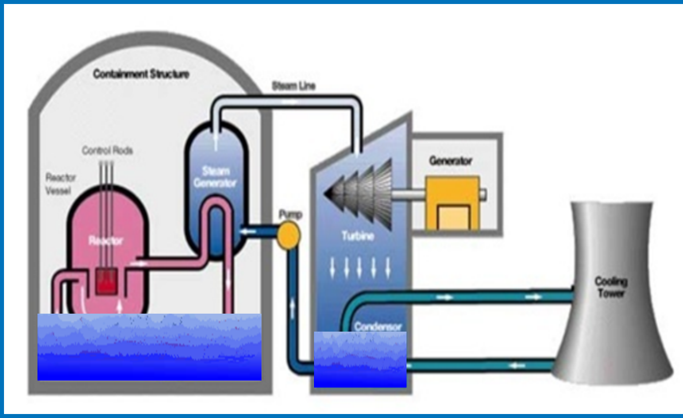
U.S. NRC Level 3 Probabilistic Risk Assessment (PRA) Project

Volume 3b: Reactor, At-Power, Level 1 PRA for Internal Flooding



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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) performed a full-scope site Level 3 probabilistic risk analysis (PRA) project (L3PRA project) for a two-unit pressurized-water reactor reference plant, responding to Commission direction in the staff requirements memorandum (SRM) (Agencywide Documents and Management System [ADAMS] Accession No. ML112640419) resulting from SECY-11-0089, "Options for Proceeding with Future Level 3 Probabilistic Risk Assessment (PRA) Activities" (ADAMS Accession No. ML11090A039).

As described in SECY-11-0089, the objectives of the L3PRA project are to:

- Develop a Level 3 PRA, generally based on current state-of-practice methods, tools, and data,[1] that (1) reflects technical advances since the last NRC-sponsored Level 3 PRAs (NUREG-1150[2]), which were completed over 30 years ago, and (2) addresses scope considerations that were not previously considered (e.g., low power and shutdown [LPSD] risk, multi-unit risk, other radiological sources).

- Extract new insights to enhance regulatory decision making and to help focus limited NRC resources on issues most directly related to the agency's mission to protect public health and safety.

- Enhance PRA staff capability and expertise and improve documentation practices to make PRA information more accessible, retrievable, and understandable.

- Demonstrate technical feasibility and evaluate the realistic cost of developing new Level 3 PRAs.

The scope of the L3PRA project encompasses all major radiological sources on the site (i.e., reactors, spent fuel pools, and dry cask storage), all internal and external hazards, and all modes of plant operation. Fresh nuclear fuel, radiological waste, and minor radiological sources (e.g., calibration devices) are not included as part of the scope. In addition, deliberate malevolent acts (e.g., terrorism and sabotage) are excluded from the scope of this study.

This report, one of a series of reports documenting the models and analyses supporting the L3PRA project, specifically addresses the reactor, at-power, Level 1 PRA model for internal floods for a single unit. The analyses documented herein are based information for the reference plant as it was designed and operated as of 2012 and does not reflect the plant as it is currently designed, licensed, operated, or maintained.[3]

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[1] "State-of-practice" methods, tools, and data refer to those that are routinely used by the NRC and industry or have acceptance in the PRA technical community. While the L3PRA project is intended to be a state-of-practice study, note that there are several technical areas within the project scope that necessitated advancements in the state-of-practice (e.g., modeling of multi-unit site risk, modeling of spent fuel in pools or casks, and of human reliability analysis for other than internal events and internal fires).

[2] NUREG-1150, "Severe Accident Risk: An Assessment for Five U.S. Nuclear Power Plants," December 1990.

[3] An overview report, which covers all three PRA levels, has been created for each major element of the L3PRA project scope (e.g., for the combined internal event and internal flood PRAs for a single reactor unit operating at full power). These overview reports include a reevaluation of plant risk based on a set of updated plant equipment and PRA model assumptions (e.g., incorporation of the current reactor coolant pump shutdown seal design at the

A full-scope site Level 3 PRA for a nuclear power plant site can provide valuable insights into the importance of various risk contributors by assessing accidents involving one or more reactor cores as well as other site radiological sources. Furthermore, some future advanced light water reactor (ALWR) and advanced non-light water reactor (NLWR) applicants may rely heavily on results of analyses similar to those used in the L3PRA project to establish their licensing basis and design basis by using the Licensing Modernization Project (LMP) (NEI 18-04, Rev. 1) which was recently endorsed via RG 1.233. Licensees who use the LMP framework are required to perform Level 3 PRA analyses. Therefore, another potential use of the methodology and insights generated from this study is to inform regulatory, policy, and technical issues pertaining to ALWRs and NLWRs.

CAUTION: While the L3PRA project is intended to be a state-of-practice study, due to limitations in time, resources, and plant information, some technical aspects of the study were subjected to simplifications or were not fully addressed. As such, inclusion of approaches in the L3PRA project documentation should <u>not</u> be viewed as an endorsement of these approaches for regulatory purposes.

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reference plant and the potential impact of the U.S. nuclear power industry's proposed safety strategy, called Diverse and Flexible Mitigation Capability [FLEX], both of which reduce the risk to the public).

FOREWORD

The U.S. Nuclear Regulatory Commission (NRC) performed a full-scope site Level 3 probabilistic risk analysis (PRA) project (L3PRA project) for a two-unit pressurized-water reactor reference plant, responding to Commission direction in the staff requirements memorandum (SRM) (Agencywide Documents and Management System [ADAMS] Accession No. ML112640419) resulting from SECY-11-0089, “Options for Proceeding with Future Level 3 Probabilistic Risk Assessment (PRA) Activities” (ADAMS Accession No. ML11090A039).

Licensee information used in performing the Level 3 PRA project was voluntarily provided based on a licensed, operating nuclear power plant. The information provided reflects the plant as it was designed and operated as of 2012 and does not reflect the plant as it is currently designed, licensed, operated, or maintained. In addition, the information provided for the reference plant was changed based on additional information, assumptions, practices, methods, and conventions used by the NRC in the development of plant-specific PRA models used in its regulatory decisionmaking. **As such, use of L3PRA project reports to assess the risk from the reference plant is not appropriate and these reports will not be the basis for any regulatory decision associated with the reference plant.**

Each set of L3PRA project reports covering the Level 1, 2, and 3 PRAs for a specific site radiological source, plant operating state, and hazard group is accompanied by an overview report. The overview reports summarize the results and insights from all three PRA levels.

In order to provide results and insights better aligned with the current design and operation of the reference plant, the overview reports also provide a reevaluation of the plant risk based on a set of new plant equipment and PRA model assumptions and compare the results of the reevaluation to the original study results. This reevaluation reflects the current reactor coolant pump (RCP) shutdown seal design at the reference plant, as well as the potential impact of FLEX strategies,[4] both of which reduce the risk to the public.

A full-scope site Level 3 PRA for a nuclear power plant site can provide valuable insights into the relative importance of various risk contributors by assessing accidents involving one or more reactor cores as well as other site radiological sources (i.e., spent fuel in pools and dry storage casks). These insights may be used to further enhance regulatory policy and decisionmaking and to help focus limited agency resources on issues most directly related to the agency’s mission to protect public health and safety. More specifically, potential future uses of the Level 3 PRA project can be categorized as follows (a more detailed list is provided in SECY-12-0123, “Update on Staff Plans to Apply the Full-Scope Site Level 3 PRA Project Results to the NRC’s Regulatory Framework,” dated September 13, 2012):

- enhancing the technical basis for the use of risk information (e.g., obtaining updated and enhanced understanding of plant risk as compared to the Commission’s safety goals)
- improving the PRA state-of-practice (e.g., demonstrating new methods for site risk assessments, which may be particularly advantageous in addressing the risk from advanced reactor designs, or in supporting the evaluation of the potential impact that a multi-unit accident, or an accident involving spent fuel, may have on the efficacy of the emergency planning zone in protecting public health and safety)

[4] FLEX refers to the U.S. nuclear power industry's proposed safety strategy, called Diverse and Flexible Mitigation Capability. FLEX is intended to maintain long-term core and spent fuel cooling and containment integrity with installed plant equipment that is protected from natural hazards, as well as backup portable onsite equipment. If necessary, similar equipment can be brought from offsite.

- identifying safety and regulatory improvements (e.g., identifying potential safety improvements that may lead to either regulatory improvements or voluntary implementation by licensees)
- supporting knowledge management (e.g., developing or enhancing in-house PRA technical capabilities)

In addition, the overall Level 3 PRA project model can be exercised to provide insights with regard to other issues not explicitly included in the current project scope (e.g., security-related events or the use of accident tolerant fuel). Furthermore, some future advanced light water reactor (ALWR) and advanced non-light water reactor (NLWR) applicants may rely heavily on the results of analyses similar to those used in the L3PRA project to establish their licensing basis and design basis by using the Licensing Modernization Project (LMP) (NEI 18-04, Rev. 1) which was recently endorsed via RG 1.233. Licensees who use the LMP framework are required to perform Level 3 PRA analyses. Therefore, another potential use of the methodology and insights generated from this study is to inform regulatory, policy, and technical issues pertaining to ALWRs and NLWRs.

The results and perspectives from this report, as well as all other reports prepared in support of the Level 3 PRA project, will be incorporated into a summary report to be published after all technical work for the Level 3 PRA project has been completed.

