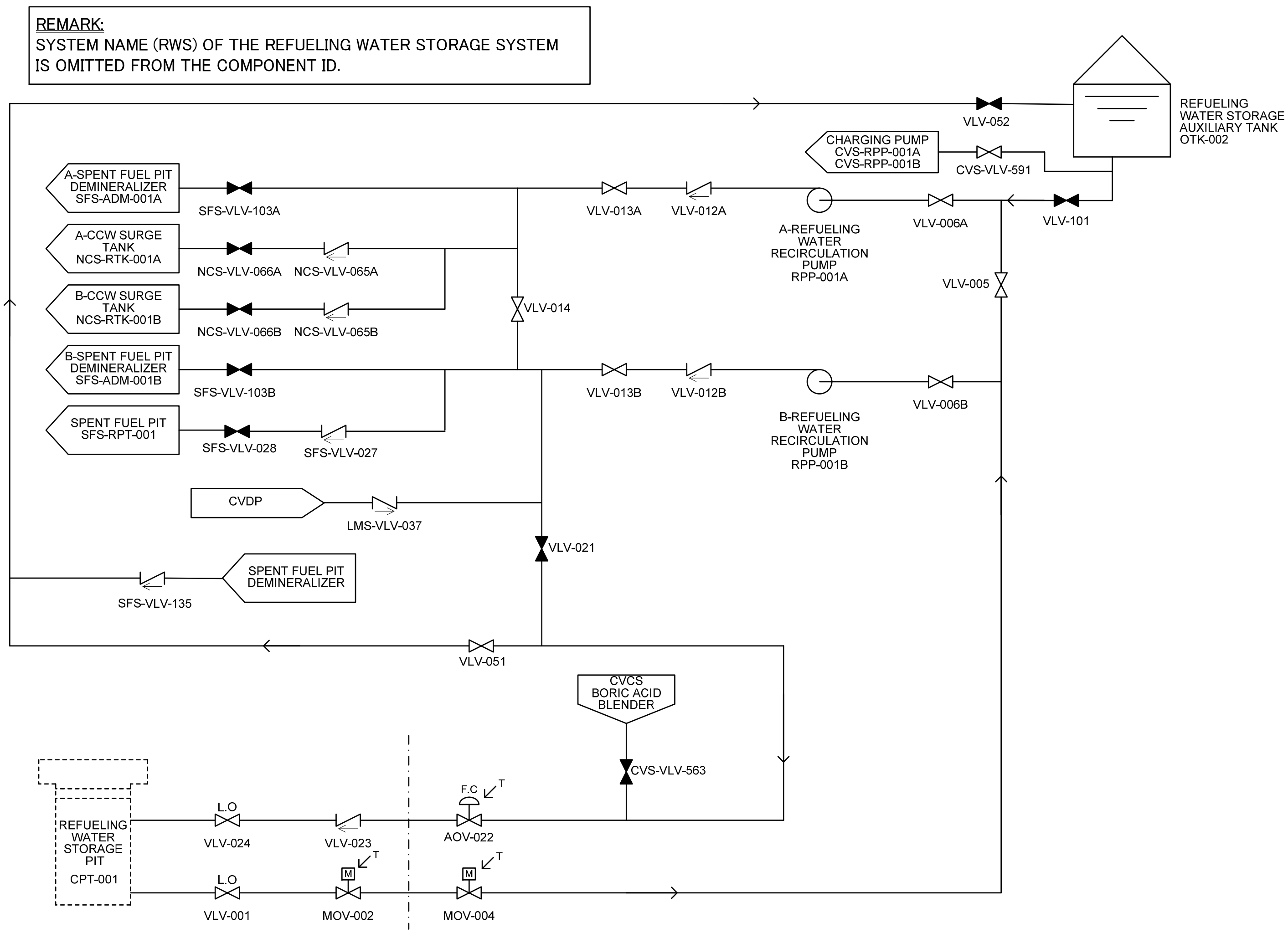


Figure 19.1-2 Simplified System Diagram (Sheet 31 of 42) (Refueling Water Storage Pit) [2of2]

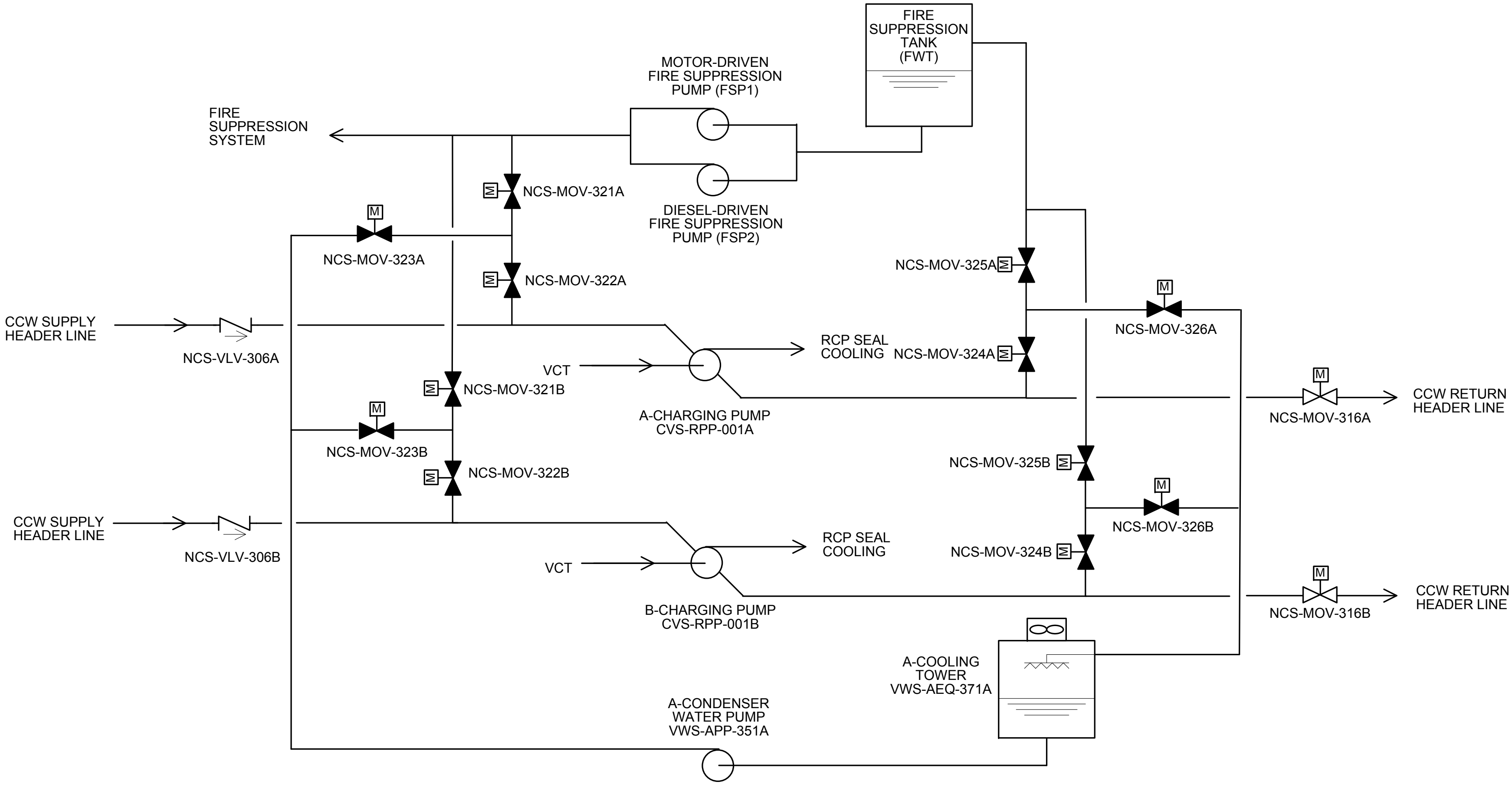


Figure 19.1-2 Simplified System Diagram (Sheet 32 of 42)

(Charging Pump Cooling by CCWS- Normal Operation)

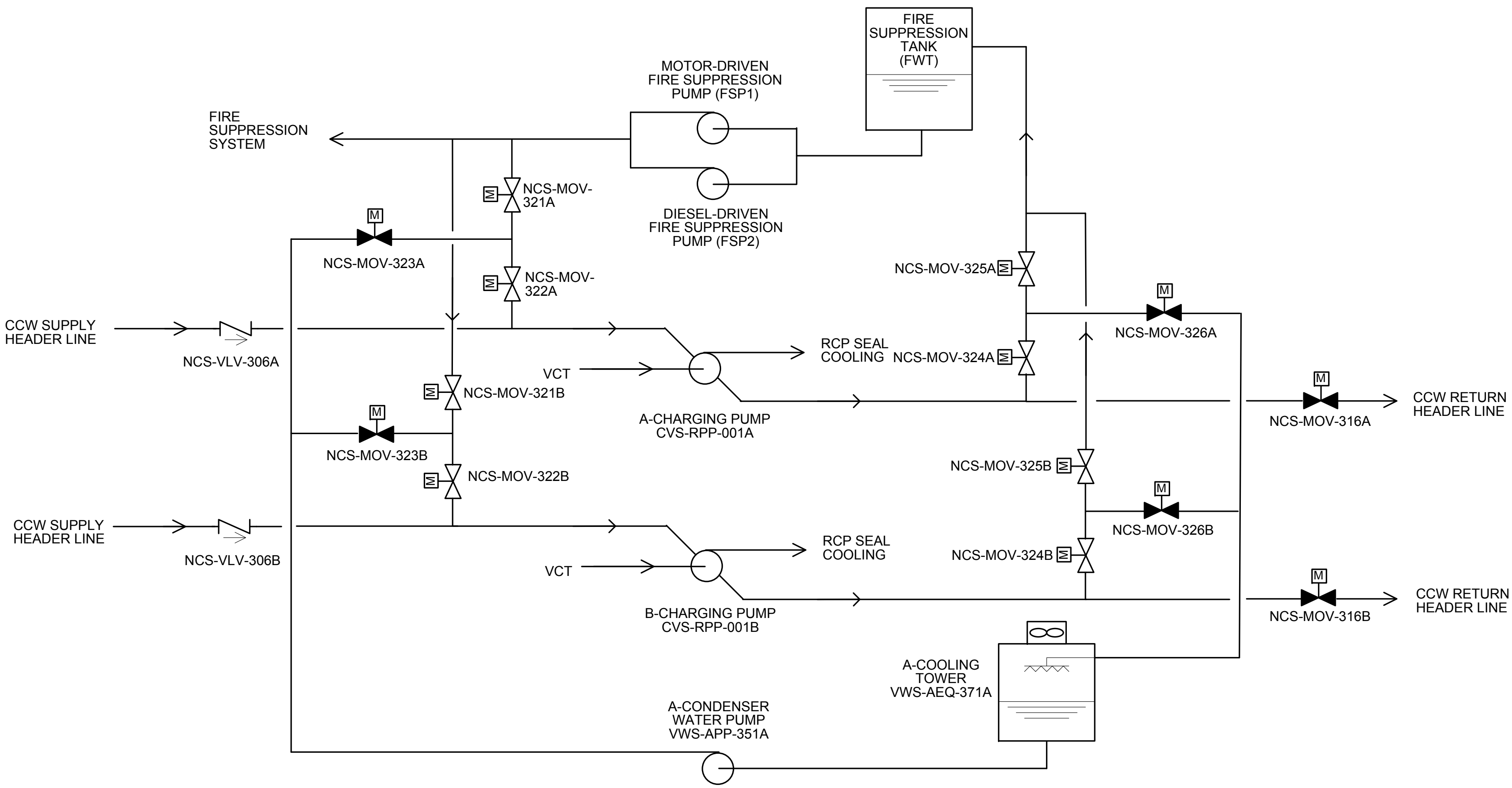


Figure 19.1-2 Simplified System Diagram (Sheet 33 of 42)

(Alternate Component Cooling by Fire Suppression System)

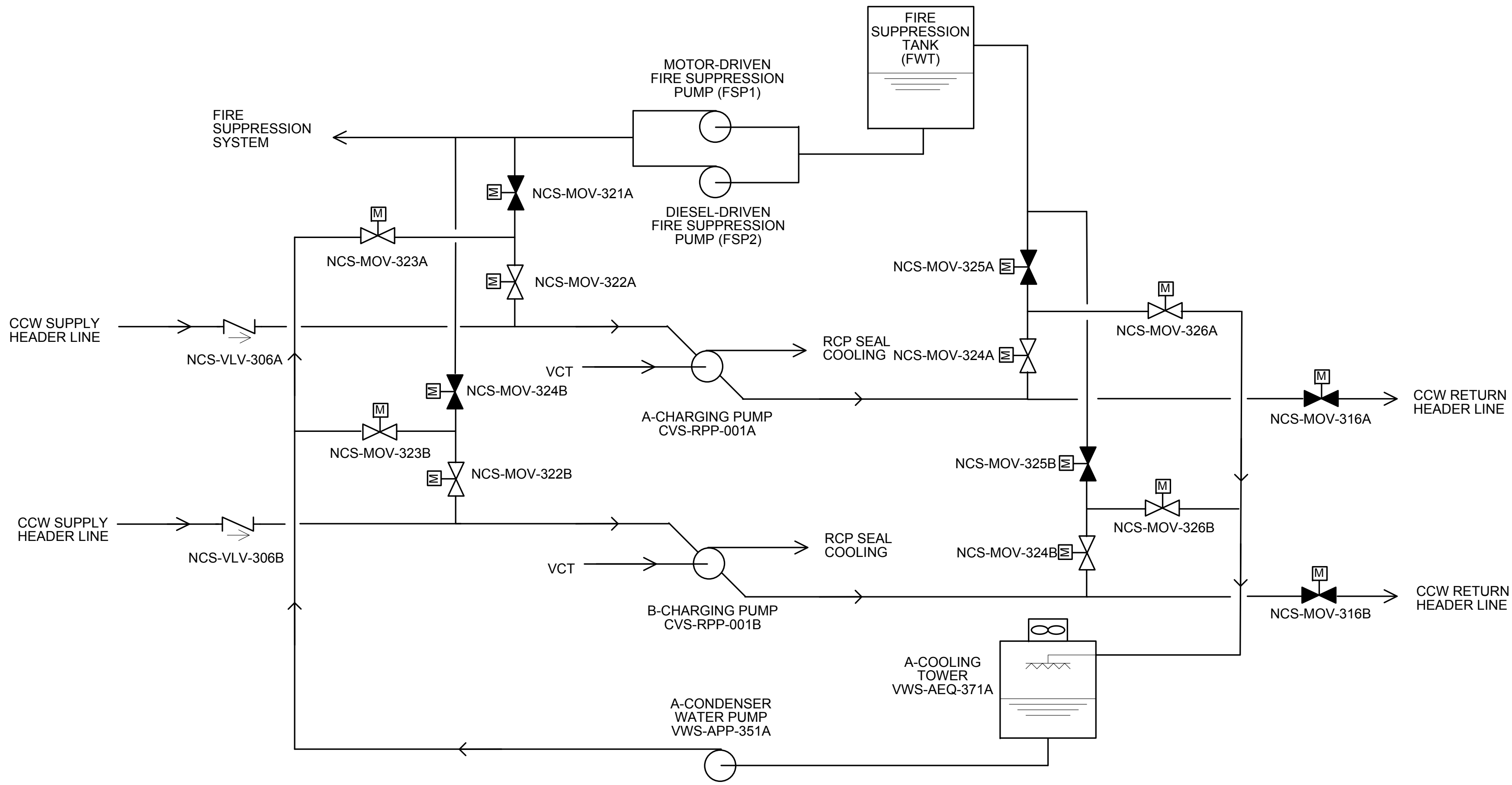


Figure 19.1-2 Simplified System Diagram (Sheet 34 of 42)

(Alternate Component Cooling by Non-essential Chilled Water System)

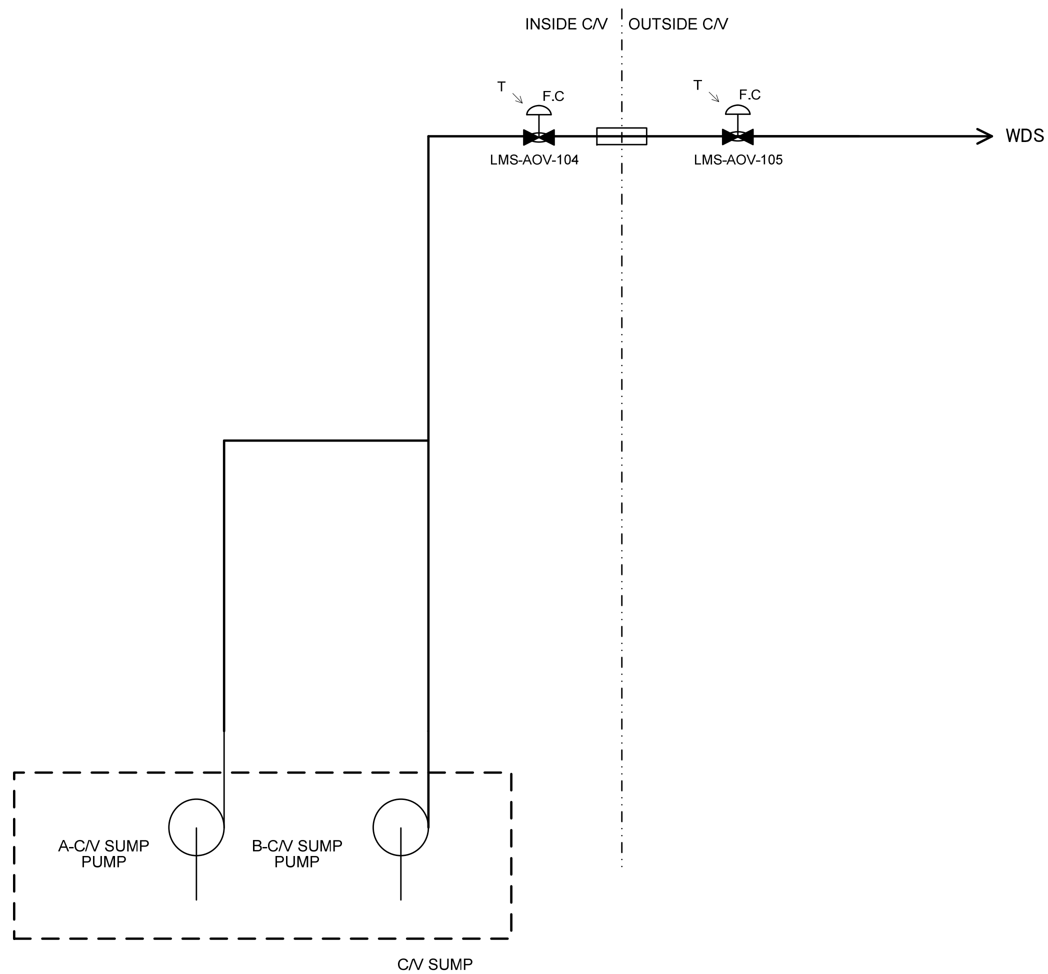


Figure 19.1-2 Simplified System Diagram (Sheet 35 of 42)

(Containment Isolation System - Liquid Waste Management System - C/V Sump Pump Discharge Line)

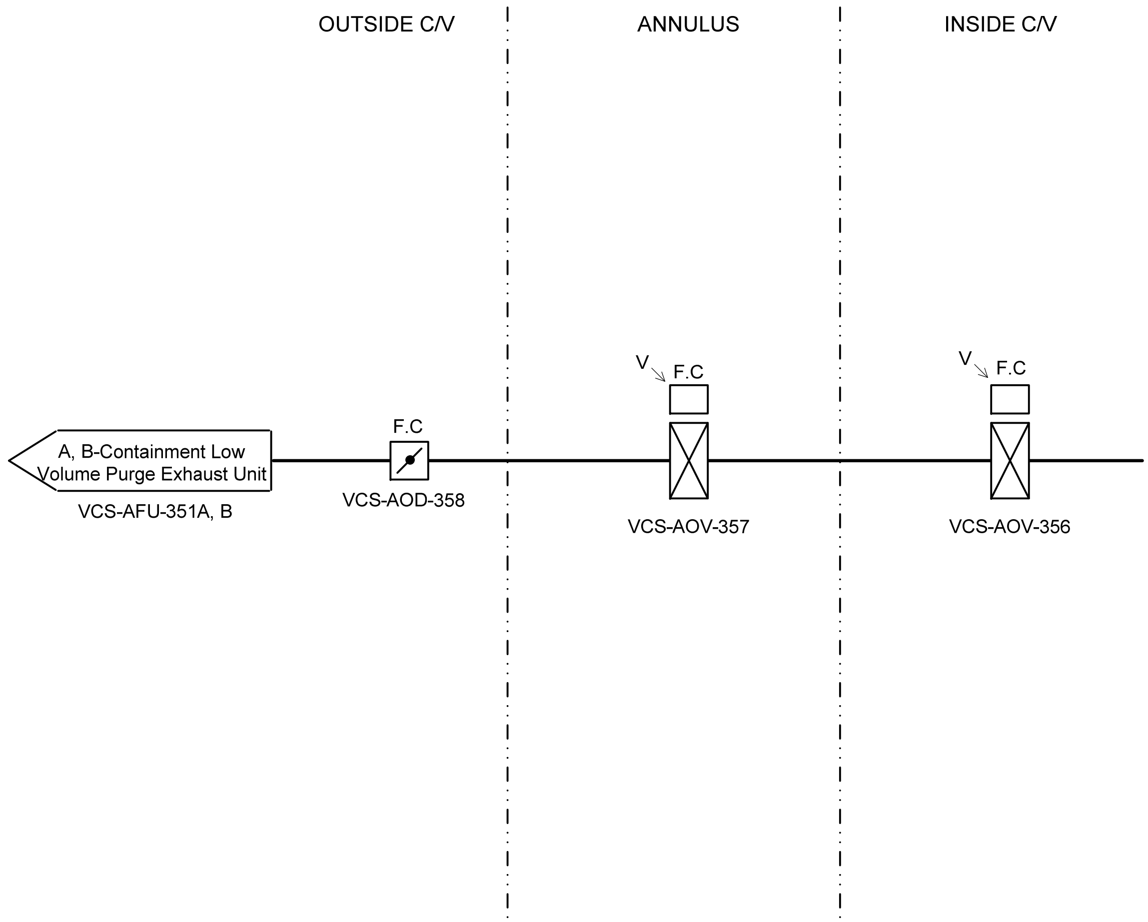


Figure 19.1-2 Simplified System Diagram (Sheet 36 of 42)

(Containment Isolation System - Containment Purge System - Containment Low Volume Purge Exhaust Line)

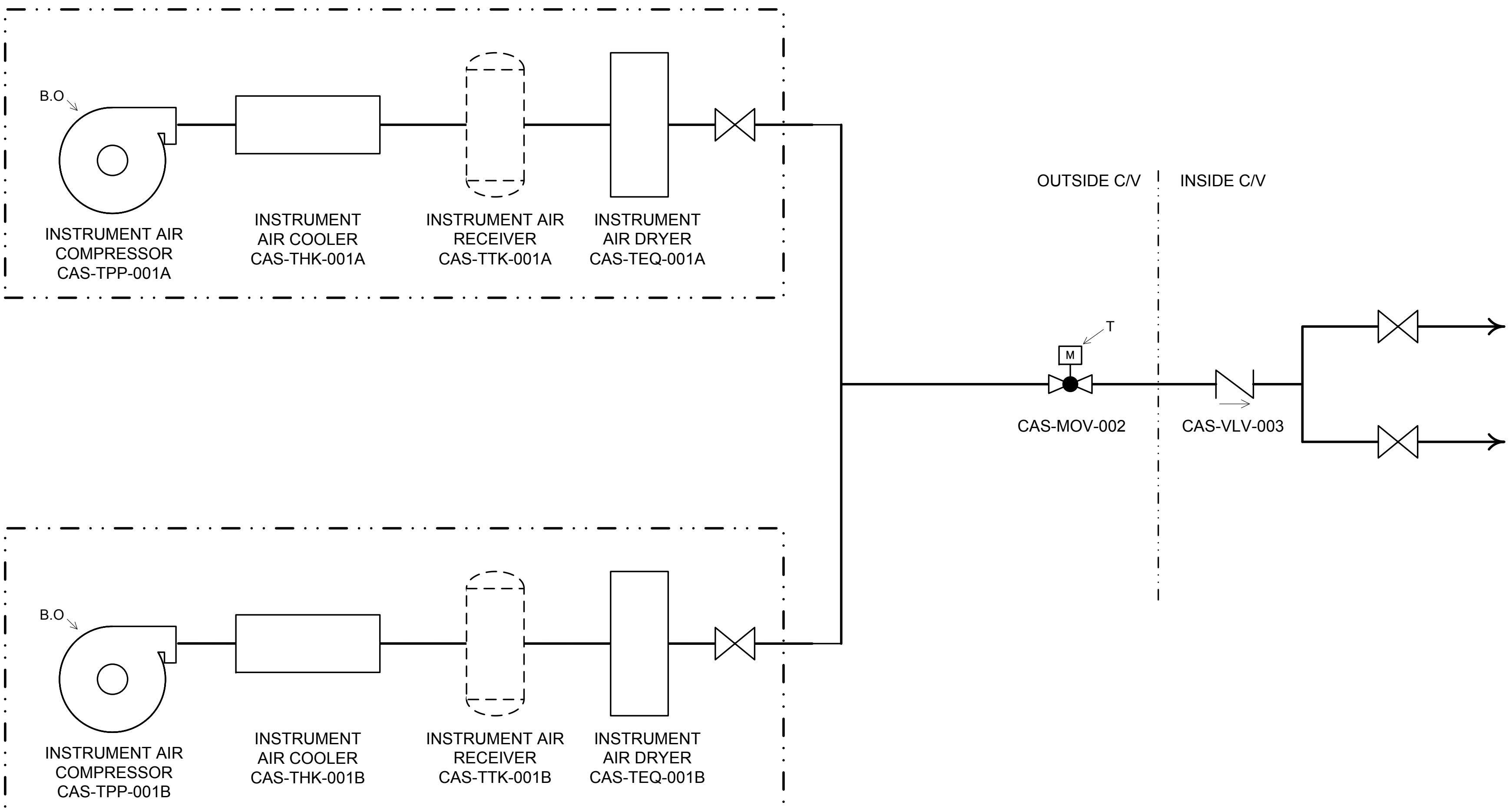


Figure 19.1-2 Simplified System Diagram (Sheet 37 of 42)
(Containment Isolation System - Instrument Air System - Instrument Air Line)

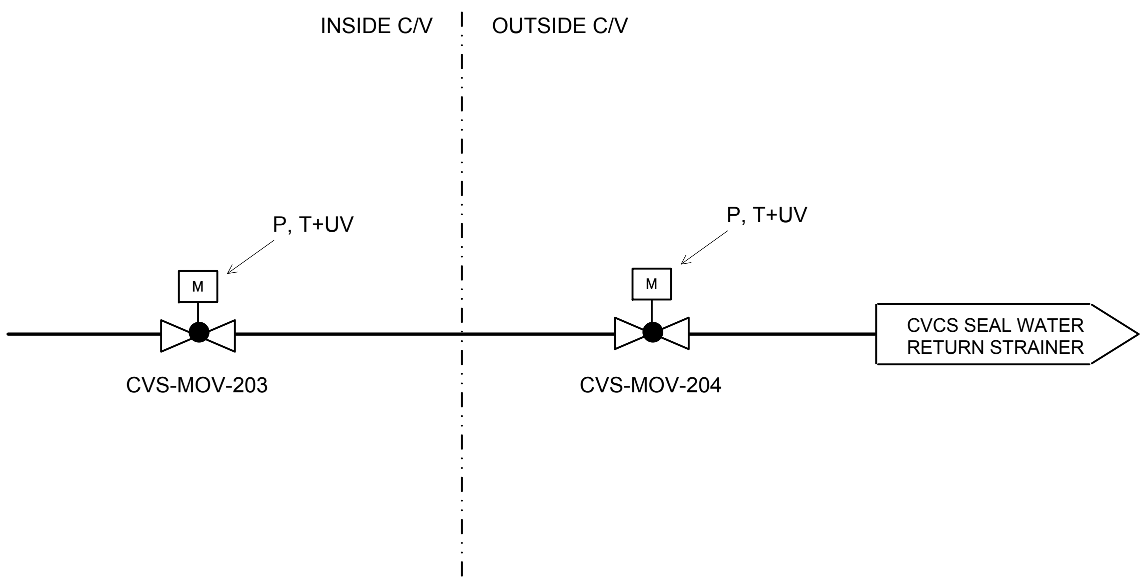


Figure 19.1-2 Simplified System Diagram (Sheet 38 of 42)

(Containment Isolation System - Chemical Volume Control System - Seal Water Return Line)