ABBREVIATIONS AND ACRONYMS

ACCW	auxiliary component cooling water
AFW	auxiliary feedwater
ANS	American Nuclear Society
ARV	atmospheric relief valve
ASME	American Society of Mechanical Engineers
CCDP	conditional core damage probability
CCW	component cooling water
CDF	core damage frequency
CS	containment spray
CVCS	chemical and volume control system
CW	circulating water
ECCS	emergency core cooling system
EDG	emergency diesel generator
EPRI	Electric Power Research Institute
FW	feedwater
HEP	human error probability
HFE	human failure event
HVAC	heating, ventilation and air conditioning
IFPRA	internal flooding probabilistic risk assessment
KV AC	kilovolts alternating current
LCO	limiting condition for operation
LOCA	loss-of-coolant accident
LOCHS	loss of condenser heat sink
LOMFW	loss of main feedwater
LOOP	loss of offsite power
LO4160VA	loss of safety-related 4160 volt bus train A
MDP	motor-driven pump
MOV	motor-operated valve
MFIV	main feedwater isolation valves
MFW	main feedwater
MS	main steam
MSIV	main steam isolation valve
MSLB	main steam line break
NRC	Nuclear Regulatory Commission
NSCW	nuclear service cooling water
PORV	power-operated relief valve
PRA	probabilistic risk assessment
PWR	pressurized-water reactor
RAT	reserve auxiliary transformer
RCP	reactor coolant pump
RCS	reactor coolant system
RHR	residual heat removal

RPS	reactor protection system
RTRIP	reactor trip
RWST	refueling water storage tank
SBO	station blackout
SG	steam generator
SI	safety injection
SRM	staff requirements memorandum
SSBI	secondary-side break upstream of MSIVs / downstream of MFIVs
SSC	structures, systems, and components
TDAFWP	turbine-driven AFW pump
TPCCW	turbine plant closed cooling water
TPCW	turbine plant cooling water system
TRANS	other transient resulting in reactor trip
TTRIP	turbine trip
VAC	volts alternating current
VDC	volts direct current

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1. INTRODUCTION

This report documents a description and results for the reactor, at-power, Level 1 probabilistic risk assessment (PRA) model for internal floods that supports the U.S. Nuclear Regulatory Commission (NRC) full-scope site Level 3 PRA project (L3PRA project) for a two-unit pressurized-water reactor (PWR) reference plant. The results provided in this report are for a single unit—a subsequent report in this series addresses multi-unit risk.

Licensee information used in performing the L3PRA project was voluntarily provided based on a licensed, operating nuclear power plant. The information provided reflects the plant as it was designed and operated as of 2012 and does not reflect the plant as it is currently designed, licensed, operated, or maintained. In addition, the information provided for the reference plant was changed based on additional information, assumptions, practices, methods, and conventions used by the NRC in the development of plant-specific PRA models used in its regulatory decisionmaking. **As such, use of this report to assess the risk from the reference plant is not appropriate and this report will not be the basis for any regulatory decision associated with the reference plant.**

Since the L3PRA project involves multiple PRA models, each of these models should be considered a "living PRA" until the entire project is complete. It is anticipated that the models and results of the L3PRA project are likely to evolve over time, as other parts of the project are developed, or as other technical issues are identified. As such, the final models and results of the project (which will be documented in a summary report to be published after all technical work for the L3PRA project has been competed) may differ in some ways from the models and results provided in the current report.

The series of reports for the L3PRA project are organized as follows:

Volume 1: Summary (to be published last)

Volume 2: Background, site and plant description, and technical approach

Volume 3: Reactor, at-power, internal event and flood PRA
- Volume 3x: Overview
- Volume 3a: Level 1 PRA for internal events (Part 1 – Main Report; Part 2 – Appendices)
- Volume 3b: Level 1 PRA for internal floods
- Volume 3c: Level 2 PRA for internal events and floods
- Volume 3d: Level 3 PRA for internal events and floods

Volume 4: Reactor, at-power, internal fire and external event PRA
- Volume 4x: Overview
- Volume 4a: Level 1 PRA for internal fires
- Volume 4b: Level 1 PRA for seismic events
- Volume 4c: Level 1 PRA for high wind events and other hazards evaluation
- Volume 4d: Level 2 PRA for internal fires and seismic and wind-related events
- Volume 4e: Level 3 PRA for internal fires and seismic and wind-related events

Volume 5: Reactor, low power and shutdown, internal event PRA
- Volume 5x: Overview
- Volume 5a: Level 1 PRA for internal events
- Volume 5b: Level 2 PRA for internal events

Volume 5c: Level 3 PRA for internal events

Volume 6: Spent fuel pool all hazards PRA
Volume 6x: Overview
Volume 6a: Level 1 and Level 2 PRA
Volume 6b: Level 3 PRA

Volume 7: Dry cask storage, all hazards, Level 1, Level 2, and Level 3 PRA

Volume 8: Integrated site risk, all hazards, Level 1, Level 2, and Level 3 PRA

The details of the internal flooding analysis, including modeling assumptions, scenario descriptions, and sources of uncertainty are documented in this report. Section 1.1 describes the overall approach for developing the NRC internal flooding PRA (IFPRA). Section 1.2 describes the arrangement of this report. Simplified diagrams for key systems are provided in Volume 2 of this NUREG series (see Agencywide Documents Access and Management System Accession No. ML22067A232).

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1.1. Approach

The purpose of this section is to describe the process of developing the internal flooding PRA model and documentation. Each of the internal flooding technical elements and associated requirements were addressed in accordance with the ASME/ANS PRA Standard (Ref. IF- 7). The licensee had completed an internal flooding PRA for the reference plant at the time this study was initiated. The reference plant's PRA was reviewed and much of the analysis was adopted for this study. The NRC's IFPRA also leverages the NRC's internal events Level 1 PRA model for the reference plant (Ref. IF- 16).

The NRC staff performed a plant walkdown to confirm aspects of the internal flooding analysis. The walkdown allowed the staff to gain familiarity with the plant layout, equipment locations, flood sources, and flood mitigation features.

While the reference plant had completed an internal flooding PRA, new analyses were performed for this study in support of the overall objectives of the Level 3 PRA project. The focus of the new analyses included:

- Incorporating insights from NRC's confirmatory plant walkdown.
- Evaluating the internal flood scenario qualitative and quantitative screening approach
- Updating the internal flood initiating event frequency estimates
- Quantifying the internal flooding modeling, including integrating the model with NRC's internal events PRA model
- Identifying sources of model uncertainty and performing sensitivity studies

1.2. Arrangement of This Report

The IFPRA analysis is described in the subsequent sections of this report. Section 2 describes the approach for addressing each of the internal flooding technical elements in the NRC IFPRA. Section 3 provides the overarching modeling assumptions and describes each of the modeled internal flooding scenarios. The IFPRA model results and uncertainty analysis are presented in Section 4, with a summary of key insights in Section 4.7. Section 5 provides a list of references.

Additional supporting information for the NRC IFPRA is provided in appendices. Appendix A contains details of the internal flood initiating event frequency analysis for each modeled flood scenario. Appendix B provides a listing of the risk-significant IFPRA cut sets, as well as the importance measures for all risk-significant basic events. Appendix C identifies a number of topics that were not addressed as part of the IFPRA, but for which additional study may be warranted. These modeling improvements should be implemented to maximize the value of the insights obtained from the study.

2. INTERNAL FLOOD PRA MODEL OVERVIEW

This section includes an overview of the technical elements that were analyzed in developing the IFPRA. The section is organized in terms of the five technical elements of an internal flooding PRA, as defined in the ASME/ANS PRA Standard (Ref. IF-7). The following subsections describe the analyses performed for each of the internal flooding PRA technical elements. Section 2.1 addresses Internal Flood Plant Partitioning. Section 2.2 covers Internal Flood Source Identification and Characterization. Section 2.3 addresses Internal Flood Scenarios. Section 2.4 covers Internal Flood-Induced Initiating Events. And, Section 2.5 addresses Internal Flood Accident Sequences and Quantification.

2.1. Internal Flood Plant Partitioning

The main objective of the internal flood plant partitioning is to identify plant areas susceptible to internal flooding that could lead to core damage. Plant partitioning consists of two high-level requirements: (1) to identify a reasonably complete set of flood areas of the plant, and (2) to document internal flood plant partitioning consistent with the applicable supporting requirements from the ASME/ANS PRA Standard.

The identification of flood areas uses plant information resources and is supplemented by walkdowns and interviews with plant staff to confirm the plant configurations. The following information sources from the reference plant were used by the licensee in developing the flood areas:

- Plant architectural drawings
- Piping and instrumentation diagrams
- Design basis flood calculation documents
- Appendix R fire areas, fire hazard analysis, and the associated drawings
- High-energy line break areas
- Individual Plant Examination internal flooding analysis notebooks
- Risk-informed inservice inspection documenation

The plant partitioning analysis identified hundreds of potential flood areas. The licensee further evaluated the flood areas to identify the structures, systems, and components (SSCs) that are susceptible to flood damage and/or can mitigate the flooding effects.

For each flood area, flood mitigating features that have the ability to terminate or contain the flood were identified in the reference plant's PRA documentation. The flood mitigating features are considered in the qualitative screening of flood areas. The flood mitigating features can include:

- Flood alarms
- Flood auto-trip logic for circulating water pumps
- Flood dikes, curbs, sumps, or structures that allow for the accumulation and retention of water
- Sump pumps
- Drainage systems
- Spray or drip shields
- Water-tight doors
- Blowout panels or dampers
- Various other types of flood barriers, including walls and other structures

The licensee evaluated the potential flood areas to identify the SSCs contained in each area that are susceptible to flood damage. The focus was specifically on those SSCs whose failure may result in accident initiation and/or negatively impact an accident mitigation function.

Prior to adopting the licensee's flood area analysis, the NRC visited the reference plant site in June 2013. The visit included confirmatory walkdowns of flooding areas, review of design basis flooding calculations, and interviews with plant staff familiar with the plant design and operation. This effort was intended to provide confirmation of key information for risk-significant flooding areas. It was not an exhaustive or complete walkdown of all flood areas in the plant. Prior to performing the walkdowns, the staff generated a list of priority flood areas to be evaluated during the plant visit. This focused the walkdown effort on those areas that were initially considered to be risk significant or of particular interest for the IFPRA. The following criteria were used to identify the priority flood areas:

- Flood areas containing high risk achievement worth importance measure SSCs based on the internal events PRA
- The top CDF contributors to internal flooding from the reference plant's internal flooding PRA
- Areas of potential cross-unit or multi-unit flooding impacts
- Other areas of interest for the NRC IFPRA

The confirmatory plant walkdown was completed for the selected risk-significant flooding areas and confirmed the information regarding equipment layout, flood sources, protective features, and susceptibilities. As such, the licensee's internal flood plant partitioning analysis was adopted for use in the NRC IFPRA.

2.2. Internal Flood Source Identification and Characterization

The purpose of this section is to describe the internal flood source identification and characterization analysis. The main objective of the internal flood source identification is to identify the plant-specific sources of internal flooding that could lead to accident sequences resulting in core damage. This task identifies the various sources of floods and equipment spray within the plant, along with the mechanisms resulting in flood or spray from these sources, and characterizes the flood/spray sources (e.g., in terms of liquid amounts and flowrates).

Flood sources include any equipment located in a flood area that can cause flooding. Examples of flood sources include: piping, flanges, valves, pumps, tanks, heat exchangers, pools, external sources of water connected to the area through systems or structures, and in-leakage from other flood areas. Primary system piping whose failure would result in a loss-of-coolant accident (LOCA) and selected high-energy line breaks[5] are not treated in the internal flooding analysis, since they were addressed and analyzed in the internal events analysis.

The licensee performed a systematic review of the flood sources for each flood area. The most prevalent sources of flooding for most flood areas are piping systems. For each flood area, the following information was collected for the piping located in the area: the system, the pipe diameter, and the length of pipe in the area. This information was used in the subsequent analysis tasks for developing the internal flood scenarios.

[5] Main feedwater line breaks were included as internal flooding initiating events, and these contribute to several of the modeled flooding scenarios described in Section 3.2. However, main steam line breaks were not included as internal flooding initiating events. Main steam line breaks are evaluated in the internal events PRA model.

2.3. Internal Flood Scenarios

The purpose of this section is to describe the internal flood scenario analysis performed by the licensee. The internal flood scenarios were developed by incorporating aspects of the plant partitioning and flood source analyses discussed in the previous sections. Next, a qualitative screening evaluation was performed to identify the potential internal flooding scenarios. Section 2.3.1 discusses this qualitative screening analysis. The remaining flood areas and flood sources were evaluated to develop the detailed characteristics of the potential flooding scenarios. Section 2.3.2 summarizes this characterization of flood scenarios.

2.3.1. Qualitative Screening Analysis

The purpose of the qualitative screening analysis is to identify and remove flood areas that are not important for the internal flooding PRA. A set of qualitative screening criteria was used to screen flood areas and associated flood sources. These criteria were based on the requirements of the ASME/ANS PRA standard (Ref. IF-7). The qualitative screening criteria are presented below:

a. If there is no flood source in the room or location, the room or location can be screened out, even if it contains accident initiation/mitigation SSCs. However, rooms with no flood sources, but that contain accident initiation/mitigation SSCs, need to be further evaluated if there is a potential for flood water from adjacent room(s) or location(s) to propagate to these rooms.

b. If flooding of the area would not cause an initiating event or a need for immediate plant shutdown, and

   - The flood area (including areas where flood sources can propagate to) contains no accident initiation/mitigation equipment susceptible to flood damage, or
   - The flood area has no flood sources sufficient (e.g., through spray, submergence, or other flood-induced hazards) to cause failure of accident initiation/mitigation equipment susceptible to flood damage in the area (including areas where flood sources can propagate to).

c. If flooding of the area would not cause an initiating event or a need for immediate plant shutdown, and the area contains flooding mitigation systems (e.g., drains or sump pumps) capable of preventing unacceptable flood levels, and the nature of the flood would not cause failure of the accident initiation/mitigation equipment susceptible to flood damage (e.g., through spray, submergence, or other flood-induced hazards).

d. If potential human mitigating actions could be used for screening (and meet ASME/ANS PRA standard Capability Category II) given that:

   - flood indication is available in the control room
   - flood sources in the area can be isolated
   - mitigating actions can be performed with high reliability for the worst flooding initiator, which can be established by demonstrating, for example, that the actions are procedurally directed, that adequate time is available for response, that the area is accessible, and that there is sufficient manpower available to perform the action

e. If the flood source is insufficient (e.g., through spray, submergence, or other flood induced hazards) to cause failure of accident initiation/mitigation equipment susceptible to flood damage.

f. If the area flood mitigating systems (e.g., drains or sump pumps) are capable of preventing unacceptable flood levels and the nature of the flood does not cause failure of accident initiation/mitigation equipment susceptible to flood damage through spray, submergence, or other flood-induced hazards.

g. If the flood only affects the system that is the flood source and the system analysis addresses this type of failure, then this flood source need not be treated as a separate internal flooding initiating event.

In applying these criteria, the ASME/ANS PRA standard specifies that the potential flood impacts on accident initiation/mitigation equipment shall include consideration of impacts on support systems (e.g., electric power, cooling water systems) whose failure would result in accident initiation or failure of mitigation functions. The licensee evaluated each of the identified flood areas and associated flood sources against the criteria above. The flood areas not screened by this process were evaluated further by defining and characterizing flood scenarios.

2.3.2. Characterization of Flood Scenarios

This section describes the overall approach to assembling the elements that were considered in defining potential flooding scenarios for the IFPRA model. Each flood scenario description includes the relevant information required for incorporation into the model. This information includes a description of the flooding initiating event (i.e., the pipe break or component failure that initiates the flood), the flood location, and attributes of the flood source (e.g., flow rate and type). The scenario description also includes the impacts of the flood and plant response, identifies the SSCs that are damaged due to the flood, and identifies the corresponding initiating event from the internal events PRA that is used to model the flood impacts. If no corresponding internal initiating event exists, then a new initiating event type is created to model the flood response. The plant response also includes identifying the plant systems and functions that are needed to prevent core damage. The detailed descriptions of each modeled flood scenario in the IFPRA are provided in Section 3.2.

The scenarios consider the flooding effects (i.e., submergence, humidity, condensation, and temperature) that could cause equipment failures. In addition, due to the energy associated with failures of high-energy piping systems, these events may cause additional consequences, such as pipe whip or jet impingement. The flood scenarios are categorized by flood type to distinguish the types of flood effects that can occur. Each flood area may have more than one flood type associated with it. The following flood types are defined:

- Local flooding – The flooding effects are considered within the same flood area where the flood initiated. The flooding effects due to submergence, humidity, condensation, and temperature are considered. The primary consideration for most flood scenarios is submergence.
- Flood propagation – The flood propagates to other flood areas. The same flooding effects as local flooding are considered.
- Human-induced local flooding – The flood is initiated by human error. The same flooding effects as local flooding are considered.

- Spray – In addition to the above mentioned flooding effects, spray events consider impacts to SSCs that are within a direct line-of-sight of the flood source. SSCs located above the maximum flood height can fail from spray before submergence. Spray events are characterized by small through-wall failures resulting in low leak rates, but may have a higher contribution to the flood initiating event frequency. Sprays are considered for both high-energy piping and non-high-energy piping.
- Jet impingement – Jet impingement is only considered for high-energy piping. The flooding effects are similar to spray events, with additional consideration for the high-energy impact of the jet stream from the flood source.
- Pipe whip – The flooding effects include consideration for pipe whip due to failure of high-energy piping.

The criteria for determining susceptibility to sprays can vary in different internal flooding analyses. The specific criteria for this study considers the adverse effects from spray sources if the susceptible equipment is within 10 feet of horizontal distance from overhead flood sources and the equipment is in the line-of-sight of pressurized-water sources. The distance is extended to include SSCs within 20 feet for high-energy flood sources. The IFPRA considers piping systems with pressures in excess of 275 psig or the maximum normal operating temperature exceeding 200ºF to be high-energy piping. The same definition of high-energy piping is used for determining which flood sources are potential sources for jet impingement and pipe whip.

The potential impacts due to submergence are evaluated by examining the maximum flood water height for each flood area. The licensee for the reference plant used the design basis flood calculations to estimate the maximum flood water height for each flood area. The flood water level estimates considered the flood propagation paths and areas of accumulation by accounting for flow through non-water-tight doors, drains, penetrations, and other features that can contribute to the flood accumulation level. The licensee did not directly use the flood level calculations to determine potential equipment failures, though they did use them to inform bounding assumptions on flood impacts. For example, for local flooding scenarios, the design basis flood calculations support the assumption that all eaqupment in a given flood area would be failed. However, for some flood propagation scenarios, the flood calculations are not conclusive regarding equipment damage. Nonetheless, the licensee assumed that for both local flooding scenarios and flood propagation scenarios, all SSCs located in a flooded room would be damaged by the flood water. The IFPRA uses the same set of flooding impact assumptions as the licensee.

The flooding scenario analysis considers actions and systems that may be used to mitigate the impacts of flood scenarios. These include flood alarms; level, pressure, and flow indicators; and post-flood operator actions. The flood mitigating actions that have the ability to terminate or contain flood propagation were identified for each flood scenario. The licensee assigned screening human error probability (HEP) values for each action. For most scenarios, the licensee assumed no credit for mitigating actions, and the screening HEP is set to 1.0. The lone exeception involved mitigating actions for scenarios due to charging system line breaks. Operator action to restore charging and seal injection according to applicable procedures was assigned a screening HEP of 0.1. The screening HEPs were used in the initial screening quantification of CDF contributions. If risk significant operator actions were identified from the initial screening quantification, then a detailed human reliability analysis would have been performed for those actions. However, no risk-significant operator actions were identified from the screening quantification. The licensee's analysis of flood scenario mitigation was adopted for use in the NRC IFPRA.

2.4. Internal Flood-Induced Initiating Events

The purpose of this section is to describe the internal flood-induced initiating event analysis. The main objectives of the analysis are to identify flood-induced initiating events and to estimate their frequencies. The approach to initiating event identification is described in Section 2.4.1. An overview of the initiating event frequency estimation approach is discussed in Section 2.4.2. Initiating event frequency analysis for each of the modeled flood scenarios is described in detail in Appendix A.

2.4.1. Identification of Flood-Induced Initiating Events

For each of the identified flood scenarios, the licensee considered two types of flood-induced initiating events:

1. Floods that cause an initiating event
2. Floods that result from an initiating event

The first type of flood initiator begins with a pressure boundary failure and likely causes an automatic actuation resulting in an initiating event. The frequency of these failures, which are primarily piping system failures, were quantified using generic industry data along with plant-specific operating experience.