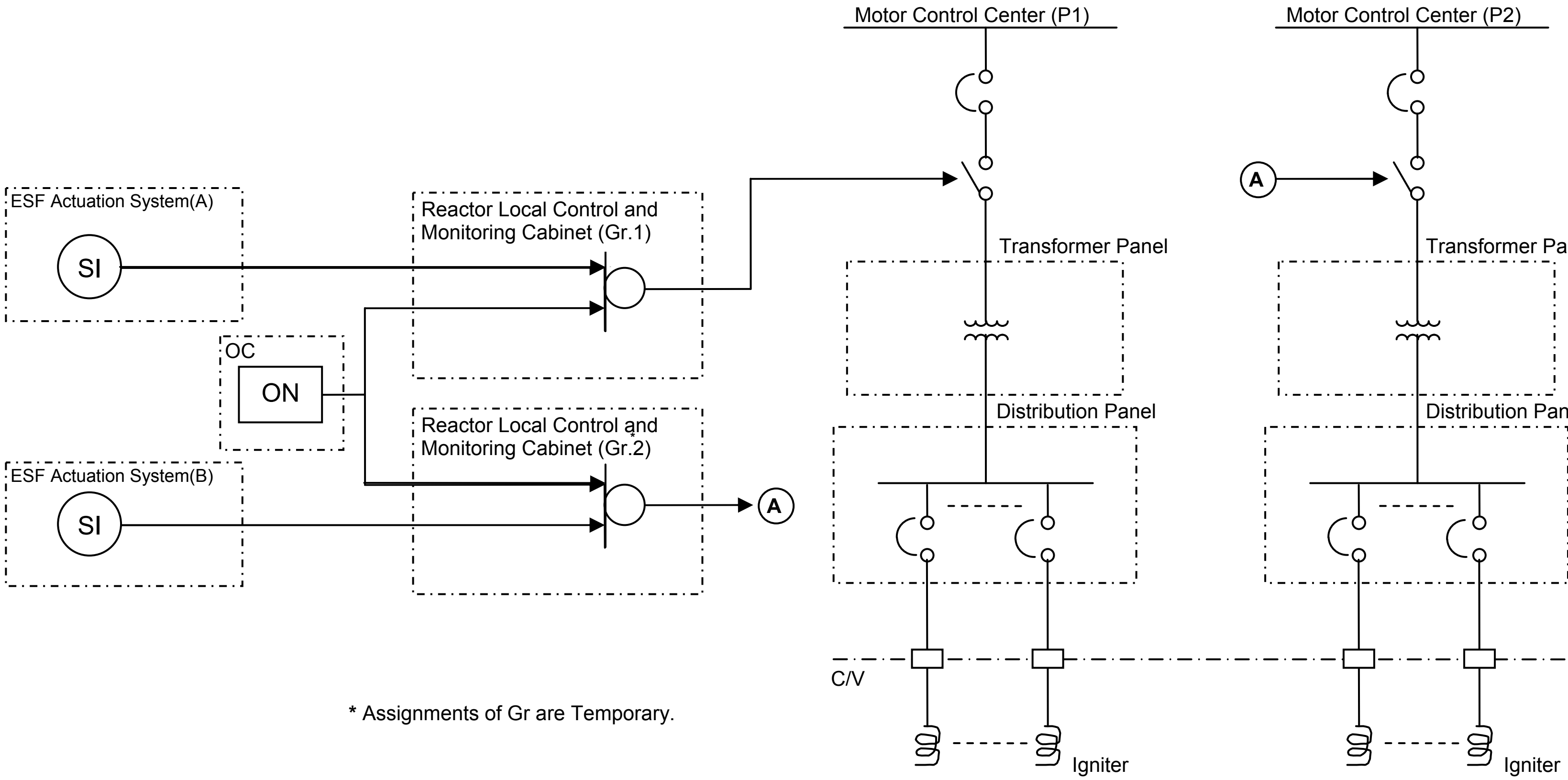


Figure 19.1-2 Simplified System Diagram (Sheet 39 of 42)

(Hydrogen Control System)

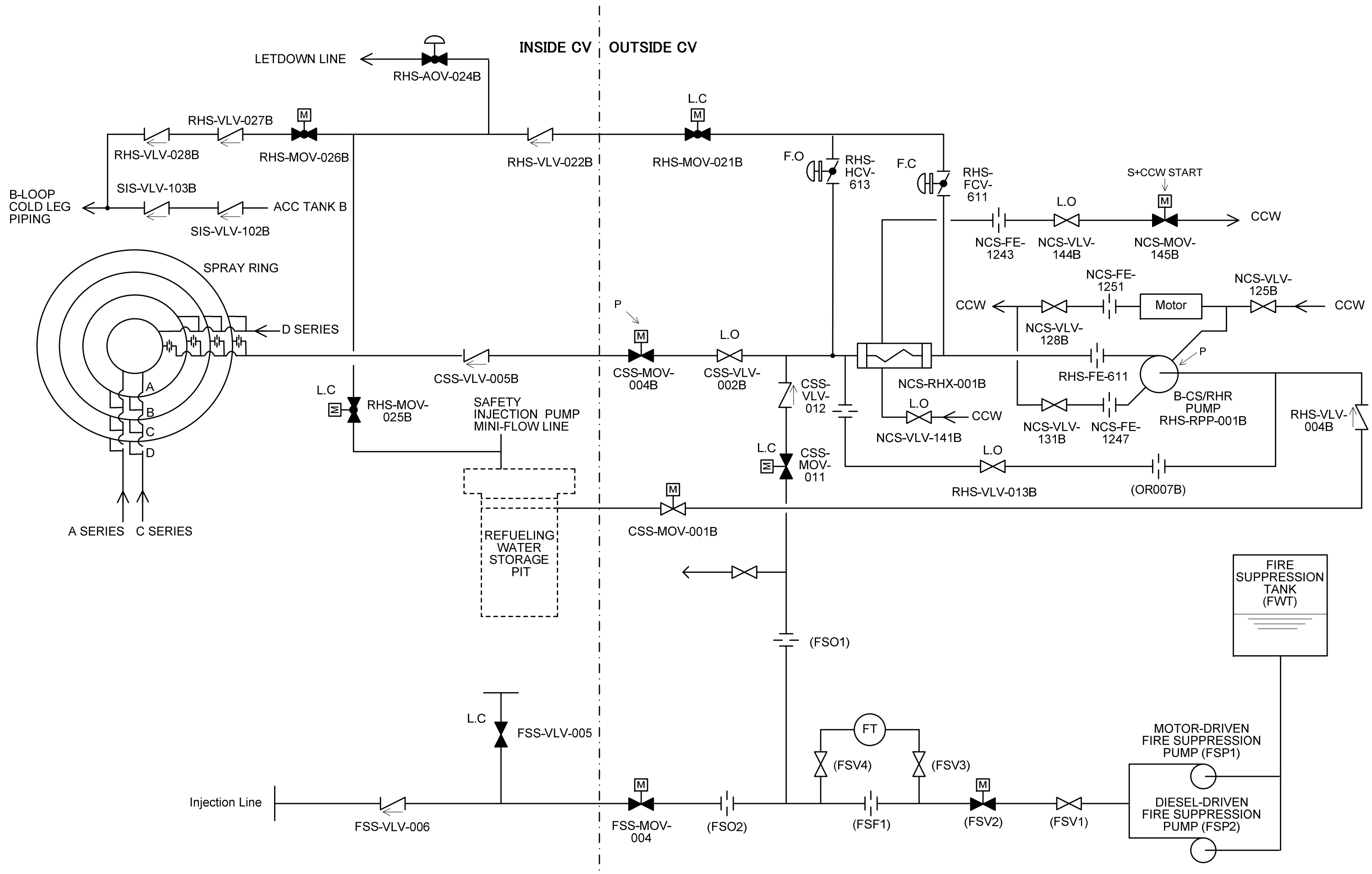


Figure 19.1-2 Simplified System Diagram (Sheet 40 of 42)
(Firewater Injection into the Reactor Cavity and into the Spray Header)

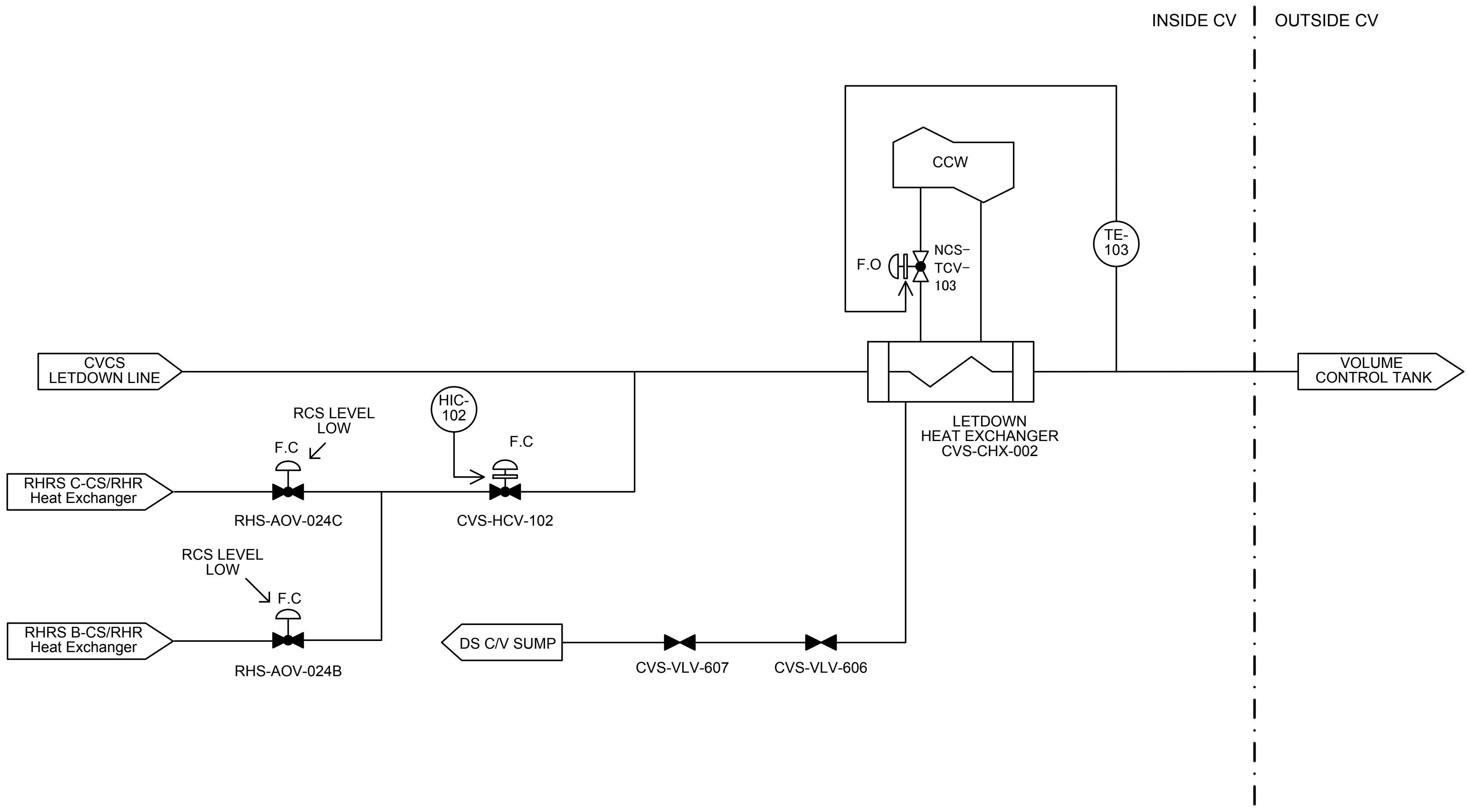


Figure 19.1-2 Simplified System Diagram (Sheet 41 of 42)

(Low-Pressure Letdown Line)

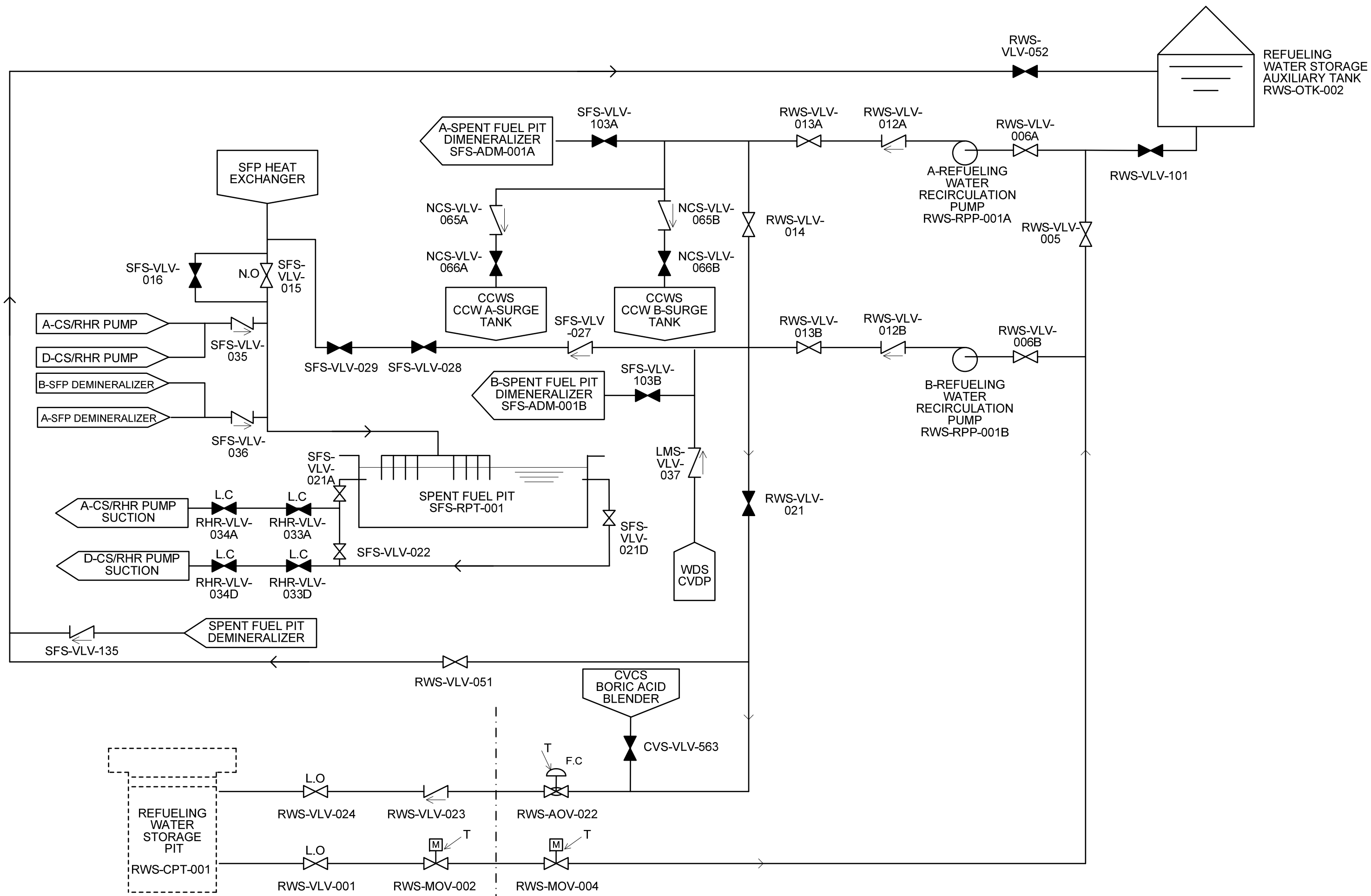
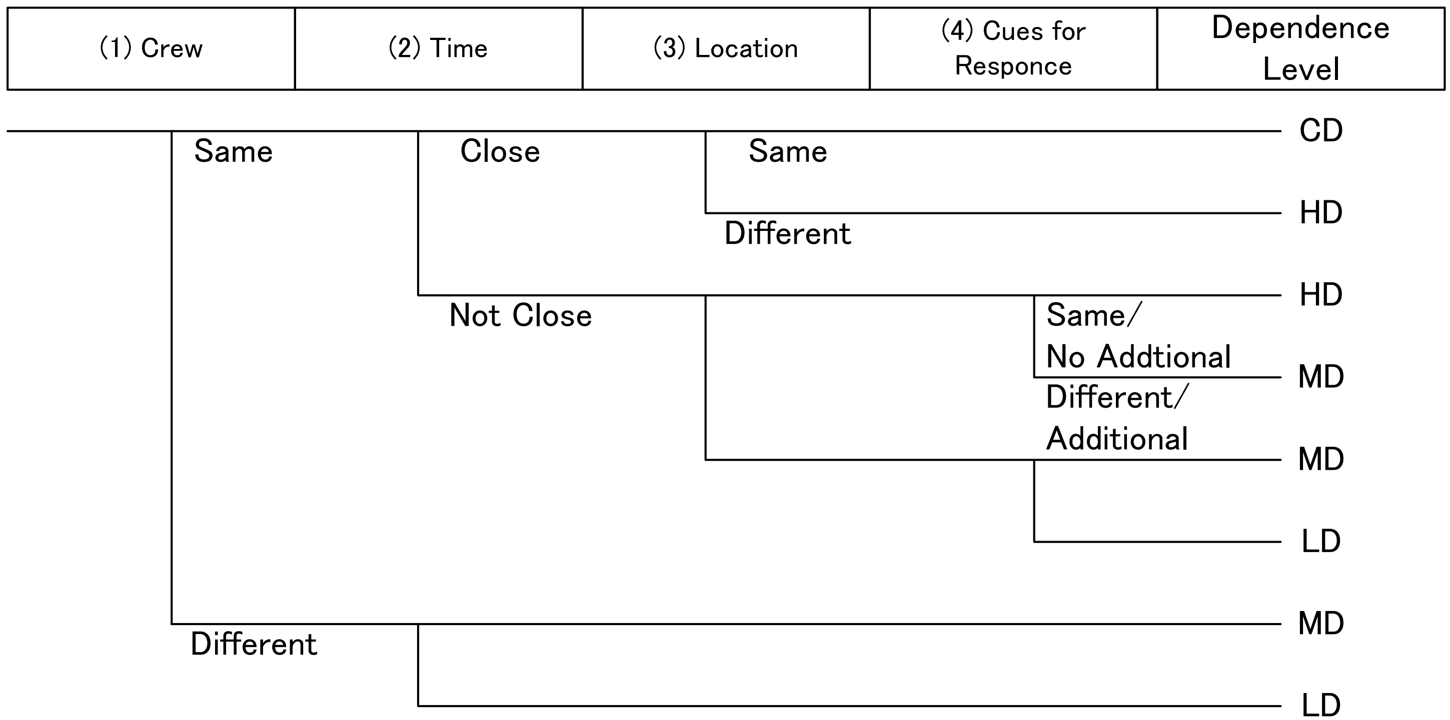