For the second type of flood initiator, plant conditions that could result in a flooding event were evaluated. This included the consideration of human-induced floods and induced pipe failures resulting from a random initiating event. A random initiating event could involve stresses on a piping system from any of the following:

- Water hammer
- Rapid pressurization
- Valve slamming open or closed
- High vibration
- Void collapse

A review of the pipe failure operating experience (as documented in Ref. IF-9) suggests that the probability of a conditional pipe break resulting from a random initiating event is expected to be much lower than other failure probabilities that would impact a given plant system's reliability. Combined with the frequency of a random initiating event, the flood initiating sequence frequency would be very low. Therefore, this type of pipe failure is screened from further consideration.

The reference plant provided an analysis of maintenance activities that could result in human-induced flooding. The analysis considered the following maintenance activities:

- Circulating water (CW) system maintenance work
- Component cooling water (CCW)/auxiliary CCW heat exchanger maintenance work
- Turbine plant closed cooling water (TPCCW) heat exchanger maintenance work
- Fire protection water system maintenance work

To estimate the frequency of causing a human-induced flooding event, the licensee used screening values for HEPs that lead to flooding events. The human-induced flooding scenarios involve two types of human failures: (1) failure to properly restore the system or component after maintenance work, and (2) failure of the maintenance crew to mitigate the flooding event when the system or component is returned to service. The first type of failure was assigned a screening HEP of 0.01. The second type of failure was assigned a screening HEP of 0.1. The restoration of equipment from maintenance is directed by applicable procedures. Also, the

reference plant has a general practice of staging operations and maintenance staff locally to identify leakage when a system/component is being refilled and placed back in service. For these reasons, human failures associated with restoring equipment and mitigating flooding are expected to be unlikely.

The licensee identified flood scenarios that may impact accident initiation or mitigating equipment. The internal event initiator that would result due to the flood was identified for each scenario. For certain pipe failures, the associated flooding effects may be inconsequential to the resulting internal event accident scenarios. Examples of these failures include pipe breaks resulting in loss-of-coolant accidents (LOCAs) and main steam line breaks (MSLBs). These scenarios are not addressed in the internal flooding analysis. The impacts from these events are captured by the internal events PRA model.

2.4.2. Flood Initiating Event Frequency Estimates

This section describes the quantitative analysis used by the L3PRA project staff to estimate the internal flooding scenario frequencies for the IFPRA. The initiating event frequency analysis is based on the approach described in the Electric Power Research Institute (EPRI) report, “Pipe Rupture Frequencies for Internal Flooding PRAs, Revision 3” (Ref. IF- 9). The initiating event frequency, *f*, for a given pipe break flooding scenario is given by the following expression:

$$f = l \times \lambda_{pipe} \times P_{pipe}(R|F) \quad [1]$$

where,

l is the length of pipe (in feet) located in the flood area

λ_{pipe} is the failure rate of the pipe per feet-critical reactor year

$P_{pipe}(R/F)$ is the conditional rupture probability given pipe failure

The EPRI report defines failure as any condition in which pipe repair or replacement was performed. Failures can include wall thinning, cracks, pinhole leaks, leaks, and major structural failures. A failure will not necessarily result in a flooding event, but the occurrence of any failure will be associated with the conditional probability of a rupture. A rupture is a substantial failure that results in the initiation of a flooding event. In this report, the terms rupture and break are used interchangeably to refer to substantial pipe failures that result in flooding events.

Similarly, the initiating event frequency can be expressed in terms of component failures that may be relevant to a flood scenario (e.g., failure of rubber expansion joints), as follows:

$$f = n \times \lambda_{component} \times P_{component}(R|F) \quad [2]$$

where,

n is the number of components located in the flood area

$\lambda_{component}$ is the failure rate per component-critical reactor year

$P_{component}(R/F)$ is the conditional rupture probability given component failure

The EPRI report provides generic failure data for different types of plant systems. The data are further categorized in terms of the severity of pipe failure (e.g., wall thinning, pinhole leak, leak, major structural failure) and pipe size. The category definitions may vary depending on the type of system. The generic data and failure rates in the report were used in the IFPRA to develop prior distributions for the pipe (or component) failure rates and conditional rupture probabilities. The prior distributions are updated with plant-specific data. The plant-specific data considered for the IFPRA cover the period from January 1, 1990 through December 31, 2012.

Additional details regarding the initiating event frequency estimates for the NRC IFPRA are provided in Appendix A.

2.5. Internal Flood Accident Sequences and Quantification

This section describes the analysis and quantification of the internal flood accident sequences performed by the L3PRA project staff. The main objective of this task is to identify the internal-flood-induced accident sequences and quantify the likelihood of core damage (Ref. IF- 7). Each internal flooding scenario is related to an internal events scenario that would be caused by the flood and accounts for flood-specific impacts on equipment and operator actions. The modeled scenarios that were adopted for the IFPRA are described in Section 3.2 of this report. For each scenario, the related internal event sequences and flood-specific impacts were reviewed to ensure the flood-related phenomena are appropriately modeled. The following sections provide a description of the quantification process used for the IFPRA. Section 2.5.1 discusses the quantitative screening analysis, and Section 2.5.2 discusses quantification of human failure events. Additional information on the IFPRA model quantification can be found in the discussion of model results in Section 4.

2.5.1. Quantitative Screening Analysis

After the licensee applied the qualitative screening criteria, 78 potential internal flooding scenarios were identified for further quantitative evaluation. A quantitative screening process was performed by the L3PRA project staff to estimate the CDF contribution of each scenario. The scenarios representing the top 95 percent of the total estimated internal flood CDF and each scenario contributing greater than 1 percent to total internal flood CDF were selected to be incorporated into the IFPRA model.

The quantitative screening approach used the NRC internal events PRA to assess the plant impacts resulting from each of the flooding scenarios. The internal events model was used to calculate the conditional core damage probability (CCDP) for each flooding scenario based on the initiating event that was caused and the SSCs that were failed due to the flooding impacts. The initiating event frequency for each flooding scenario was estimated based on generic data from the EPRI technical report, “Pipe Rupture Frequencies for Internal Flooding Probabilistic Risk Assessments” (Ref. IF-9).

This process was used to estimate the CDF of each flooding scenario and determine its contribution to the overall flooding CDF. The scenarios with the highest contributions to CDF were evaluated further to assess whether they should be incorporated into the NRC IFPRA model. This process was repeated for the top contributing scenarios until the modeled scenarios represented greater than 95 percent of the total flooding CDF and each scenario contributing greater than 1 percent to total flooding CDF was identified. This process resulted in 23 internal event flood scenarios being incorporated into the IFPRA model.

2.5.2. Quantification of Human Failure Events

The analysis of human failure events consists of three types of failures: pre-initiator human failures, post-initiator actions for flood mitigation, and post-flood actions unrelated to the flood but required for responding to the accident scenario.

The licensee’s internal flooding PRA identified pre-initiator human actions that may lead to flooding events. They then reviewed plant-specific maintenance practices, procedures and experience to identify potential human errors that could result in flooding. The identified human-induced flooding scenarios were previously discussed in Section 2.4.1. Also as discussed in

Section 2.4.1, in estimating the human-induced flooding scenario frequencies, the licensee assigned screening values for the HEPs that contribute to the floods.

The licensee's internal flooding analysis identified post-initiator flood mitigation actions that may be performed to limit or prevent impacts after a flood is initiated. The plant procedures, instrumentation, and indications were reviewed to assess how operators become aware that a flooding situation has occurred. The plant features that could alert operators may include:

- Flood alarms – The presence of flood alarms will reduce the time to discover a flood and take action to islote the flood.
- Flow and pressure indicators – Many systems contain flow indicators that are monitored from the main control room. Operators may use flow indications to recognize flooding conditions. Similarly, low pressure indications may assist in flood indentificaiton.
- Radwaste control panels – These panels provide diagnostic information for locating leaks inside plant buildings.
- Radiation detectors – These may be considered in identifying flood source failures where high radiation may be involved.

As discussed previously in Section 2.3.2, flood mitigating actions were identified based on plant procedures and available flood indication inside the control room. The licensee applied a screening HEP of 1.0 to most of these actions (exceptions are described in Section 2.3.2). As previously stated, there is no credit given for flood mitigation actions in the modeled flooding scenarios.

The internal flooding analysis also considers the impact on post-flood human failure events that are unrelated to flood mitigation. These are actions that are performed to mitigate the resulting plant accident scenario and may be influenced by the flooding conditions. In the IFPRA, post-flood actions are assumed to fail if local action occurs in an area impacted by the flood. For actions that are performed in locations unaffected by the flood, the failure probabilities of those actions may be influenced by the flood occurrence. For actions that are not located in areas affected by the flooding, the stress level is expected to be the primary performance shaping factor that impacts the change in the HEP value. The time window for the action should also be considered. If the time window is sufficiently long (e.g., > 1 hour), then the increase in the stress level due to the flooding event may be insignificant. A consensus approach for scaling the HEP values for actions unaffected by the flood location was not identified for this study. Potential impacts on HEP values were considered, but ultimately there was no method implemented in the model. Future work in this area may be needed to develop a consensus approach for adjusting HEP values. For this study, the issue is addressed by considering a sensitivity case with increased HEP values. The sensitivity case is discussed in Section 4.5.3.

3. INTERNAL FLOOD PRA MODEL ANALYSIS

The purpose of this section is to describe the NRC IFPRA modeled flood scenarios. Section 3.1 identifies the important model assumptions that were made in developing the NRC IFPRA. Section 3.2 describes the internal flooding scenarios as they are modeled in the NRC IFPRA.

3.1. Internal Flood Model Assumptions

The following assumptions were made in developing the NRC IFPRA model's internal flooding scenarios. Assumptions were made in cases where information about the plant's flooding risk was unavailable or not well developed. Additional effort to develop analyses or gather more information was deemed to be unwarranted because the significance of these issues to the overall plant core damage frequency (CDF) from all hazards was considered to be low.

1. **Dual-unit or cross-unit flooding scenarios:** Based on information reviewed from the reference plant flooding analysis and confirmatory walkdowns performed by NRC staff for the NRC IFPRA, potential dual-unit or cross-unit flooding scenarios were screened from further analysis. The key fluid systems at the reference plant include dedicated systems for each unit. There is limited dependency on shared or cross-tied systems that could act as a dual-unit flood source. The potential for flood propagation between units is limited by sufficient use of compartment walls, doors (including watertight doors for significant flood sources), curbs, drains, and spatial separation. No risk-significant internal flooding propagation paths were identified that would impact accident initiation or mitigating equipment in both units. Also, no risk-significant propagation paths were identified that could initiate in one unit and impact accident initiation or mitigating equipment in the other unit. These assumptions are supported by the NRC staff's analysis of the reference plant; however, they may not be applicable to other multi-unit plant sites. Also, changes in plant conditions that could increase internal flooding risks may require revisiting these assumptions. For example, if cross-unit flood barriers are defeated or potential flood sources are aligned in off-normal alignments, then the potential for cross-unit flooding may need to be reevaluated. Nevertheless, for normal plant operating conditions at the reference plant, the NRC staff deemed the potential for dual-unit or cross-unit internal flooding to be unlikely. Note, further analysis of floods impacting both units is identified as a consideration for future work in Appendix C.
2. **Applicability of results to Unit 2:** The flooding scenarios were based on analysis of Unit 1 of the reference plant. The Unit 1 internal flooding analysis was deemed applicable to corresponding flooding areas located in Unit 2. No major differences between the two reactor units at the reference plant were identified that would impact the internal flooding analysis.
3. **Loss-of-coolant accidents (LOCAs) and main steam line breaks (MSLBs):** Loss of primary coolant accidents and main steam line breaks are addressed in the internal events analysis, and were not addressed in the internal flooding analysis. This approach appears to be consistent with the current internal events PRA state of practice. However, additional analysis could be pursued to consider multiple locations for these breaks and incorporate the local impacts in the plant response model. This would improve the realism of these scenarios, but was not pursued for this study. The internal events PRA evaluation of high-energy line breaks was deemed sufficient for this study. Note, the contribution of steam line breaks to the internal flooding analysis is identified as a potential model enhancement in Appendix C.

4. **Flood source flow rate characterization:** The flow rate from a failed flood source can vary depending on the type of failure that occurs. The Electric Power Research Institute (EPRI) pipe rupture report (IF- 9) defines three flood failure categories, with associated break flow rate ranges: spray events with ≤ 100 gpm; flood events with break sizes that produce 100 gpm to 2000 gpm; and major flood events with flow rates greater than 2000 gpm. The same categories were adopted for the NRC IFPRA.

   Each flood scenario may include multiple flood sources that could fail in a variety of ways and result in a range of break flow rates. A representative flow rate was selected for each scenario, according to the following:

   - For spray events, the representative flow rate was assumed to be 100 gpm.
   - For flood events where all failed pipes have a diameter of 2 in. or less, the representative flow rate was assumed to be 1000 gpm.
   - For flood events where at least one failed pipe has a diameter greater than 2 in., the representative flow rate was assumed to be 2000 gpm.
   - For major floods, the representative flow rate was assumed to be 100,000 gpm.[6]

   The choice of representative flow rate for the flooding scenarios does not have a significant impact on the NRC IFPRA results. Assumptions regarding equipment failures due to flooding (see assumption 5, below) make the results insensitive to the choice of representative flow rate.

5. **Equipment damage due to flooding:** For the NRC IFPRA, the structures, systems, and components (SSCs) that may contribute to accident initiation and mitigation were assumed to fail if the room was impacted by a flood, regardless of flood height.

6. **Impact of sprays:** Failures resulting in spraying or splashing are assumed to affect components located within a 10-foot radius and within line-of-sight of a pressurized-water source.[7] The spray impact assessment should include consideration of the spatial and directional effects of sprays. In some PRA studies, a spray directional factor that accounts for the spray's direction with respect to the pipe's circumference is applied when supported by a detailed engineering evaluation. For the spray scenarios modeled in the NRC IFPRA, there was not sufficient information available to support a detailed evaluation of the directional effects of sprays. Therefore, a spray directional factor was not applied in any of the modeled flood scenarios.

7. **Flood mitigation operator actions:** For all of the modeled flooding scenarios, there was no credit given for flood mitigation actions. In other words, there was no credit given for operator actions prior to scenario flood damage occurring. It was assumed that each flooding scenario is eventually terminated by automatic or operator actions after initial flooding damage and accident initiation occur. Long-term actions to terminate floods may or may not be required to place the plant in a safe and stable condition, depending on (1) the capacity of the source and (2) location of the breach and flood water accumulation areas.

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[6] 100,000 gpm is assumed for major floods that involve failures of the circulating water system. The EPRI flooding frequency report (IF- 9) reports significant circulating water failure historical events that resulted in estimated flow rates ranging from 3,000 gpm to 200,000 gpm. Based on this range, 100,000 gpm is deemed to be a reasonable estimate for major floods.

[7] EPRI's "Guidelines for Performing of Internal Flooding Probabilistic Risk Assessment" (Ref. IF-14) suggests a general guideline that spraying or splashing water should be assumed to affect electrical components located within a minimum 10-foot radius and within line-of-sight of a pressurized-water source. This guideline is considered to be consistent with current internal flooding PRA state of practice.

Long-term actions to terminate floods were not modeled. It was assumed that any additional damage from long-term flooding was bounded by the initial flood damage and accident initiation that was captured in the modeled scenarios.

3.2. Internal Flood Modeled Scenarios

The purpose of this section is to describe the internal flooding scenarios that were modeled in the NRC IFPRA model. Each flooding scenario description consists of:

- Flooding initiating event – the pipe break or component failure that initiates the flooding
- Flood location – flood area(s) impacted by the flood
- Flood type – spray, local flooding, or flood propagation
- Representative flow rate – flood sources can produce a range of possible flow rates. A representative flow rate was selected using guidlines consistent with those provided in the first revision of EPRI's flooding frequency report (Ref. IF- 8).
- Corresponding internal initiating event – each flooding scenario results in impacts to the plant that map to an internal initiating event that is modeled in the internal events PRA. For example, a flooding event from a feedwater pipe break that results in isolation of main feedwater (MFW) maps to the internal event "loss of MFW."
- Flood impact – the impacts on the plant due to flooding (i.e., the SSCs included in the PRA model that are assumed to be failed due to the flood)
- Plant response – the plant systems and functions that are needed to prevent core damage given the SSC failures associated with the flood

The NRC IFPRA model includes 23 internal flood scenarios. The flooding scenarios were primarily based on the reference plant's internal flooding analysis; however, some modifications were made to support the NRC IFPRA. The motivations for modifying the scenarios are described below.

Update to Initiating Event Frequency Estimates: For the NRC IFPRA, the staff used generic data from the EPRI technical report, "Pipe Rupture Frequencies for Internal Flooding PRAs, Revision 3," (IF- 9IF- 8). The revised initiating event frequencies have generally increased (by factors ranging from approximately 2 to 4) with respect to the values published in previous versions of EPRI's report.

Subsuming Related Scenarios: For the NRC IFPRA, related flood scenarios that have the same or similar plant impacts were subsumed into a single flood scenario. For example, a spray scenario and a local flooding scenario that both affect the same equipment in the same room were treated as a single scenario, and the initiating event frequency includes both spray and local flooding contributions. These related scenarios were subsumed to provide more inclusive coverage of the flooding risk, rather than modeling only the highest contributing scenario from a group of related scenarios.

The internal flooding scenarios are described below. Each scenario description includes information on the flood location, type of scenario, and impacts on the plant. The scenario descriptions also identify the corresponding event tree from the internal events PRA that was used to model the flooding scenaro.

3.2.1. Internal Flood Scenario: 1-FLI-AB_108_SP1

Flooding Initiating Event

Feedwater (FW) or auxiliary component cooling water (ACCW) pipe failure results in a spray that impacts steam generator relief and isolation valves.

Location:	Auxiliary building – south main steam valve room
Flood type:	Spray
Representative flow rate:	100 gpm
Corresponding internal event:	Secondary-side break upstream of MSIVs / downstream of MFIVs (SSBI)

Flood Impact

The scenario impact involves the spurious operation of steam generator 1 (SG1) MSIVs, MS isolation bypass valves, and atmospheric relief valve (ARV). Assuming the SG1 ARV fails open and operators cannot quickly close it, a plant trip would occur. The modeled impact on the SG1 ARV may be pessimistic, since the spray directional factor and the likelihood of equipment damage given it is sprayed were not factored into the spray scenario frequency. Spray has no impact on code safety valves. The room is not susceptible to local flooding. Flood water would accumulate at a lower level of this room, and not propagate to other flood areas.

Spray from FW or ACCW pipe failures can only impact either the SG1 or SG4 valves due to a wall partition. It is assumed that half of the time the source pipe rupture will impact the SG1 valves (i.e., initiating event frequency for this scenario = 0.5 x total pipe rupture frequency). Stated differently, half of the source pipe length was assumed to impact SG1 and is modeled in this scenario. The other half of the source pipe length was assumed to impact SG4 and is modeled in scenario 1-FLI-AB_108_SP2, described in 3.2.2.

Plant Response

Auxiliary feedwater (AFW) is the primary means of heat removal for this scenario. After a secondary-side break, the MSIVs will close on low steam line pressure. This eliminates the use of steam dump valves as a means of removing decay heat. Therefore, heat removal needs to be accomplished using the ARV or 1 of 5 code safety valves for at least one SG. Although the ARV for SG1 is assumed to fail open to initiate the event, heat removal by this ARV may not be available. Due to the flood impacts, the ARV is susceptible to spurious operation and could re-close. The worst-case assumption is applied to this scenario, and therefore, heat removal by the ARV for SG1 is assumed unavailable. The operator action to open the SG1 ARV locally with a hydraulic pump will be directly impacted by a flooding event in this location and cannot be credited. Successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided (1) successful isolation of the faulted SG, (2) no reactor coolant pump (RCP) seal LOCA occurs, and (3) a power-operated relief valve (PORV) did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

Main steam lines are located in this room, but they do not contribute to the spray event modeled in this scenario. The impact of main steam line failures were modeled as separate initiating events in the internal events model.

3.2.2. Internal Flood Scenario: 1-FLI-AB_108_SP2

Flooding Initiating Event FW or ACCW system pipe failure results in a spray that impacts SG relief and isolation valves.