Figure 19.1-2 Simplified System Diagram (Sheet 42 of 42)
(Gravitational Injection)



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

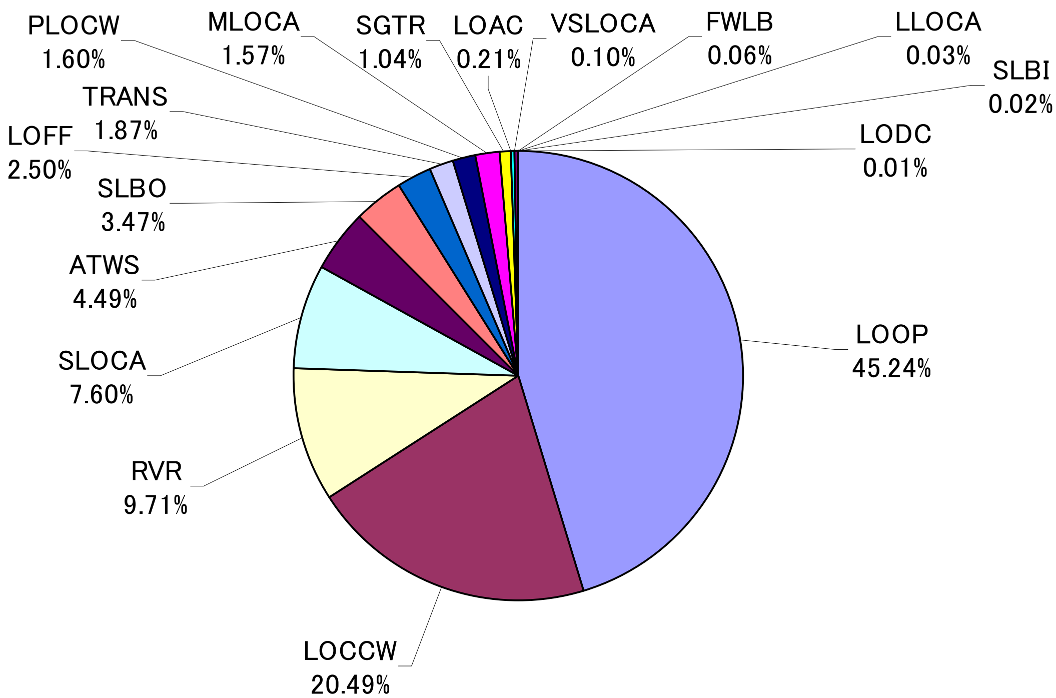


Figure 19.1-4 Internal Events Core Damage Frequency Contribution

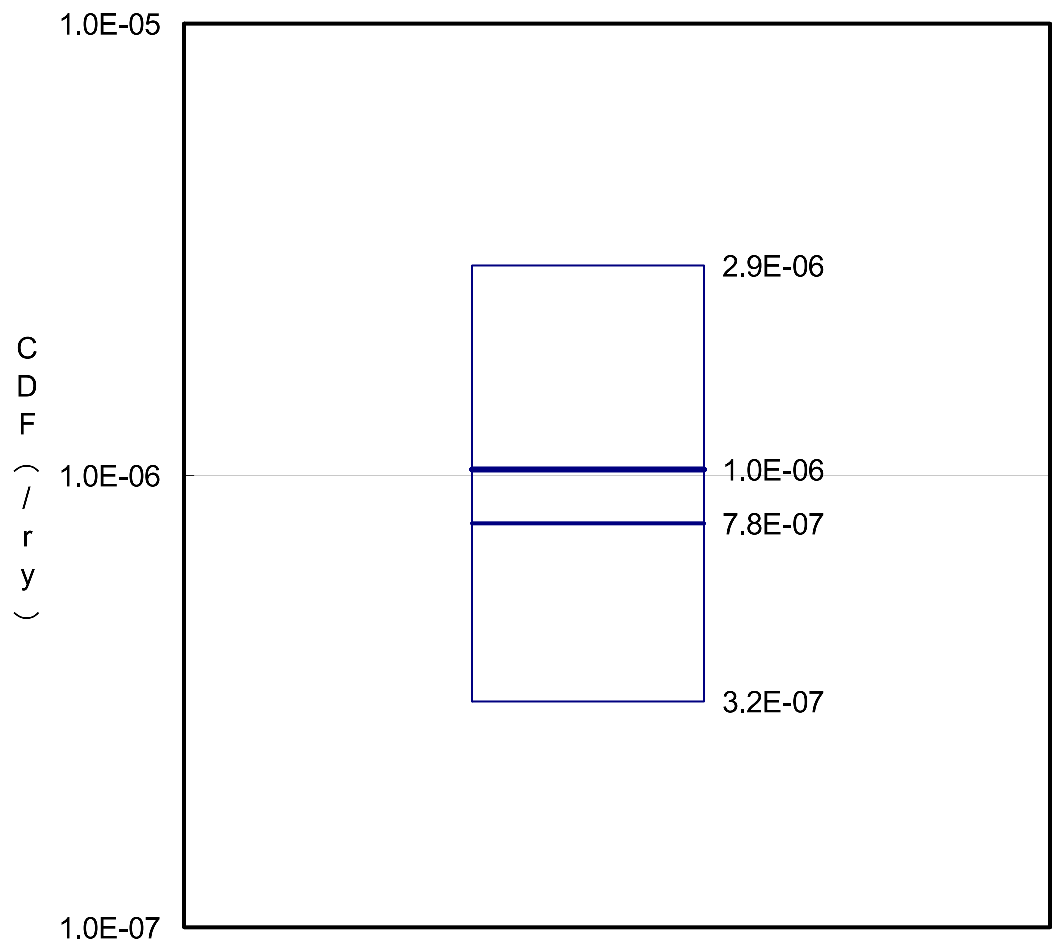


Figure 19.1-5 Result of Uncertainty Quantification for Internal Events at Power

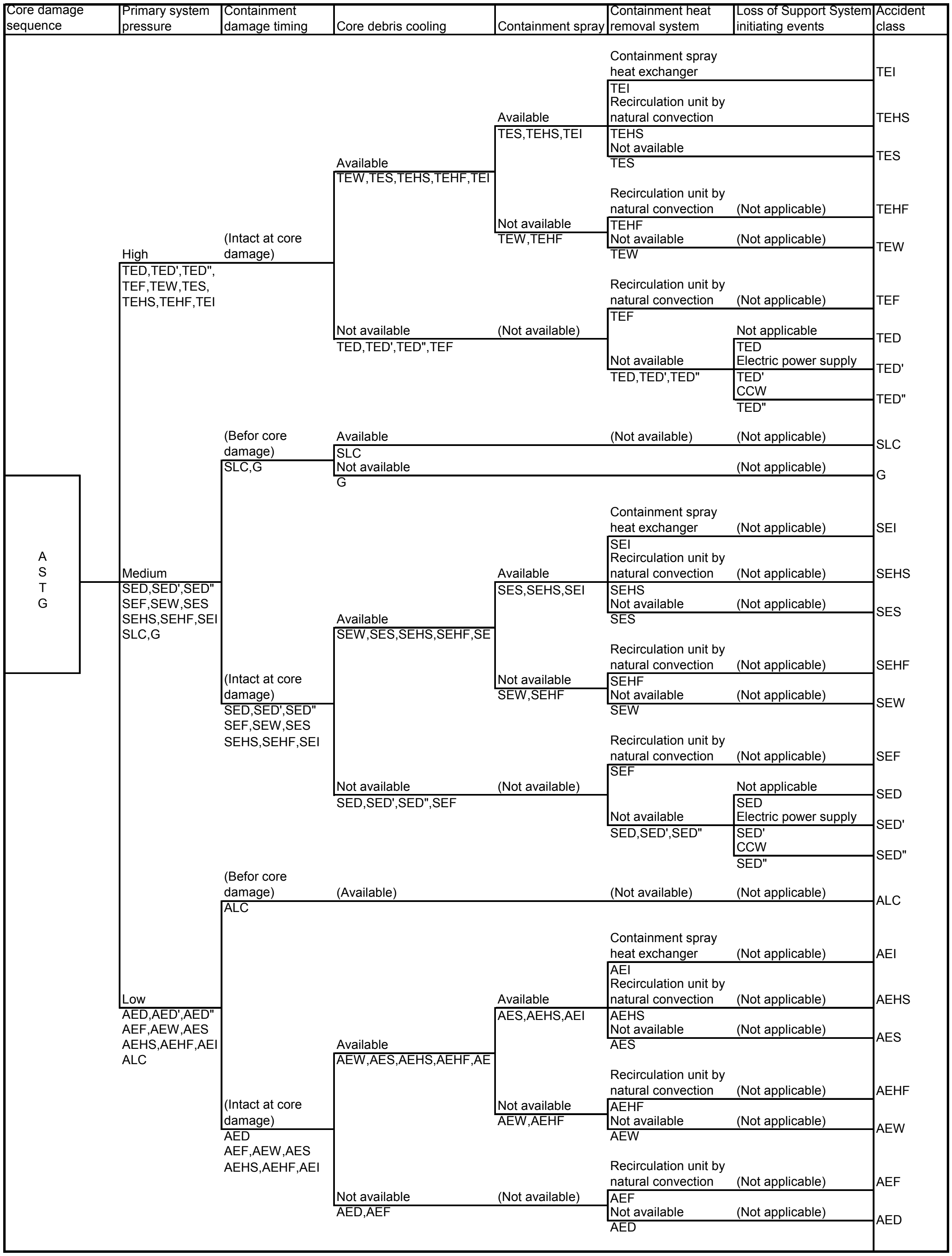


Figure 19.1- 6 Logic Tree for ACL Classification

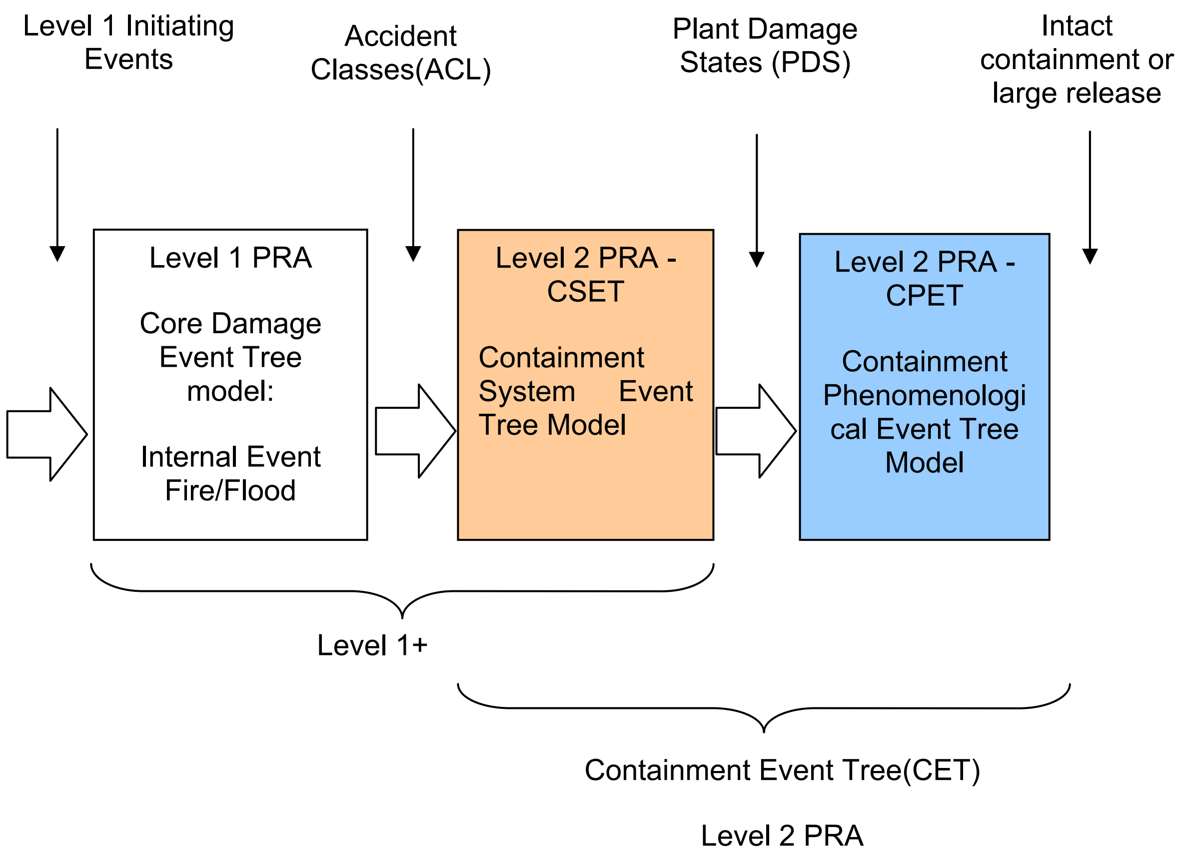


Figure 19.1- 7 CET Development Methodology

CSET	CSET	CSET	CSET	CSET		
Containment isolation	RCS depressurization	Igniters	Cavity flooding	Recovery of CSS&HX(SBO)	No.	PDS
CI	FD	IG	CF	RS		