Location:	Auxiliary building – south main steam valve room
Flood type:	Spray
Representative flow rate:	100 gpm
Corresponding internal event:	Secondary-side break upstream of MSIVs / downstream of MFIVs (SSBI)

Flood Impact

The scenario impact involves the spurious operation of SG4 MSIVs, MS isolation bypass valves, and ARV. Assuming the SG4 ARV fails open and operators cannot quickly close it, a plant trip would occur. The modeled impact on the SG4 ARV may be pessimistic, since the spray directional factor and the likelihood of equipment damage given it is sprayed were not factored into the spray scenario frequency. Spray has no impact on code safety valves. The room is not susceptible to local flooding. Flood water would accumulate at a lower level of this room, and not propagate to other flood areas.

Spray from FW or ACCW pipe failures can only impact either the SG1 or SG4 valves due to a wall partition. It is assumed that half of the time the source pipe rupture will impact the SG4 valves (i.e., initiating event frequency for this scenario = 0.5 x total pipe rupture frequency). Stated differently, half of the source pipe length was assumed to impact SG4 and is modeled in this scenario. The other half of the source pipe length was assumed to impact SG1 and is modeled in scenario 1-FLI-AB_108_SP1, described in 3.2.1.

Plant Response

AFW is the primary means of heat removal for this scenario. After a secondary-side break, the MSIVs will close on low steam line pressure. This eliminates the use of steam dump valves as a means of removing decay heat. Therefore, heat removal needs to be accomplished using the ARV or 1 of 5 code safety valves for at least one SG. Although the ARV for SG4 is assumed to fail open to initiate the event, heat removal by this ARV may not be available. Due to the flood impacts, the ARV is susceptible to spurious operation and could re-close. The worst-case assumption is applied to this scenario, and therefore, heat removal by the ARV for SG4 is assumed unavailable. The operator action to open the SG4 ARV locally with a hydraulic pump will be directly impacted by a flooding event in this location and cannot be credited. Successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided (1) successful isolation of the faulted SG, (2) no RCP seal LOCA occurs, and (3) a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

Main steam lines are located in this room, but they do not contribute to the spray event modeled in this scenario. The impact of main steam line failures are modeled as separate initiating events in the internal events model.

3.2.3. Internal Flood Scenario: 1-FLI-AB_A20

Flooding Initiating Event Condensate pipe failure in room A06 results in flood propagation to room A20, or feedwater pipe failure results in spray impacting equipment in room A20. For the flood sources in room A20, this scenario only considers spray due to small leaks in feedwater piping. Large leaks that could cause local flooding are modeled in scenario 1-FLI-AB_A20_FP. Pipe failure frequencies for flooding sources in both rooms A06 and A20 were included in this scenario. Flood water propagates from room A06 to room A20 via piping penetrations at various heights from the floor. The propagation of flood water from room A06 to room A20 was assumed to be unmitigated.

Location:	Auxiliary building, rooms A06 and A20
Flood type:	Spray from sources in room A20 and propagation from sources in A06 to A20 (Local flooding from room A20 sources is modeled in scenario 1-FLI-AB_A20_FP, which impacts room A20 and also propagates to rooms A11 and A12.)
Representative flow rate:	2000 gpm
Corresponding internal event:	Loss of MFW (LOMFW)

Flood Impact

The impacted components in room A20 include the FW control/regulator valves and the FW control/regulator bypass valves for feed lines to SG 1 and SG 4. The FW bypass valves are assumed to fail to full open, resulting in a loss of MFW transient.

Plant Response

Successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided there is no RCP seal LOCA and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation can also provide successful decay heat removal if secondary-side cooling is unavailable.

3.2.4. Internal Flood Scenario: 1-FLI-AB_C113_LF1

Flooding Initiating Event The scenario involves failure of the nuclear service cooling water (NSCW) piping located in the boric acid batching tank room. This scenario only considers NSCW pipe failures as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Auxiliary building – boric acid batching tank room
Flood type:	Local flooding

Representative flow rate:	1000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The failure of the flood source results in unavailability of NSCW train A. Local flooding impacts the refueling water storage tank (RWST) to a charging pump suction isolation valve that fails to open. The NSCW failure would not result in an immediate plant trip. The NSCW failure could lead to a subsequent plant shutdown if required action and associated completion time were not met under a limiting condition for operation (LCO). For the purposes of modeling the scenario, a plant trip with loss of NSCW train A was assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.5. Internal Flood Scenario: 1-FLI-CB_122_SP

Flooding Initiating Event FW pipe failure results in a spray that impacts SG relief and isolation valves.

Location:	Control Building – north main steam valve room
Flood type:	Spray
Representative flow rate:	100 gpm
Corresponding internal event:	Secondary-side break upstream of MSIVs / downstream of MFIVs (SSBI)

Flood Impact

The scenario impact involves the spurious operation of SG3 MSIVs, MS isolation bypass valves, and ARV. Assuming the SG3 ARV fails open and operators cannot quickly close it, a plant trip would occur. The modeled impact on the SG3 ARV may be pessimistic, since the spray directional factor and the likelihood of equipment damage given it is sprayed were not factored into the spray scenario frequency. Spray has no impact on code safety valves. The room is not susceptible to local flooding. Flood water would accumulate at a lower level of this room, and not propagate to other flood areas.

Plant Response

AFW is the primary means of heat removal for this scenario. After a secondary-side break, the MSIVs will close on low steam line pressure. This eliminates the use of steam dump valves as a means of removing decay heat. Therefore, heat removal needs to be accomplished using the

ARV or 1 of 5 code safety valves for at least one SG. Although the ARV for SG3 is assumed to fail open to initiate the event, heat removal by this ARV may not be available. Due to the flood impacts, the ARV is susceptible to spurious operation and could re-close. The worst-case assumption is applied to this scenario, and therefore, heat removal by the ARV for SG3 is assumed unavailable. The operator action to open the SG3 ARV locally with a hydraulic pump will be directly impacted by a flooding event in this location and cannot be credited. Successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided (1) successful isolation of the faulted SG, (2) no RCP seal LOCA occurs, and (3) a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

Main steam lines are located in this room, but they do not contribute to the spray event modeled in this scenario. The impact of main steam line failures were modeled as separate initiating events in the internal events model.

3.2.6. Internal Flood Scenario: 1-FLI-CB_123_SP

Flooding Initiating Event FW pipe failure results in a spray that impacts SG relief and isolation valves.

Location:	Control Building – north main steam valve room
Flood type:	Spray
Representative flow rate:	100 gpm
Corresponding internal event:	Secondary-side break upstream of MSIVs / downstream of MFIVs (SSBI)

Flood Impact

The scenario impact involves the spurious operation of SG2 MSIVs, MS isolation bypass valves, and ARV. Assuming the SG2 ARV fails open and operators cannot quickly close it, a plant trip would occur. The modeled impact on the SG2 ARV may be pessimistic, since the spray directional factor and the likelihood of equipment damage given it is sprayed were not factored into the spray scenario frequency. Spray has no impact on code safety valves. The room is not susceptible to local flooding. Flood water would accumulate at a lower level of this room, and not propagate to other flood areas.

Plant Response

AFW is the primary means of heat removal for this scenario. After a secondary-side break, the MSIVs will close on low steam line pressure. This eliminates the use of steam dump valves as a means of removing decay heat. Therefore, heat removal needs to be accomplished using the ARV or 1 of 5 code safety valves for at least one SG. Although the ARV for SG4 is assumed to fail open to initiate the event, heat removal by this ARV may not be available. Due to the flood impacts, the ARV is susceptible to spurious operation and could re-close. The worst-case assumption is applied to this scenario, and therefore, heat removal by the ARV for SG2 is assumed unavailable. The operator action to open the SG2 ARV locally with a hydraulic pump will be directly impacted by a flooding event in this location and cannot be credited. Successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided (1) successful isolation of the faulted SG, (2) no RCP seal LOCA occurs, and (3) a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

Main steam lines are located in this room, but they do not contribute to the spray event modeled in this scenario. The impact of main steam line failures were modeled as separate initiating events in the internal events model.

3.2.7. Internal Flood Scenario: 1-FLI-CB_A48

Flooding Initiating Event The train A 4.16 KV AC switchgear room does not contain flood sources. However, flood water may propagate to the train A 4.16 KV AC switchgear room by flowing through the gap under the normally closed double doors from an adjacent hallway. The likelihood of propagation to the switchgear room depends on break size, location, and effectiveness of the flood mitigation features (e.g., floor drains). For the purposes of the NRC's IFPRA model, an NRC staff walkdown of the reference plant in ths location supported the assumption that flood propagation to the 4.16 KV AC switchgear room was unlikely; therefore, a flood propagation factor of 0.1 was assumed.

Location:	Control building, room A48 – train A 4.16 KV AC swithgear room and room A58 – train A corridor
Flood type:	Flood propagation
Representative flow rate:	1000 gpm
Corresponding internal event:	Loss of safety-related (Class 1E) 4160V bus train A (LO4160VA)

Flood Impact

The switchgear cabinets located in the room were assumed to be impacted by flood water that propagates to the room. The failed switchgear results in a loss of power to Class 1E 4160 VAC bus train A. Power to the bus is assumed to be non-recoverable. The loss of Class 1E 4160 VAC bus A will cause loss of power to multiple 480 VAC switchgears and battery chargers for dc buses. After four hours, power to the affected Class 1E 125 vdc buses will be lost as the batteries deplete. This will cause a reactor trip and will affect the actuation and control of train A engineered safety features.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path. The redundancy of equipment available for the plant response is significantly impacted by the loss of power to the Class 1E 4160 VAC bus train A. The train A AFW motor-driven pump and centrifugal charging pump are unavailable, as well as many other train A engineered safety feature electrical loads.

3.2.8. Internal Flood Scenario: 1-FLI-CB_A60

Flooding Initiating Event The scenario considers impacts from flood sources located in adjacent rooms A60 and A59. The flood sources include fire protection and utility water pipes that can lead to local flooding and flood propagation.