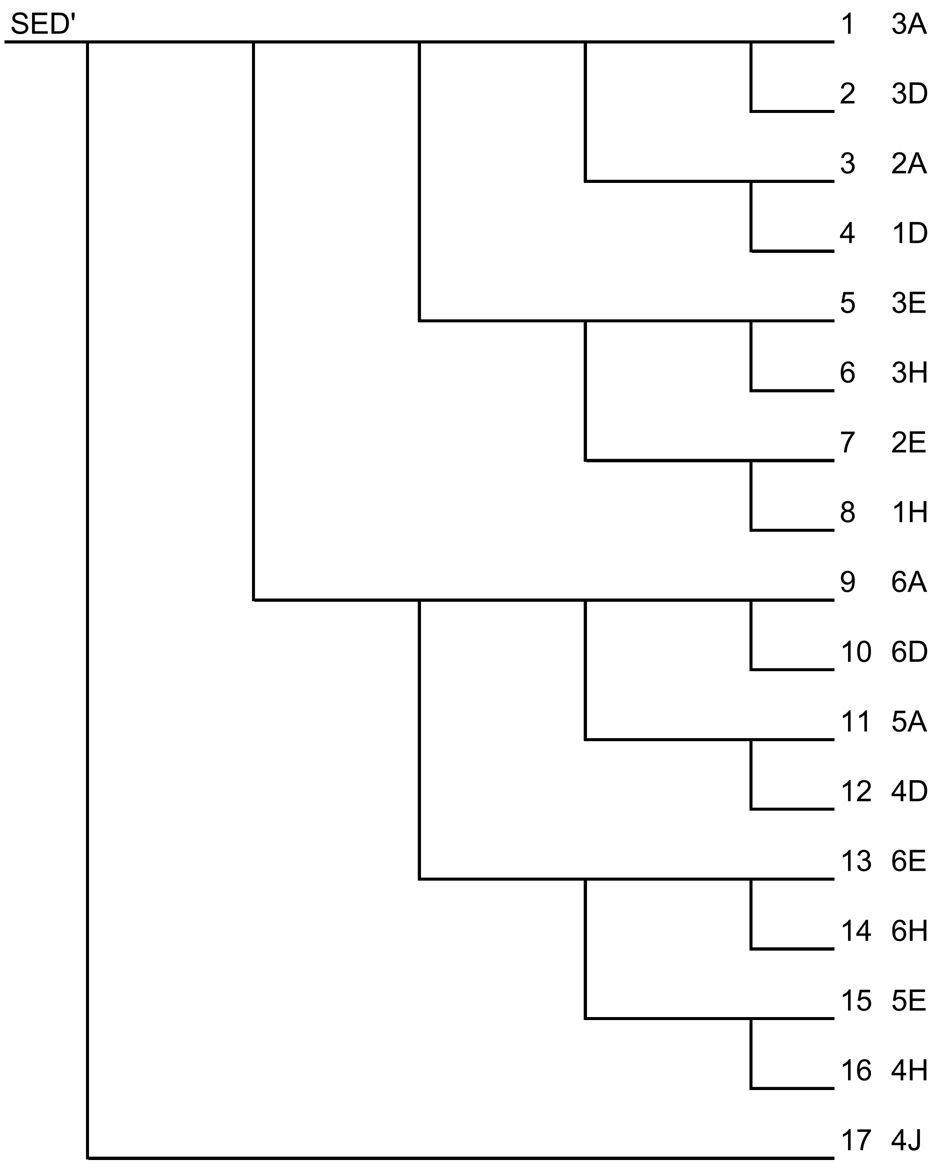
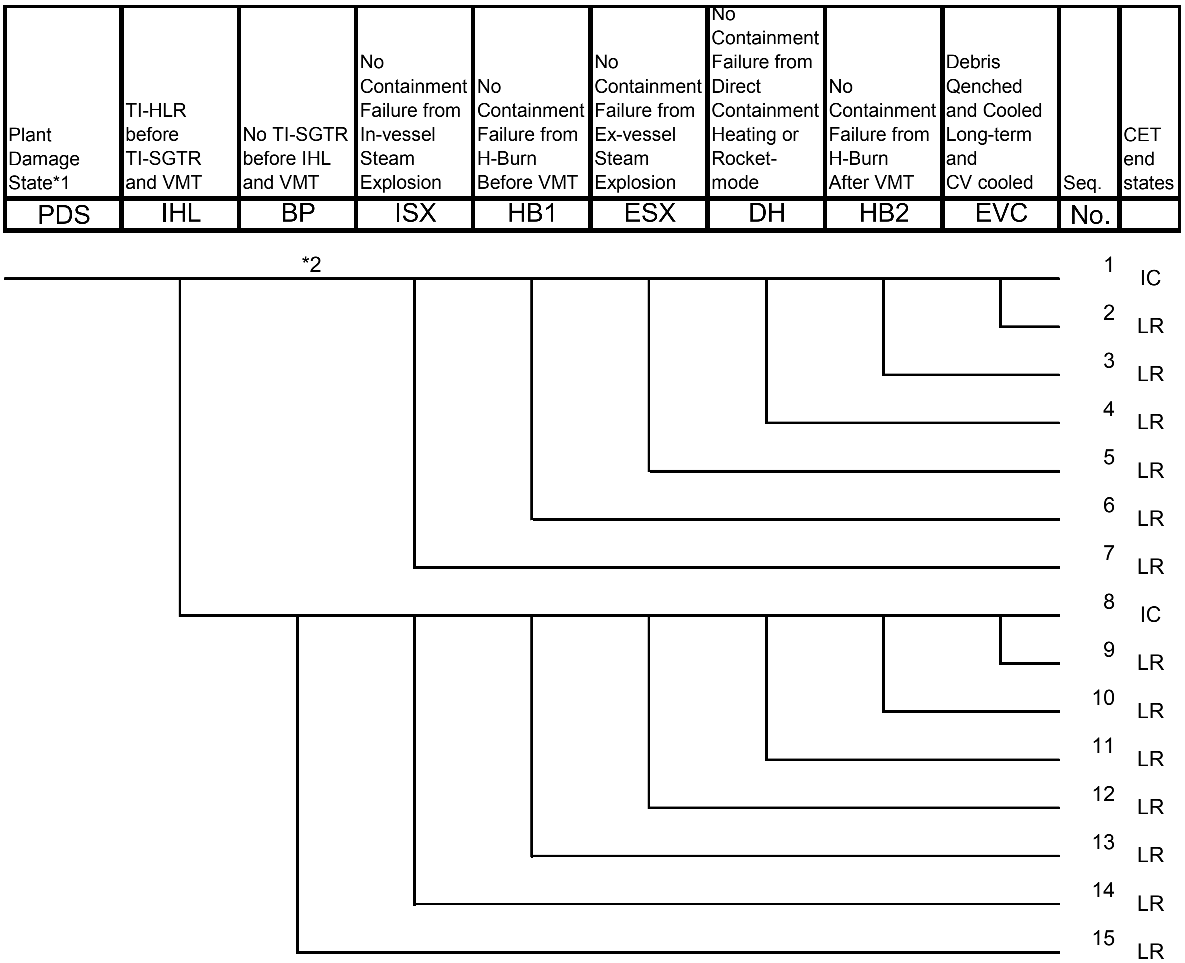


Figure 19.1- 8 Containment System Event Tree (Example)