Location:	Control building, room A60 – HVAC room and room A59 – corridor
Flood type:	Local flooding in room A60 and propagation from A59 to A60
Representative flow rate:	1000 gpm
Corresponding internal event:	Secondary-side break upstream of MSIVs / downstream of MFIVs (SSBI)

Flood Impact

The flood sources impact the ARV signal converter for either SG2 or SG3, both located in room A60. The flood sources located in room A60 contribute to local flooding and spray impacts on one of the ARV signal converters. No spray directional factor is applied. The flood scenario also includes a contribution from flood sources in room A59 that can propagate to room A60 by flowing through the gap under the normally closed double doors. Room A59 contains no accident initiation or mitigating equipment. The modeled scenario subsumes different flood types (e.g., spray, propagation) and simplified assumptions were made about the impacts on equipment. A detailed analysis including flood water height, spray directional effects, and flood water impact on signal converters was not performed. Rather, a pessimistic assumption was made that any flood impacting room A60 will result in a single stuck open ARV and an effective secondary-side line break (assumed to be associated with SG2). If operators cannot quickly close the SG2 ARV, this would lead to a plant trip.

Plant Response

AFW is the primary means of heat removal for this scenario. After a secondary-side break, the MSIVs will close on low steam line pressure. This eliminates the use of steam dump valves as a means for removing decay heat. Therefore, heat removal needs to be accomplished using an ARV or 1 of 5 code safety valves for at least one SG. Although the ARV for SG2 is assumed to fail open to initiate the event, heat removal by this ARV may not be available. Due to the flood impacts, the ARV is susceptible to spurious operation and could re-close. The worst-case assumption is applied to this scenario, and therefore, heat removal by the ARV for SG2 is assumed unavailable. Successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided (1) successful isolation of the faulted SG, (2) no RCP seal LOCA occurs, and (3) a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

3.2.9. Internal Flood Scenario: 1-FLI-TB_500_HI1

Flooding Initiating Event Human failures associated with the circulating water system and condenser water box manways can lead to human-induced local flooding. This scenario considers circulating water system maintenance work leading to a flooding event. Maintenance work requiring the opening of the condenser water box for tube cleaning/plugging was estimated to occur during plant operation at a frequency of 9.4×10^{-2} per reactor-critical-year. Human errors that result in failure to properly secure the manway cover(s) after completion of the work would lead to spilling of water out of the condenser water box and impacting equipment on level A of the turbine building. Screening values were assumed for human error probabilities. These were deemed to be conservative estimates of the likelihood of operator failure. The frequency of the flood scenario is expected to be lower than the estimate provided here if more realistic HEP values are used.[8]

A screening value of 0.01 was assigned for the probability of the crew failing to properly secure the manway cover(s). The flood scenario can be mitigated by the control room operators tripping the circulating water pumps, if they are notified before significant flooding occurs. A screening value of 0.1 was assigned for operator failure to mitigate the flooding event. The frequency of this human-induced flood scenario was estimated by assuming the occurrence of all three of the following events:

- condenser water box maintenance during plant operation
- maintenance crew failure to properly secure the manway cover(s)
- operator failure to mitigate the flood scenario

The frequency of this human-induced flooding scenario was estimated to be:

$$9.4\times10^{-2} \text{ per reactor-critical-year} \times 0.01 \times 0.1 = 9.4\times10^{-5} \text{ per reactor-critical-year}$$

Location:	Turbine building, level A fire zone 500
Flood type:	Human-induced local flooding
Representative flow rate:	100,000 gpm
Corresponding internal event:	Loss of condenser heat sink (LOCHS)

[8] A sensitivity analysis documented in Section 4.5.2 shows that the overall internal flooding CDF is relatively insensitive to the HEP values chosen.

Flood Impact

The loss of circulating water through the condenser manway(s) would cause a plant trip due to loss of condenser vacuum. With the condenser unavailable, the steam dump system cannot dump steam to the condenser. The MFW pump will trip on low condenser vacuum, which causes a total loss of MFW flow. Although feedwater could be used after resetting feedwater isolation, the MFW and condensate systems were assumed to be unavailable. The large flow volume from the circulating water system through the condenser manway(s) would also cause significant flooding in the turbine building. All the equipment on level A of the turbine building would be impacted.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators. Secondary-side pressure control and heat removal are accomplished using the ARVs. The main condenser is unavailable due to the initiating event. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

3.2.10. Internal Flood Scenario: 1-FLI-TB_500_LF

Flooding Initiating Event The scenario considers flood sources that contribute to local flooding of level A of the turbine building. The largest contribution to local flooding in the turbine building is due to failure of circulating water piping or expansion joints. Other flood sources include fire protection, heater drain, demineralized water, and TPCCW system piping.

Location:	Turbine building, level A fire zone 500
Flood type:	Local flooding
Representative flow rate:	100,000 gpm
Corresponding internal event:	Loss of condenser heat sink (LOCHS)

Flood Impact

The loss of circulating water would cause a plant trip due to loss of condenser vacuum. With the condenser unavailable, the steam dump system cannot dump steam to the condenser. The MFW pump will trip on low condenser vacuum, which causes a total loss of MFW flow. Although feedwater could be used after resetting feedwater isolation, the MFW and condensate systems were assumed to be unavailable. The large flow volume from the circulating water system would impact all the equipment on level A of the turbine building.

Failures of other flood sources would be limited in their impacts. For example, failures of the TPCCW system would be expected to only impact the equipment of that system. However, this scenario conservatively assumes the bounding conditions of a circulating water piping failure for all modeled flood sources. The condensate system piping is another potential flood source located in the turbine building, but this source was not included in this scenario. The condensate system flooding impact was modeled separately in scenario 1-FLI-TB_500_LF-CDS.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators. Secondary-side pressure control and

heat removal are accomplished using the ARVs. The main condenser is unavailable due to the initiating event. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

3.2.11. Internal Flood Scenario: 1-FLI-AB_B08_LF

Flooding Initiating Event The scenario involves failure of the NSCW piping located in room B08. This scenario only considers NSCW pipe failure as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Auxiliary building, room B08 – pipe penetration room
Flood type:	Local flooding
Representative flow rate:	2000 gpm
Corresponding internal event:	Reactor trip (RTRIP)

Flood Impact

The failure of the flood source results in unavailability of NSCW train A. Local flooding impacts a safety-related containment pressure transmitter. Failure of the containment pressure transmitter is assumed to result in a reactor protection system (RPS) actuation and reactor trip. A basic event representing containment pressure transmitter failure was not modeled, but the impact of the pressure transmitter failure was modeled by assuming a reactor trip occurs.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.12. Internal Flood Scenario: 1-FLI-AB_B24_LF2

Flooding Initiating Event The scenario involves failure of the NSCW piping located in room B24. The failure of the flood source results in unavailability of NSCW train A. This scenario only considers NSCW pipe failure as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Auxiliary building, room B24 – ACCW pump room
Flood type:	Local flooding

Representative flow rate:	1000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

Local flooding impacts ACCW pump 1 and fails the pump's discharge pressure interlock. The NSCW failure would not result in an immediate plant trip. The NSCW failure could lead to a subsequent plant shutdown if required action and associated completion time are not met under LCO conditions. For the purposes of modeling the scenario, a plant trip with loss of NSCW train A was assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.13. Internal Flood Scenario: 1-FLI-AB_B50_JI

Flooding Initiating Event Chemical and volume control system (CVCS) pipe failure results in spray and jet impingement on a nearby cable tray in pipe chase room B50. No propagation scenarios were identified for this flood area.

Location:	Auxiliary building, room B50 – pipe chase train B
Flood type:	Jet impingement
Representative flow rate:	100 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The failure of the cable tray results in loss of instrumentation and control for several pieces of equipment, including ACCW pump 1, all three CCW train B pumps, and all three NSCW train B pumps. The equipment controlled via the cable tray were assumed failed for this scenario. The failed equipment would ultimately result in a reactor trip or a plant shutdown under LCO conditions.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open.

Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.14. Internal Flood Scenario: 1-FLI-AB_C115_LF

Flooding Initiating Event The scenario involves failure of the NSCW piping located in the train A centrifugal charging pump room. This scenario only considers NSCW pipe failure as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Auxiliary building – CVCS centrifugal charging pump room train A
Flood type:	Local flooding
Representative flow rate:	2000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The failure of the flood source results in the unavailability of NSCW train A. Local flooding impacts the train A centrifugal charging pump. The NSCW failure would not result in an immediate plant trip. The NSCW failure could lead to a subsequent plant shutdown if required action and associated completion time were not met under LCO conditions. For the purposes of modeling the scenario, a plant trip with loss of NSCW train A was assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.15. Internal Flood Scenario: 1-FLI-AB_C118_LF

Flooding Initiating Event The scenario involves failure of the NSCW piping located in the train B centrifugal charging pump room. This scenario only considers NSCW pipe failure as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Auxiliary building – CVCS centrifugal charging pump room train B
Flood type:	Local flooding
Representative flow rate:	1000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The failure of the NSCW piping results in the unavailability of NSCW train B. The local flooding impacts the train B centrifugal charging pump. The NSCW failure would not result in an immediate plant trip. The NSCW failure could lead to a subsequent plant shutdown if required action and associated completion time were not met under LCO conditions. For the purposes of modeling the scenario, a plant trip with loss of NSCW train B was assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.16. Internal Flood Scenario: 1-FLI-AB_C120_LF

Flooding Initiating Event The scenario involves failure of the NSCW piping located in the vestibule area outside of the charging pump rooms. This scenario only considers NSCW pipe failure as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Auxiliary building – vestibule area charging pump rooms
Flood type:	Local flooding
Representative flow rate:	1000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The failure of the NSCW piping results in the unavailability of NSCW train A. The local flooding would impact the RWST to charging pump suction isolation valve, which is assumed to fail to open if demanded. The NSCW failure would not result in an immediate plant trip. The NSCW

failure could lead to a subsequent plant shutdown if required action and associated completion time were not met under LCO conditions. For the purposes of modeling the scenario, a plant trip with loss of NSCW train A was assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.17. Internal Flood Scenario: 1-FLI-AB_D74_FP

Flooding Initiating Event Fire protection pipe failure in room D74 results in flooding that propagates to safety-related 480 VAC switchgear room D105. There is no significant equipment located in room D74; however, the propagation of flood waters to room D105 results in failure of a class 1E 480 VAC switchgear and a 4160/480 VAC transformer.