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

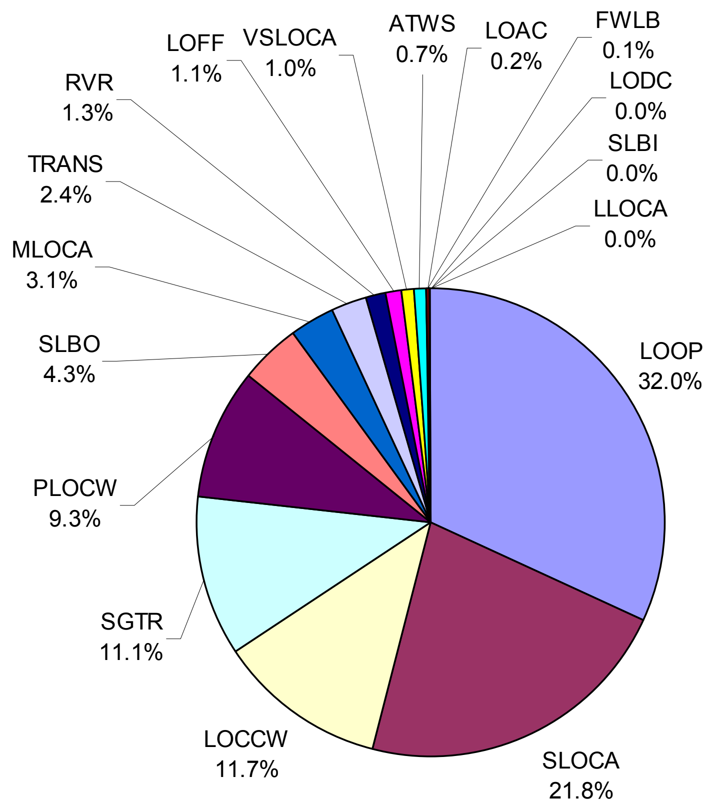


Figure 19.1-10 Contribution of Initiating Events to LRF

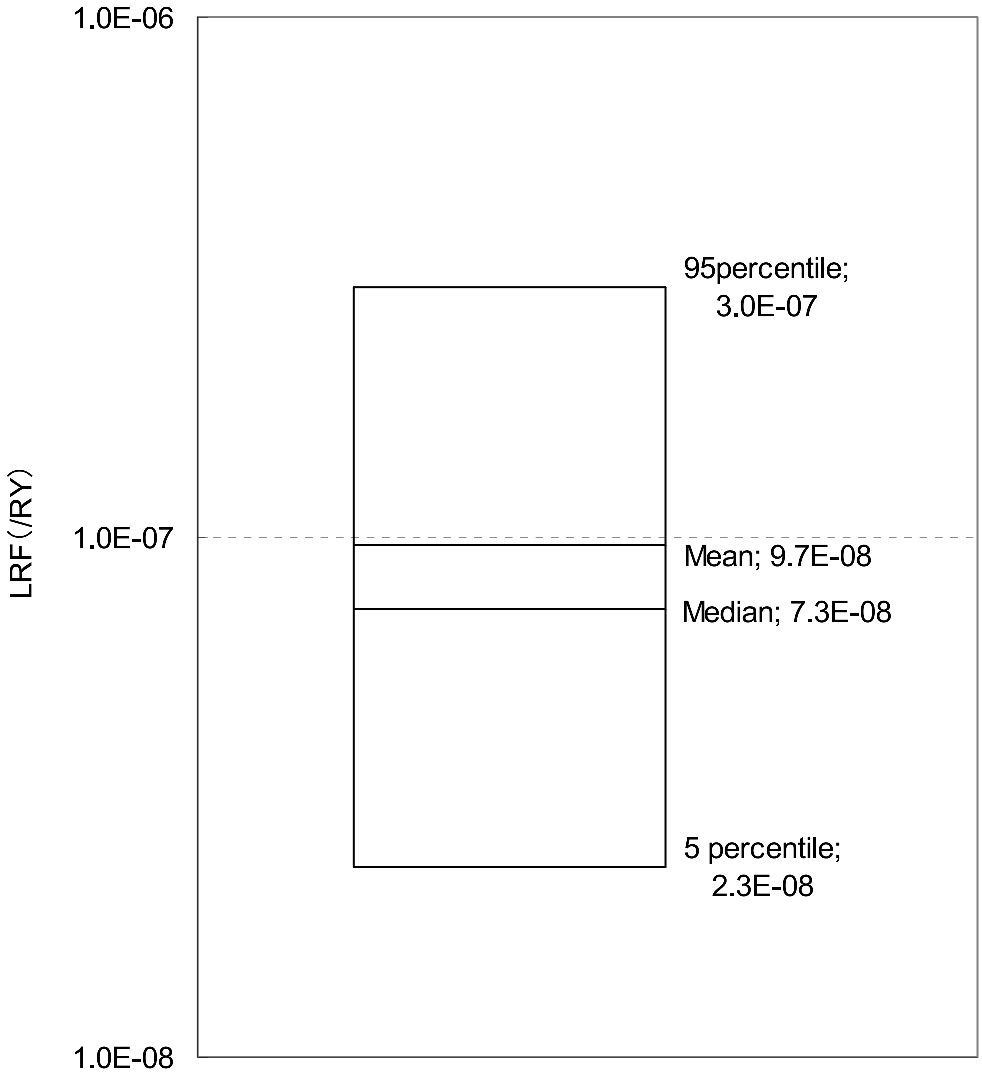


Figure 19.1- 11 Result of Parametric Uncertainty for LRF

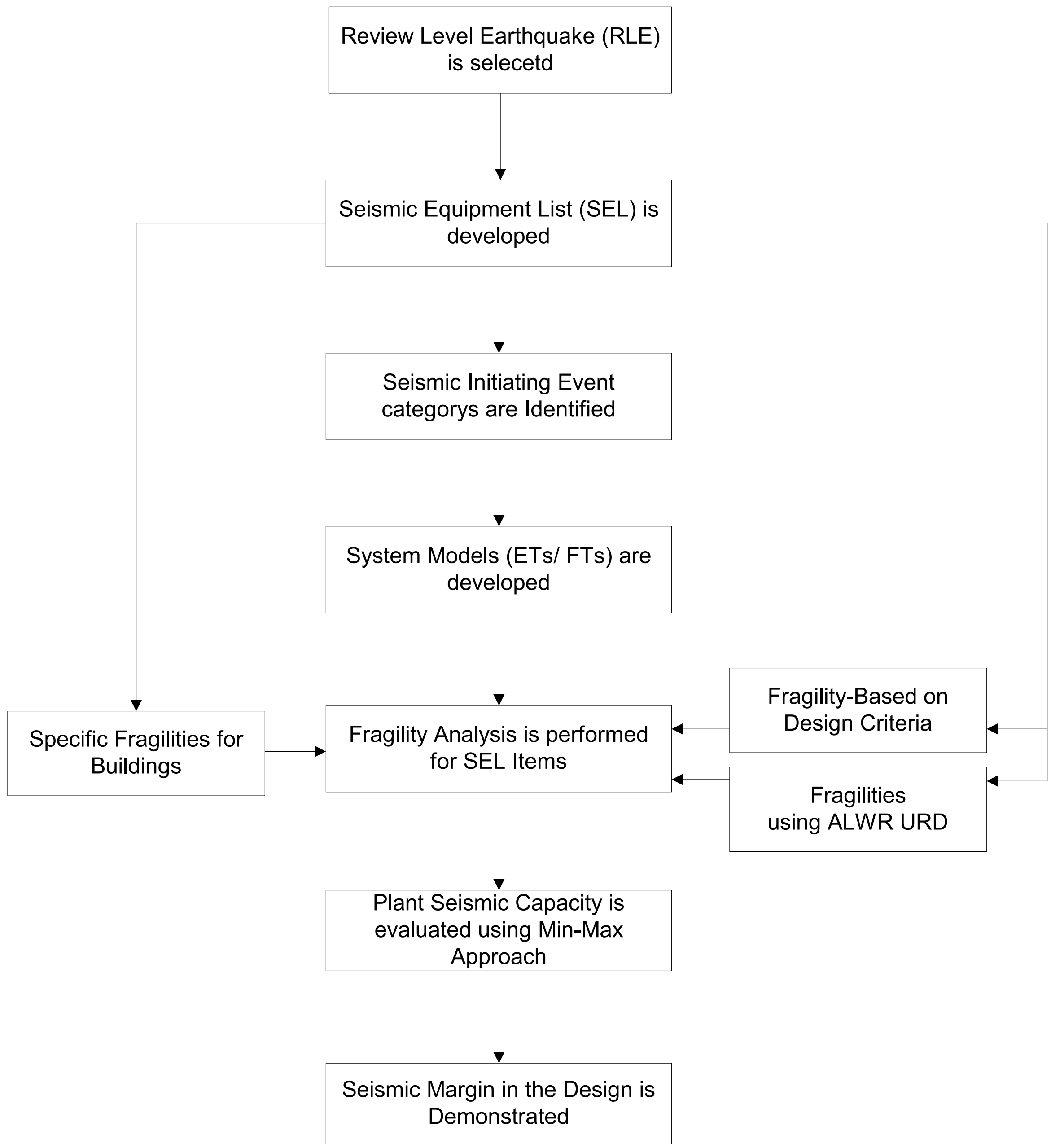


Figure 19.1-12 Outline for the PRA Based Seismic Margin Analysis

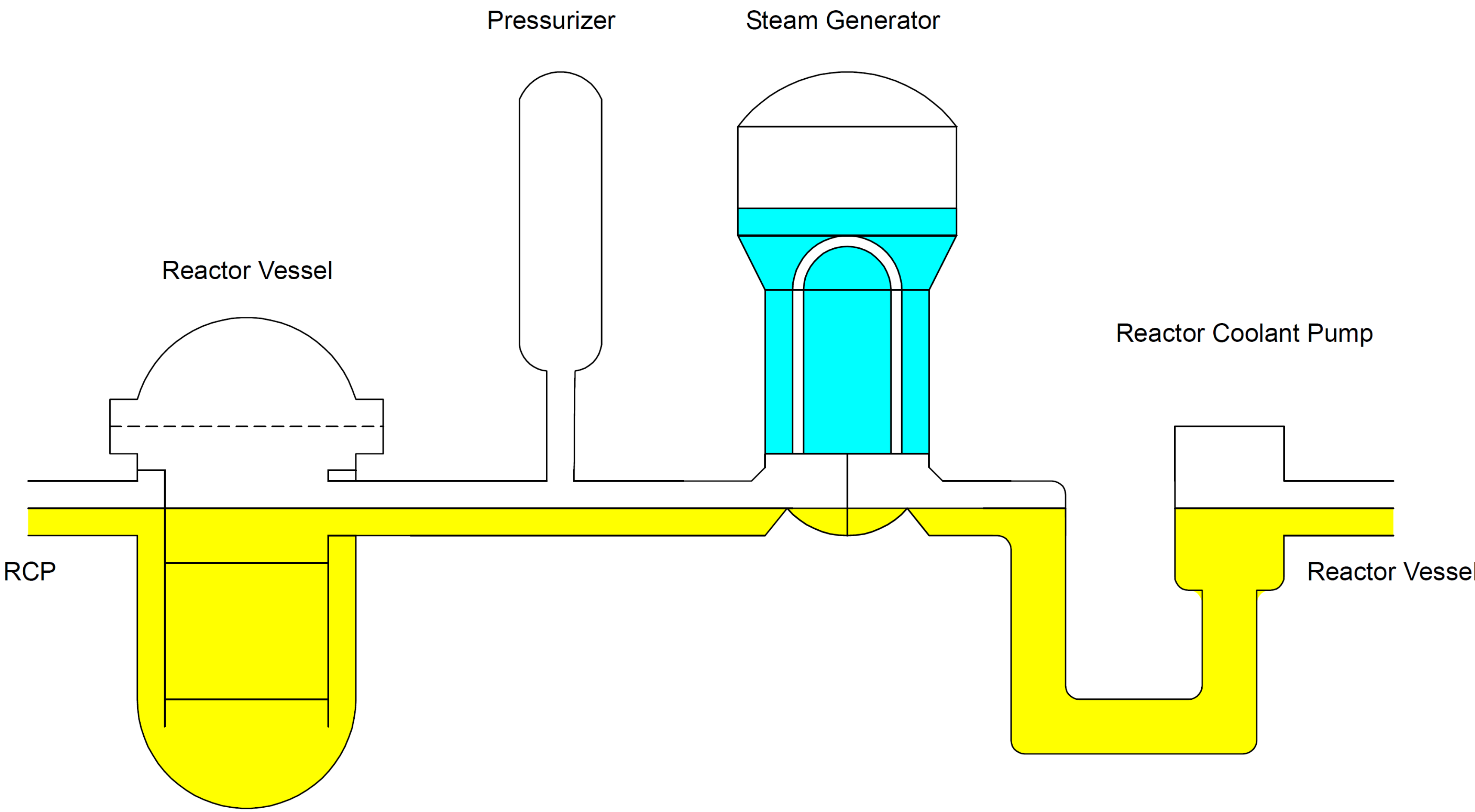


Figure 19.1-13 Feature of RCS Condition (POS 4-1 and POS 8-3)

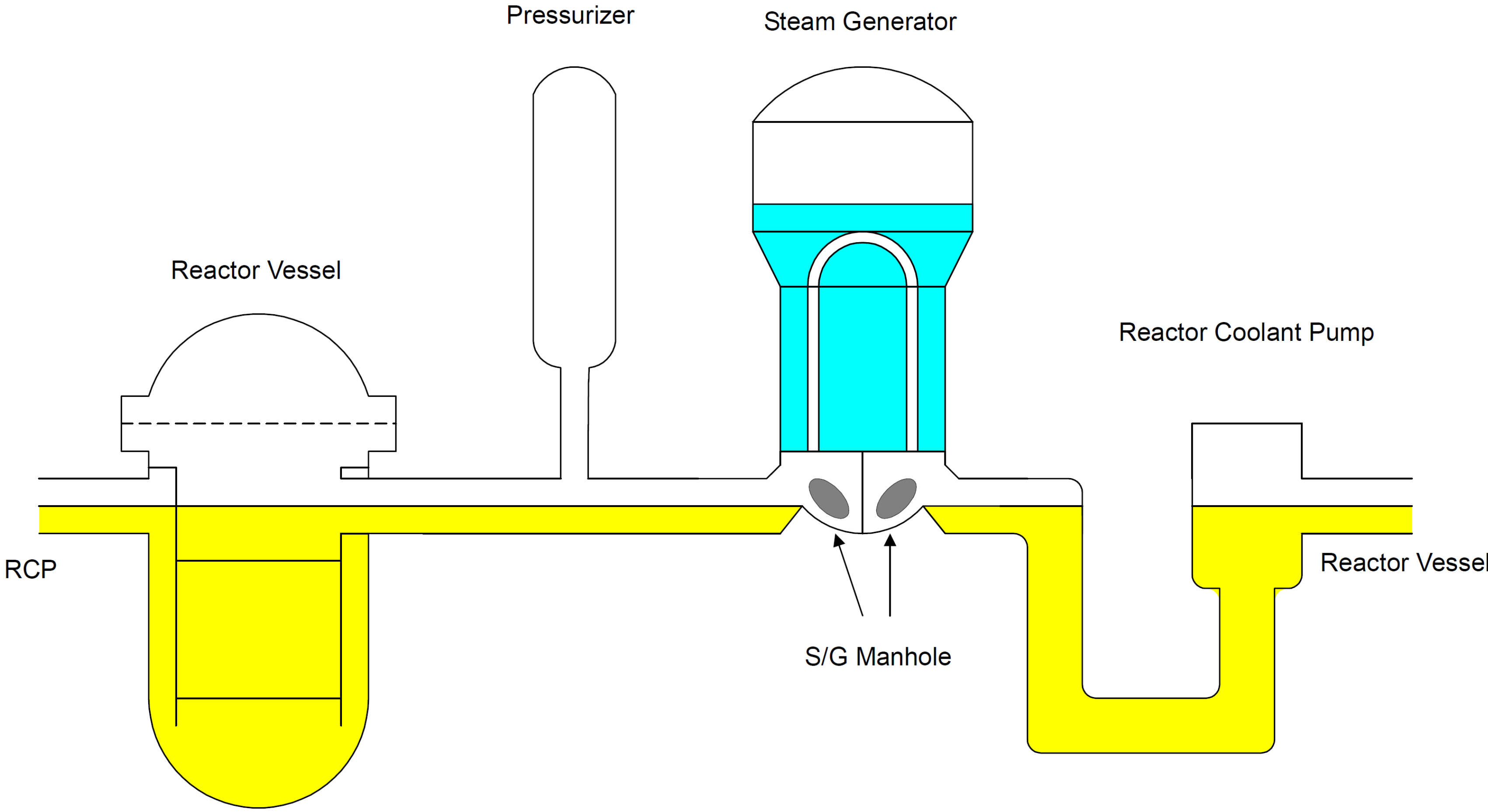


Figure 19.1-14 Feature of RCS Condition (POS 4-2 and POS 8-2)

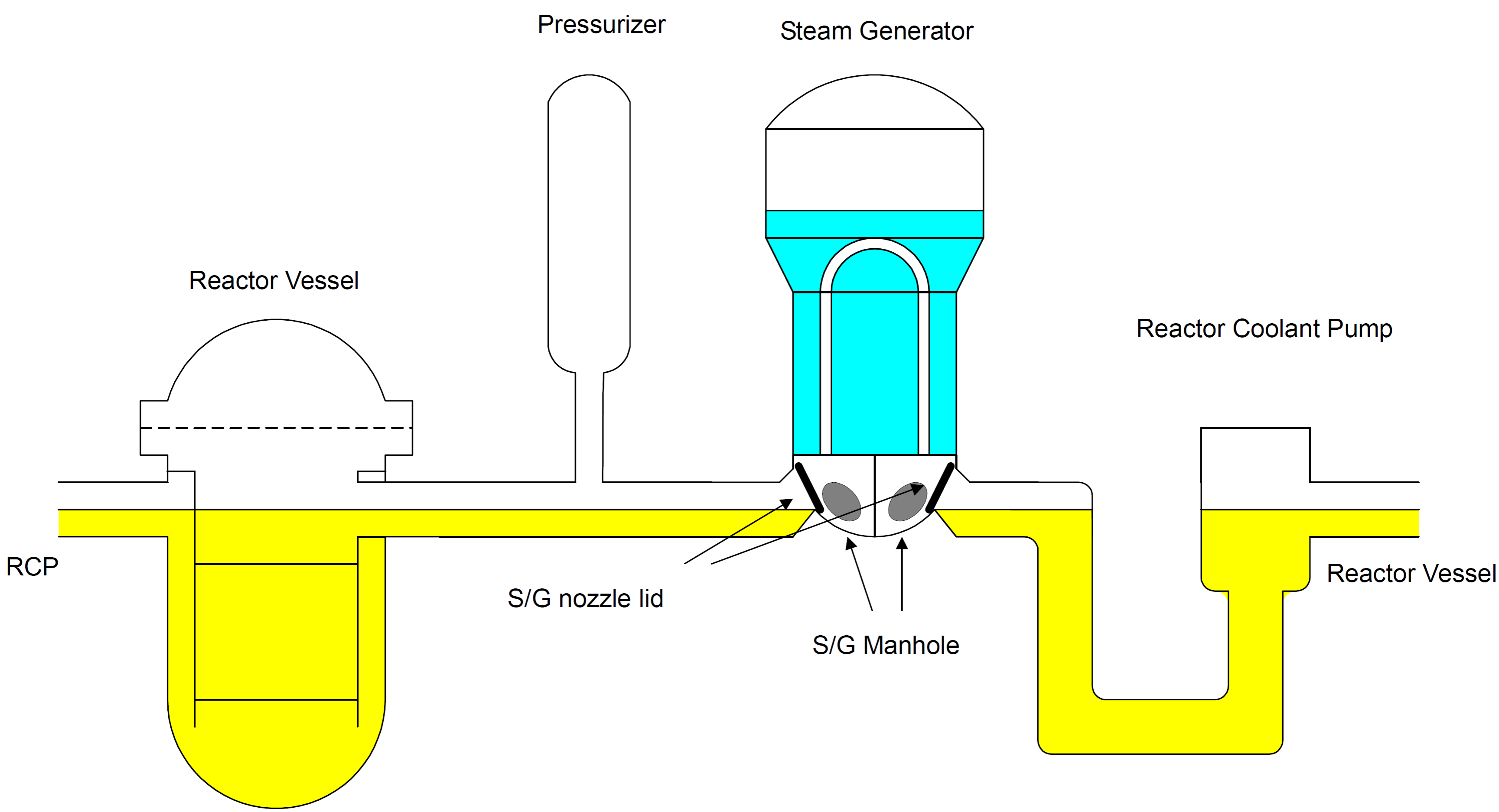
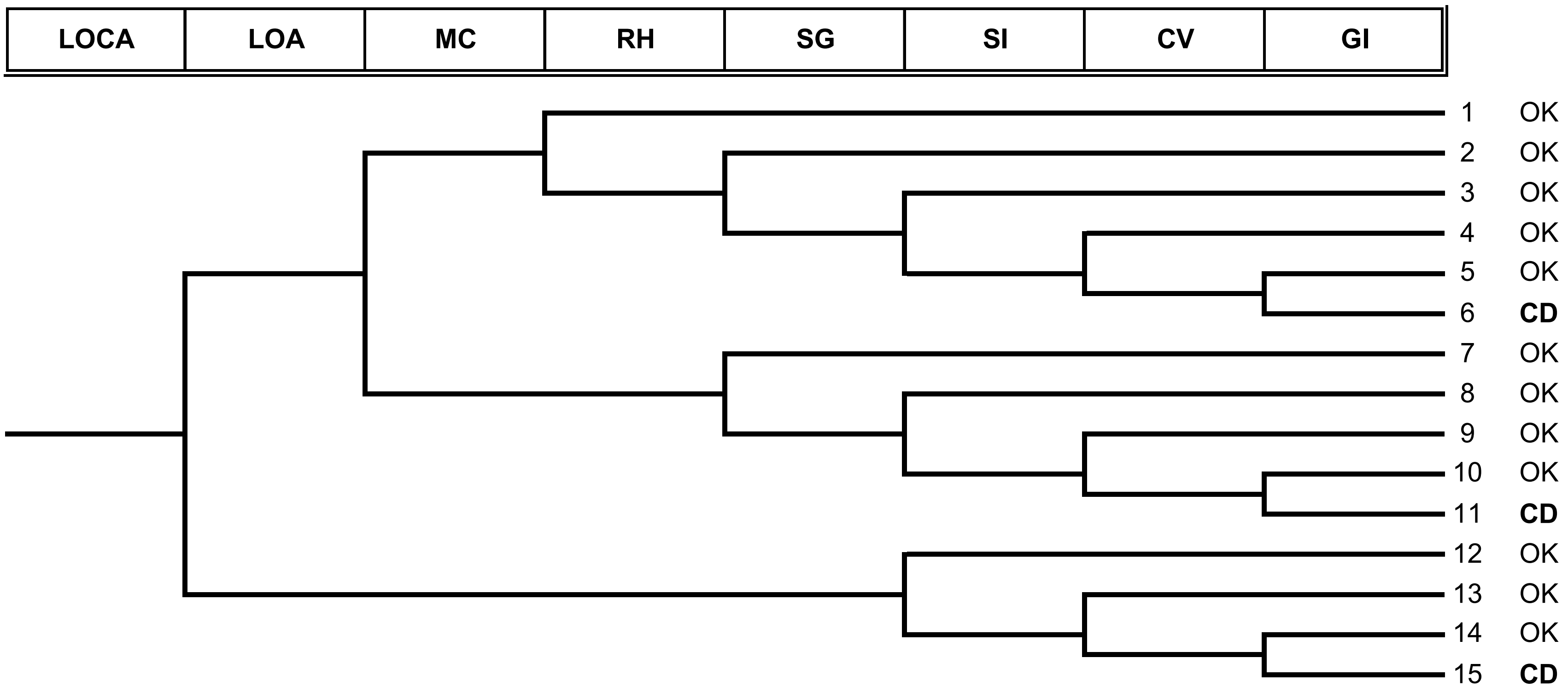
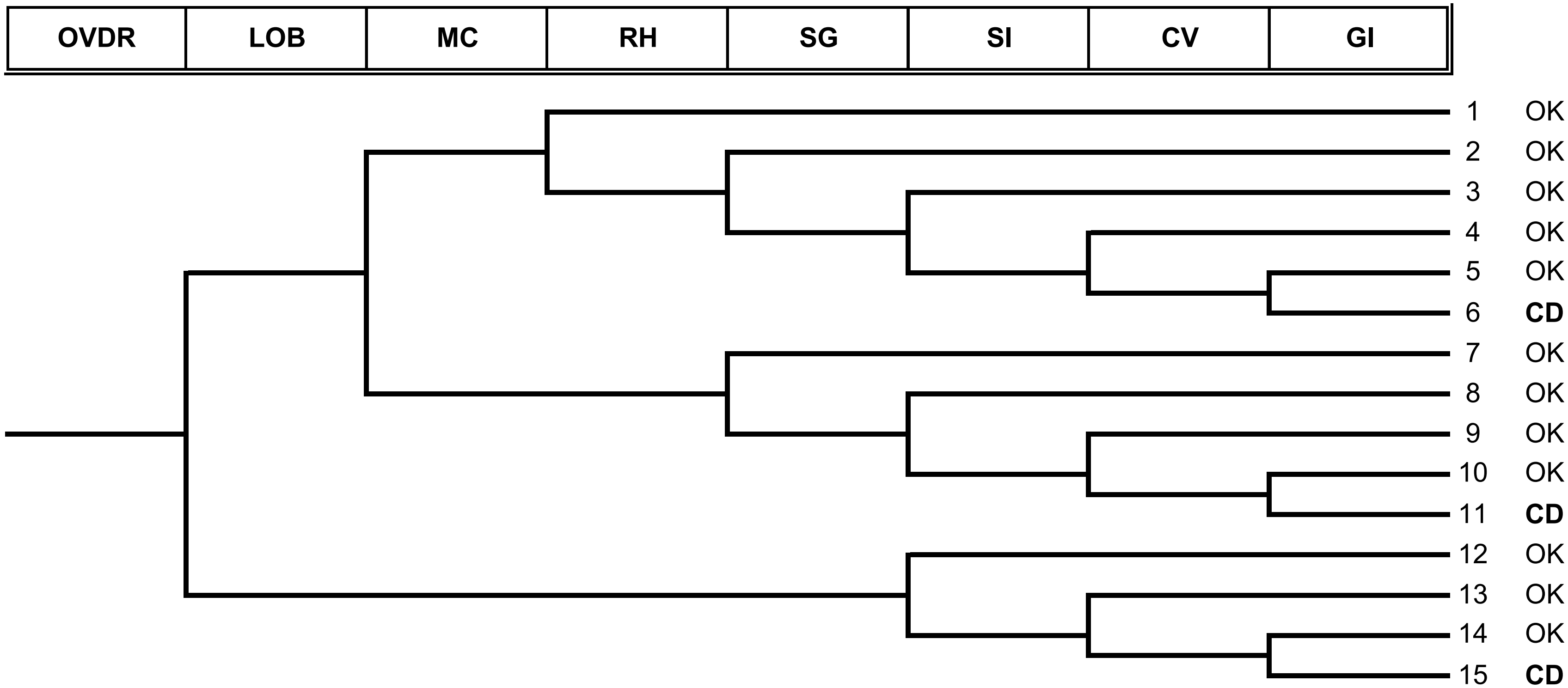


Figure 19.1-15 Feature of RCS Condition (POS 4-3 and POS 8-1)



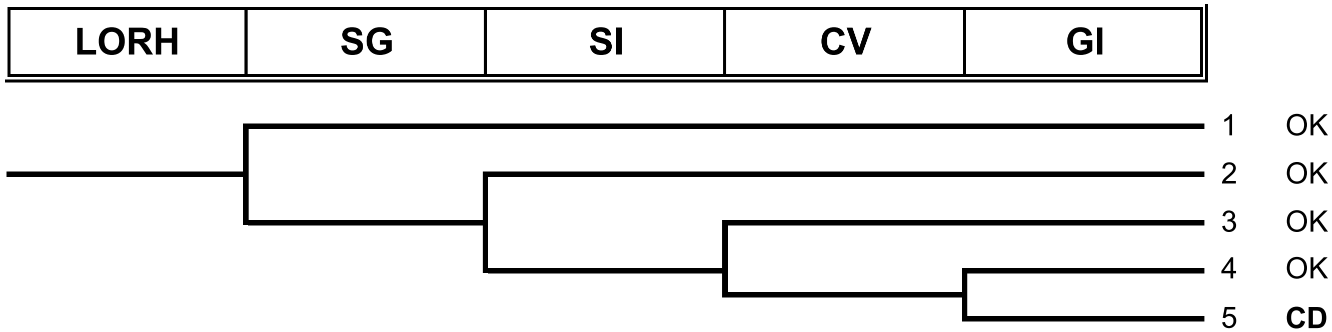
Event	Description
LOCA	: Loss of coolant accident
LOA	: Isolation of CS/RHR hot leg suction valves
MC	: RCS Makeup by charging pump
RH	: Decay heat removed from the RCS by the RHRS on standby
SG	: Decay heat removed from the RCS via SGs
SI	: High head injection
CV	: Injection by the CVCS
GI	: Gravitational injection

Figure 19.1- 16 Loss of Coolant Accident Event Tree



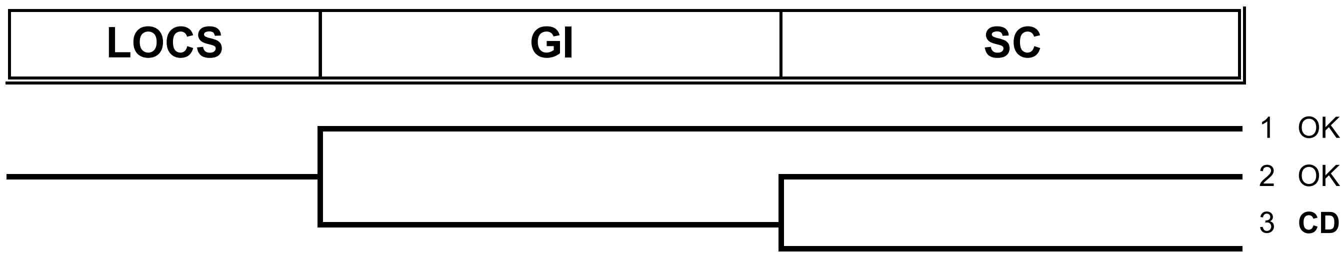
Event	Description
OVDR	: Loss of RHRS due to over-drain
LOB	: Isolation of low-pressure letdown line
MC	: RCS makeup by charging pump
RH	: Decay heat removed from the RCS by the RHRS on standby
SG	: Decay heat removed from the RCS via SGs
SI	: High head injection
CV	: Injection by the CVCS
GI	: Gravitational injection

Figure 19.1- 17 Loss of RHRS due to Over-drain Event Tree



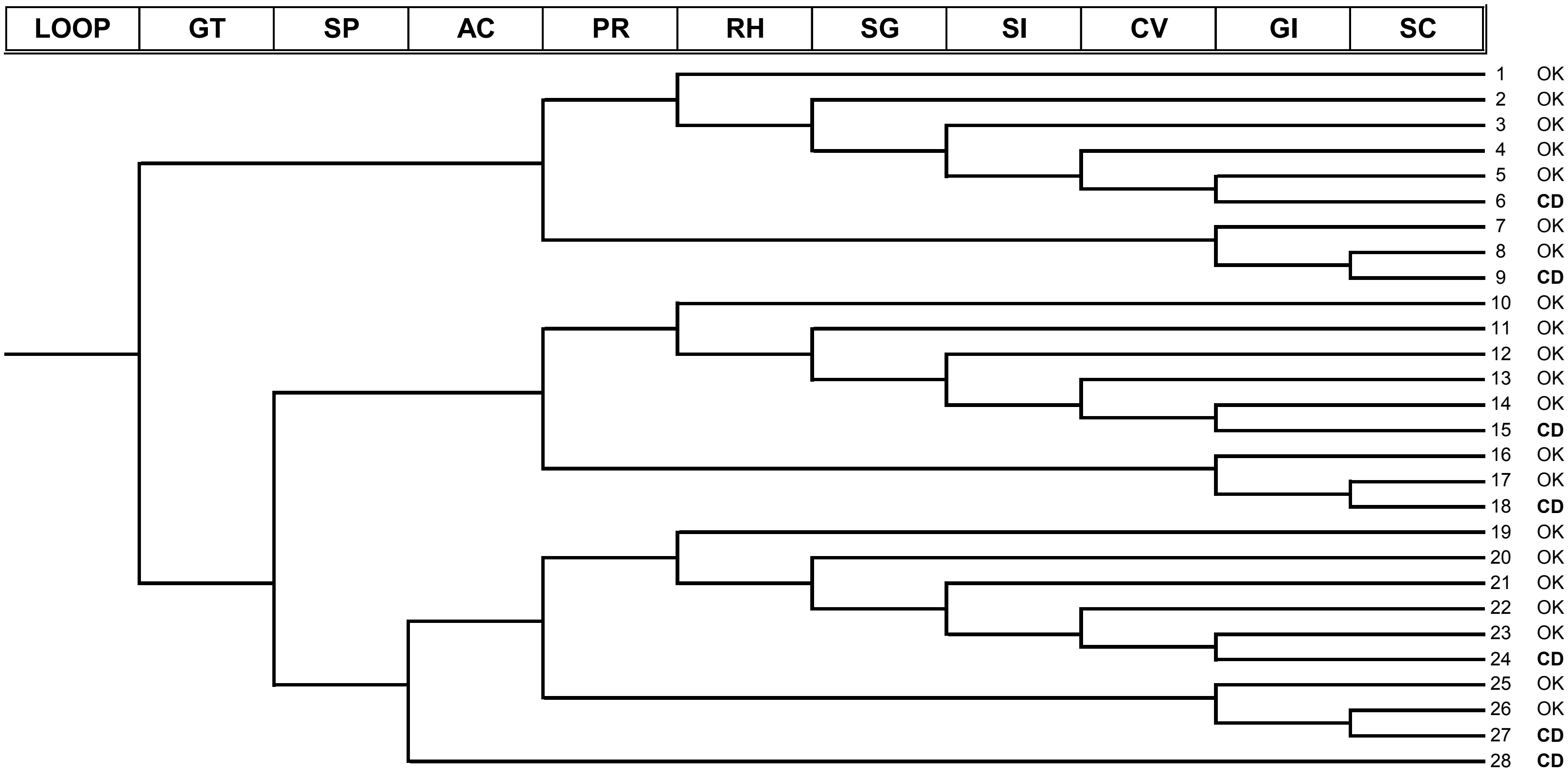
Event	Description
LORH	Loss of RHRS caused by other failures
SG	: Decay heat removed from the RCS via SGs
SI	: High head injection
CV	: Injection by the CVCS
GI	: Gravitational injection

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

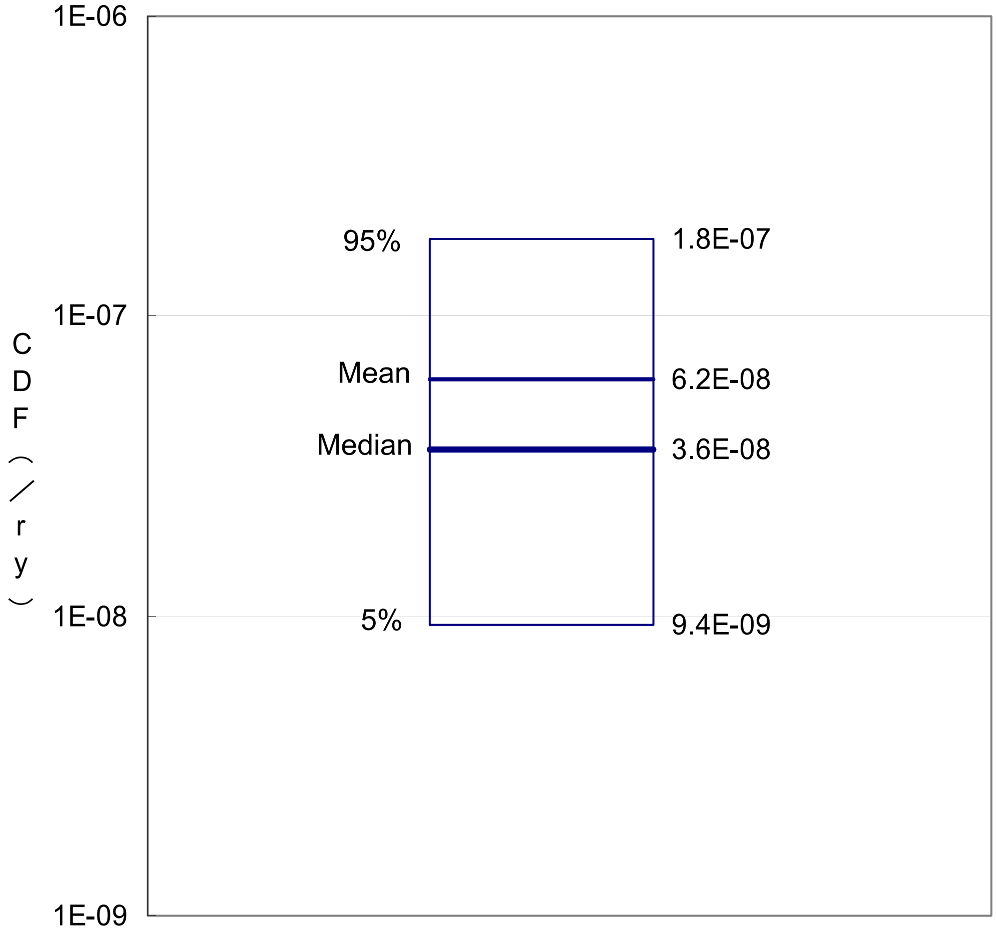


Figure 19.1- 21 Result of Uncertainty Quantification of POS 8-1 for LPSD PRA

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 alternate 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 alternate 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 alternate 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 alternate 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 alternate 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))

<u>Analysis approach</u>

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

<u>Analysis result</u>

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 is127 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.

Mitigation features

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

Summary of relevant studies and experiments

A summary of relevant studies and experiments about core debris coolability is found in Table 19.2-3.

Goals of analysis

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 19.2-7) 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 19.2-8) 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 19.2-9) 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 19.2-10). 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 (Reference19.2-10) 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 19.2-11, 19.2-12, and 19.2-13), 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 alternate 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

- Alternate 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
- Alternate 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 alternate 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 alternate 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).

According to RG 1.136 (Reference 19.2-14), it is necessary to evaluate that the containment maintains integrity to the following load:

D + Pg1 + [Pg2 or Pg3] where

D = Dead load

Pg1 = Pressure resulting from an accident that releases hydrogen generated from 100% fuel clad metal-water reaction

Pg2 = Pressure resulting from uncontrolled hydrogen burning

Pg3 = Pressure resulting from post-accident inerting, assuming carbon dioxide is the inerting agent

For the US-APWR containment design, the horizontal stress caused by D is calculated based on the global finite element model of PCCV and the maximum value of horizontal compressive stress 57.7 psi occurs at the point fixed to basemat. This stress is converted as the equivalent internal pressure as follows,

P_D = 57.7 (psi) × t / Din = 3.4 (psi)

P_D = Equivalent internal pressure converted from the stress caused by D

t = Wall thickness of PCCV (4” - 4’)

Din = Inner radius of PCCV (74” - 7)

Pressure related to hydrogen generation and control is evaluated in the US-APWR PRA report (Reference 19.2-15). Referred to the PRA report, Pg1 and Pg2 are evaluated as 46.7 psia and 127 psia, respectively. The US-APWR design does not adopt post-accident inerting as the hydrogen control, and hence Pg3 is ignored.

Containment pressure due to hydrogen generation and control can be evaluated as:

Before uncontrolled burn: D + Pg1 = P_D+ Pg1 = 50.1 pisa

After uncontrolled burn: D + Pg2 = P_D+ Pg2 = 130.4 pisa

These loads are less than the containment ultimate pressure of 216 psia. Accordingly it is confirmed that containment structural integrity is maintained from the challenge caused by hydrogen generation and control.

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 0.095, 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 0.15. 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 19.2-16). 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 guidance. The severe accident management framework discussed below as well as the important PRA assumptions and insights summarized in Table 19.1-119 are extensively addressed in the US-APWR accident management guidelines, including Emergency Response Guideline, Severe Accident Management Guidance, etc.

<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 guidance 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 19.2-16.

(1) To prevent core damage

(During operations at power)

Key function of accident management to prevent core damage is to keep the core in a condition covered by coolant water. During operations at power, 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. alternate 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 alternate 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 alternate 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 protection water supply system provides alternate 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 protection water supply system to component cooling water line to charging pumps, and supply alternate component cooling water to charging pumps.

(During LPSD operations)

During LPSD operations, accident management functions to prevent core damage include gravitational water injection from SFP, activation of safety injection system, recovery of RCS water level by utilizing charging pumps, heat removal through the secondary system including reflux cooling, and RHR isolation.

- If loss of coolant water through RHRS is identified, operators are required to manually isolated the failed RHR train and stop leakage of coolant water.

- Malfunction of RHR pumps may be because of decrease of RCS water level. If the water level in the RCS is insufficient for RHR pump suction, RHR pumps are forced stopped in order to avoid failure due to cavitations. Operators are required to control the CVCS charging pumps to provide water to recover the RCS water level, accordingly the RHR function recovers. This charging injection is also expected for the decay heat removal. In parallel, operators are required to establish the lineup between RWSP and RWSAT to continuously provide source for CVCS. Water supply from RWSP to RWSAT is achieved by a motor-driven pump.

- Heat removal through the secondary system is expected during LPSD operations, including natural circulation during the operations that RCS is fully filled with water and reflux cooling during mid-loop operations. Operators are required to handle the related devices to achieve the secondary system cooling. Secondary system cooling is available when RCS is closed so that the natural circulation flow within RCS is established.

- SI system is forced off during LPSD operations for maintenance purposes; however at least two SI trains are in standby (not in maintenance) in all POSs. Therefore it is highly likely that function of SI system is maintained available for core cooling. Operators are required to manually activate the SI system for emergency injection.

- During safety injection and charging injection, conditions of low temperature and over pressure may occur if RHR relief valves are inoperable. In order to avoid the subsequent adverse event, operators are required to manually open the safety depressurization valves.

- If water in the spent fuel pit is available, operators are required to manually control several valves installed between SFP and RCS and gravitationally provide adequate amount of water to the RCS. In parallel, operators are required to establish the lineup between RWSP and SFP to continuously provide coolant water. Water supply from RWSP to SFP is achieved by a motor-driven pump. Gravity injection is available when RCS is open and RCS pressure is maintained near atmospheric so that the SFP water can be drained into the RCS.

(2) To terminate the progress of core damage if it begins and to retain the core within the reactor vessel

(During operations at power)

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 alternate 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 alternate 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 alternate 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.

(During LPSD operations)

During LPSD operations, accident management functions to terminate the progress of core damage are fundamentally same with the ones for operations at power.

(3) To maintain containment integrity as long as possible

(During operations at power)

Key functions of accident management to maintain containment integrity during operations at power 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 protection water supply 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 protection water supply 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 alternate 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 alternate 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 protection water supply system is employed in case neither CSS nor alternate containment cooling is available in order to acquire longer recovery time. Fire protection water supply system is lined up to the containment spray header and provides water as spray droplet. This operation temporarily depressurizes containment however the fire protection water supply 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 or operation of alternate containment cooling 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. It is widely known that the low inert limit of steam concentration is approximately 55% and the low flammability limit of hydrogen concentration is approximately 4%. Hydrogen impact when depressurizing containment is evaluated and a material, such as a map of hydrogen concentration vs. containment pressure to show if hydrogen burn is safe or potential danger, is prepared to support the containment depressurization operation. MCR alarm for hydrogen concentration is also provided through the containment hydrogen monitoring system when the hydrogen concentration reaches 4% and 8%. The control room operators are required to carefully monitor the condition of containment.

(During LPSD operations)

It is likely that containment is not isolated during LPSD operations in order for various maintenance activities. The accident management functions to maintain containment integrity during LPSD include firstly recovery of containment isolation from the environment, and secondary heat removal from the isolated containment.

- According to the identification of some symptoms, such as loss of decay heat removal capability and onset of boiling in core, operators are required to take actions of containment isolation.

- For decay heat removal, accident management functions are fundamentally same with the ones for operations at power, i.e. reactor cavity flooding, activation of CSS or alternate containment cooling by natural circulation, or otherwise firewater injection to spray header.

(4) To minimize offsite release

(During operations at power)

Key function of accident management to minimize offsite release during operations at power is fission products removal from containment vessel atmosphere. CSS and fire protection water supply 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 protection water supply system connected to the spray header if available.

(During LPSD operations)

It is likely that containment is not isolated during LPSD operations in order for various maintenance activities. The accident management functions to minimize offsite release during LPSD include firstly recovery of containment isolation from the environment, and secondary deposition of fission products within the containment.

- According to the identification of some symptoms, such as loss of decay heat removal capability and onset of boiling in core, operators are required to take actions of containment isolation.
- Operators are required to activate CSS after confirming that the containment isolation is established and personnel in the containment all evacuated.
- If CSS is not available, operators are required to establish the lineup of the fire protection water supply system to the spray header.

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 complete Severe Accident Mitigation Design Alternatives (SAMDA) analysis is reported in the Applicant's Environmental Report - Standard Design Certification (Reference 19.2-17), and its summary is described in this section.

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 19.2-18).

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 19.2-19).

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 19.2-20 and 19-2-21). Industry implementation guidance (NEI 05-01, Rev. A) is applied to identify and screen SAMDAs (Reference 19.2-22). 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 19.2-23).

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. 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 (Reference 19.2-17).

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 19.2-24) 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 19.2-25). The population data and other assumptions applied are found in the Environmental Report for the US-APWR (Reference 19.2-17).

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 19.2-22). 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 19.2-20) and NEI 05-01, Rev. A (Reference 19.2-22) 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.

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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	-	-	-	-	-	-	-
Alternate 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 19.2-26) (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 19.2-27)	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 19.2-28)	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 19.2-29)	SNL reported that hydrogen detonation was observed for hydrogen concentration 13.5%~70%.
NUREG/CR-6524 (Reference 19.2-30)	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 19.2-31)	NRC staff recommends that assessments be based on available cavity area and an assumed maximum coolable depth of 25 cm.
SWISS (Reference 19.2-32)	Debris cooling failed due to formation of stable crust and water pool above melt was kept below boiling point.
MACE (References 19.2-33, 19.2-34)	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 19.2-35)	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 19.2-36)	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 19.2-37, 19.2-38, 19.2-39)	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 19.2-40, 19.2-41)	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 19.2-42)	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 19.2-43)	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. 19.2-44, 19.2-45, 19-2-46, 19.2-47)	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 19-2.48)	Experiment performed by ANL showed that containment atmosphere temperature rise is very small when reactor cavity was filled with water.
NUREG/CR-6510 (References 19.2-49, 19.2-50)	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 19.2-7)	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 19.2-51)	Scaling experiment by SNL showed that the pressure rise during DCH was as much as 0.5 MPa.
NUREG/CR-6075 (Reference 19.2-8) 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 19.2-54) NUREG-1524 (Reference 19.2-9)	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 19.2-10)	It was concluded that alpha-mode failure has no importance with regard to risk perspective.
ALPHA (References 19.2-55, 19.2-56) NUREG/CR-5372 (Reference 19.2-57)	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 19.2-58) FARO (Reference 19.2-59) KROTOS (Reference 19.2-60)	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 19.2-61)	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 19.2-62)	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 19.2-63)	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 19.2-64)	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 19.2-11)	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 19.2-12)	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 19.2-13)	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 19.2-65)	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 19.2-66)	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 19.2-67)	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 19.2-68, 19.2-69)	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

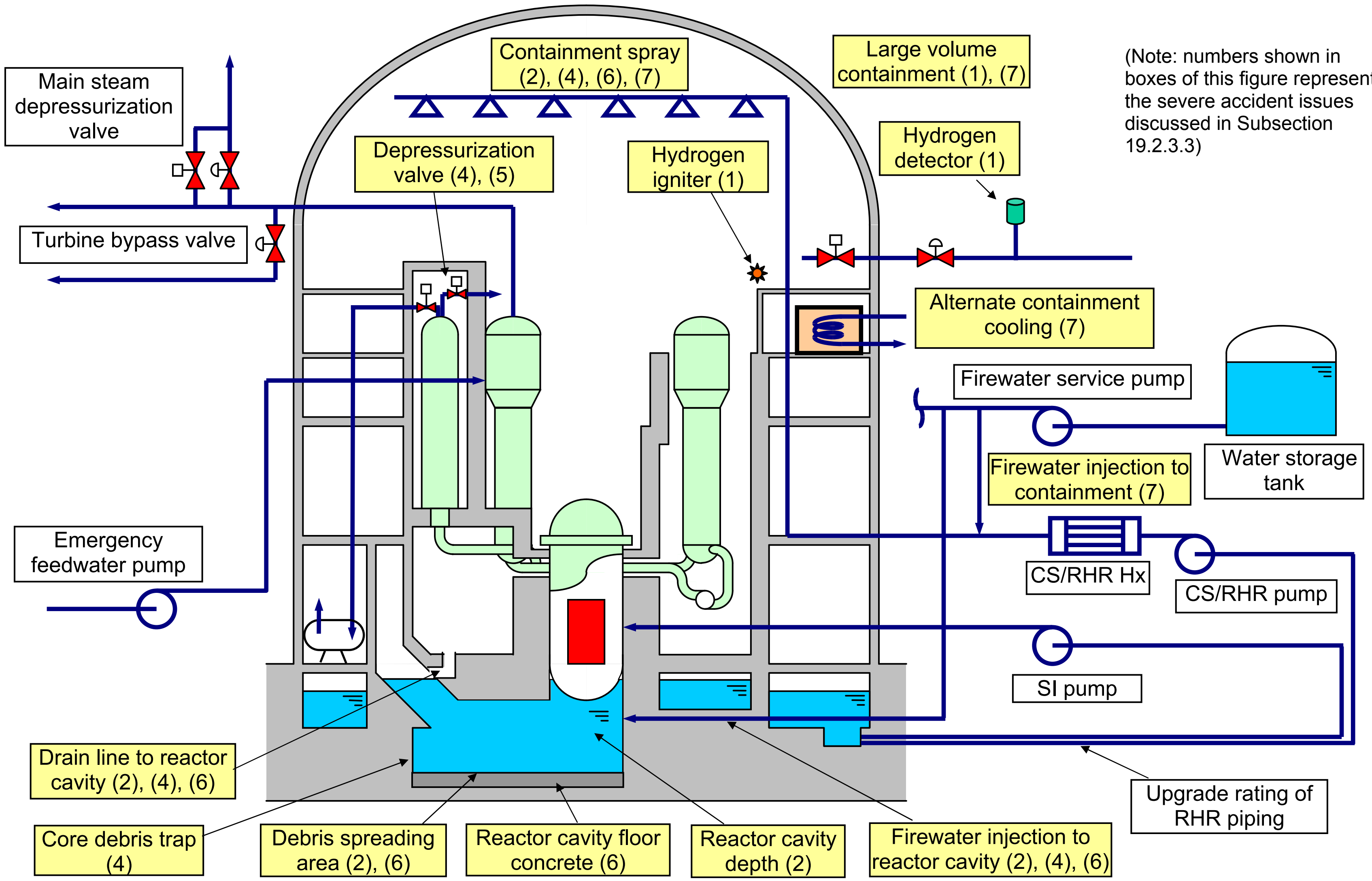

Figure 19.2-1 Schematic Diagram of the US-APWR Severe Accident Mitigation Features

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) Deleted

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) Deleted

COL 19.3(6) The COL applicant develops an accident management program which includes severe accident management procedures that capture important operator actions. Training requirements are also included as part of the accident management program.

APPENDIX 19A US-APWR BEYOND DESIGN BASIS AIRCRAFT IMPACT ASSESSMENT

CONTENTS

19A US-APWR Beyond Design Basis Aircraft Impact Assessment

19A.1 Introduction and Background

The design of the US-APWR takes into account the potential effects of the impact of a large commercial aircraft, which the NRC has determined is a beyond design basis event. In accordance with 10 CFR 50.150(a), a design-specific assessment has been performed for the US-APWR using realistic analysis to demonstrate that, in the event an US-APWR is struck by a large commercial aircraft, design features and functional capabilities exist to ensure that the following functions are maintained:

- The reactor core remains cooled, or the containment remains intact; and
- Spent fuel cooling or spent fuel pool integrity is maintained.

The assessment demonstrates the inherent robustness of the US-APWR design with regard to potential large aircraft impacts.

Specific assumptions used in the US-APWR aircraft impact assessment are based on requirements and guidance provided by the NRC and the Nuclear Energy Institute (NEI). The NRC provided the physical characteristics, including the loading function of the impacting aircraft, in July of 2007 (Reference 19A-1). The methodology for assessing effects for aircraft impact are described in NEI 07-13, “Methodology for Performing Aircraft Impact Assessments for New Plant Designs,” Revision 7 (Reference 19A-2).

This appendix describes the design features and functional capabilities of the US-APWR identified in the detailed assessment that assure the reactor core remains cooled or the reinforced concrete containment vessel (PCCV) remains intact, and spent fuel cooling or spent fuel pool integrity is maintained. These identified design features are designated as “key” design features and functional capabilities.

19A.2 Scope of the Assessment

Security-Related Information – Withheld Under 10 CFR 2.390

Security-Related Information – Withheld Under 10 CFR 2.390

19A.3 Assessment Methodology

Security-Related Information – Withheld Under 10 CFR 2.390

19A.4 Assessment Results

Security-Related Information – Withheld Under 10 CFR 2.390

19A.4.1 PCCV

Security-Related Information – Withheld Under 10 CFR 2.390

Security-Related Information – Withheld Under 10 CFR 2.390

19A.4.2 Plant Arrangement

Security-Related Information – Withheld Under 10 CFR 2.390

19A.4.3 Fire Barriers and Fire Protection Features

Security-Related Information – Withheld Under 10 CFR 2.390

Security-Related Information – Withheld Under 10 CFR 2.390

19A.5 Conclusions of Assessment

This assessment concludes that key design features and functional capabilities of the US-APWR ensure adequate protection of public health and safety in the event of an impact of a large commercial aircraft, as defined by the NRC. The postulated aircraft impacts would not impair the US-APWR's core cooling capability, containment integrity, spent fuel pit integrity, or adequate spent fuel cooling. The assessment resulted in identification of key design features and functional capabilities described in Section 19A.4, changes to which are required to be controlled in accordance with 10 CFR 50.150(c).

19A.6 References

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2. NEI 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," Revision 7, May 2009.

Security-Related Information – Withheld Under 10 CFR 2.390