Location:	Auxiliary building – spray additive tank room
Flood type:	Flood propagation
Representative flow rate:	1000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

Flood propagation results in failure of a class 1E 480 VAC switchgear and a 4160/480 VAC transformer. Failure of the switchgear is assumed to cause a plant trip. The loss of power to the 480 VAC bus results in unavailability of NSCW train A.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.18. Internal Flood Scenario: 1-FLI-DGB_101_LF

Flooding Initiating Event The scenario involves failure of the NSCW piping located in the emergency diesel generator (EDG) train B room. This scenario only considers NSCW pipe failure as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Diesel generator building – diesel generator train B room
Flood type:	Local flooding
Representative flow rate:	2000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The failure of the NSCW piping results in the unavailability of NSCW train B. The local flooding impacts the train B EDG and a safety-related 480 VAC motor control center. The NSCW failure would not result in an immediate plant trip. The NSCW failure could lead to a subsequent plant shutdown if required action and associated completion time are not met under LCO conditions. For the purposes of modeling the scenario, a plant trip with loss of NSCW train B was assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.19. Internal Flood Scenario: 1-FLI-DGB_103_LF

Flooding Initiating Event The scenario involves failure of the NSCW piping located in the EDG train A room. This scenario only considers NSCW pipe failure as a flood source. Other potential flood sources are located in the room. The other flooding sources were determined to not be significant contributors to overall internal flooding risk and were not modeled in the NRC IFPRA. No propagation scenarios were identified for this flood area.

Location:	Diesel generator building – diesel generator train A room
Flood type:	Local flooding
Representative flow rate:	2000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The failure of the NSCW piping results in the unavailability of NSCW train A. The local flooding impacts the train A EDG and a safety-related 480 VAC motor control center. The NSCW failure would not result in an immediate plant trip. The NSCW failure could lead to a subsequent plant

shutdown if required action and associated completion time are not met under LCO conditions. For the purposes of modeling the scenario, a plant trip with loss of NSCW train A is assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path, but one centrifugal charging pump is unavailable due to the dependency on the failed NSCW train.

3.2.20. Internal Flood Scenario: 1-FLI-AB_A20_FP

Flooding Initiating Event Feedwater pipe failure results in local flooding in room A20 and flood propagation to rooms A11 and A12. Pipe failure frequencies for flooding sources in room A20 are included in this scenario. No flood sources are identified in rooms A11 and A12. The impacts on rooms A11 and A12 are only due to the propagation of flood water from room A20. The propagation is assumed to be unmitigated.

Location:	Auxiliary building, rooms A11 and A12 with propagation from A20
Flood type:	Local flooding in room A20 and propagation to rooms A11 and A12.
Representative flow rate:	2000 gpm
Corresponding internal event:	Loss of MFW (LOMFW)

Flood Impact

The impacted components in room A20 include the FW control/regulator valves and the FW control/regulator bypass valves for feed lines to SG1 and SG4. The valves are assumed to fail to open resulting in a loss of MFW transient. The impacted components in room A11 include the SG1 FW isolation valve and turbine-driven AFW pump (TDAFWP) discharge valves. The impacted components in room A12 include the SG4 FW isolation valve, ACCW supply/return isolation valves, and AFW motor-driven pump (MDP) train A discharge valves to SG1 and SG4. The AFW pump discharge valves were assumed to fail in their normally open state. The ACCW valves were assumed to fail closed.

Plant Response

In response to the loss of MFW transient, successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided there is no RCP seal LOCA and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation can also provide successful decay heat removal, if secondary-side cooling is unavailable.

3.2.21. Internal Flood Scenario: 1-FLI-AB_D78_FP

Flooding Initiating Event The scenario involves failure of the residual heat removal (RHR) system piping and piping from the RWST located in rooms D78 and D79. The flooding

propagates to Class 1E 480 VAC switchgear room D105 via a non-water-tight door and piping penetrations.

Location:	Auxiliary building, train A piping rooms D78 and D79 with propagation to 480 VAC switchgear room D105
Flood type:	Flood propagation
Representative flow rate:	2000 gpm
Corresponding internal event:	Other transient resulting in reactor trip (TRANS)

Flood Impact

The flood results in the failure of the 480 VAC switchgear and 4.16 KV AC / 480 VAC transformer located in room D105. The loss of power to the 480 VAC bus results in unavailability of NSCW train A. The RWST is also assumed to be unavailable due to the pipe failure. The switchgear failure and RWST unavailability would not result in an immediate plant trip. The failures could lead to a subsequent plant shutdown if required action and associated completion time are not met under LCO conditions. For the purposes of modeling the scenario, a plant trip with loss of the impacted equipment was assumed.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling is not available due to the flood impacting the ability to align suction to the RWST.

3.2.22. Internal Flood Scenario: 1-FLI-TB_500_LF-CDS

Flooding Initiating Event The scenario considers only the condensate system flood sources that contribute to local flooding of level A of the turbine building. Other flood sources in the area are modeled in scenario 1-FLI-TB_500_LF.

Location:	Turbine building, level A fire zone 500
Flood type:	Local flooding
Representative flow rate:	2000 gpm
Corresponding internal event:	Loss of MFW (LOMFW)

Flood Impact

The failure of condensate system piping results in a loss of MFW and a plant trip. The flood fails the condensate pumps. The MFW system is assumed unavailable through the duration of the event due to the failed condensate pumps. The condensate system flood sources are expected to have less severe impacts compared to other large capacity, high flow rate sources in the area

(e.g., circulating water). Therefore the condensate system flood sources are modeled separately in this scenario.

Plant Response

In response to the loss of MFW transient, successful operation of secondary-side cooling (AFW) can place the reactor in a stable condition provided there is no RCP seal LOCA and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation can also provide successful decay heat removal, if secondary-side cooling is unavailable.

3.2.23. Internal Flood Scenario: 1-FLI-TB_500_HI2

Flooding Initiating Event Human failures in restoring the turbine plant closed cooling water (TPCCW) heat exchangers after maintenance can lead to human-induced local flooding. This scenario considers failure of the maintenance crew to properly close up the heat exchanger (on the turbine plant cooling water [TPCW] system side) after maintenance work.

Maintenance work requiring the opening of a TPCCW heat exchanger was estimated to occur during plant operation at a frequency of 9.4×10^{-2} per reactor-critical-year. Human errors that result in failure to properly close the heat exchanger would lead to TPCW water spilling out of the heat exchanger and impacting TPCCW equipment on level A of the turbine building. The types of human errors that can lead to flooding include:

- failure to isolate the tube-side (TPCW) drain valve after maintenance
- failure to install the gasket for the “end bell” of the heat exchanger
- failure to properly bolt or torque the “end bell” of the heat exchanger

Screening values were assumed for human error probabilities. These were deemed to be conservative estimates of the likelihood of operator failure. The frequency of the flood scenario is expected to be lower than the estimate provided here if more realistic HEP values are used.[9] The screening value for the probability of the crew failing to properly close the drain valve or install the heat exchanger end bell was 0.01. The flood scenario can be mitigated if the crew re-closes the TPCW inlet isolation valve near the heat exchanger when they detect water flowing out of the system. The screening value for operator failure to mitigate the flooding event was 0.1. The frequency of the human induced flood scenario is estimated by assuming the occurrence of all three of the following events:

- TPCCW heat exchanger maintenance during plant operation
- maintenance crew failure to properly secure the heat exchanger
- maintenance crew failure to mitigate the flood scenario

The frequency of the human-induced flooding scenario was estimated as:

$$9.4\times10^{-2} \text{ per reactor-critical-year} \times 0.01 \times 0.1 = 9.4\times10^{-5} \text{ per reactor-critical-year}$$

Location:	Turbine building, level A fire zone 500
Flood type:	Human-induced local flooding
Representative flow rate:	2000 gpm

[9] A sensitivity analysis documented in Section 4.5.2 shows that the overall internal flooding CDF is relatively insensitive to the HEP values chosen.

Corresponding internal event: Turbine trip (TTRIP)

Flood Impact

The impact of the flooding scenario associated with the TPCCW heat exchanger was conservatively assumed to be the loss of the TPCW leading to a turbine trip.

Plant Response

After the plant trip, the primary means of heat removal is secondary-side cooling with steam generators. AFW is used for feeding steam generators and MFW is available, if needed. Secondary-side pressure control and heat removal are accomplished using the ARVs or steam dumps to the main condenser. Successful operation of secondary-side cooling can place the reactor in a stable condition provided no RCP seal LOCA occurs and a PORV did not open. Feed-and-bleed cooling with high-pressure recirculation is also a viable success path.

4. INTERNAL FLOOD MODEL RESULTS

The objective of this section is to describe the results of NRC's Level 1, at-power, internal flooding PRA (IFPRA) model for a single unit. The NRC's IFPRA consists of 23 internal flooding scenarios that were integrated into the NRC's Level 1 PRA for at-power internal events. The combined model was developed and is maintained using the NRC's SAPHIRE software (IF- 5). The results of the internal flooding scenarios are presented here for the Unit 1 model. The Unit 1 internal flooding results were deemed applicable to corresponding flooding areas located in Unit 2, based on the symmetry between the two units. No major differences between the two reactor units were identified that would impact the internal flooding analysis.

The internal flooding scenarios include the flooding initiating event (i.e., the pipe break or component failure that initiates the flooding), the impacts on the plant due to flooding, and the plant response to the event. Each internal flooding scenario was represented by a unique event tree in the NRC IFPRA model. Each scenario can comprise several flooding accident sequences, which involve different combinations of operator errors and/or mitigating system failures resulting in core damage. Each accident sequence represents a unique event tree branch in the NRC IFPRA model. The following sections provide the NRC IFPRA results. 4.1 presents the CDF results obtained for each of the modeled internal flooding scenarios. 4.2 provides results for the significant internal flooding accident sequences. 4.3 presents the significant internal flooding cut set results. 4.4 shows the results of parameter uncertainty analysis for the IFPRA CDF results. Section 4.5 discusses sources of model uncertainty and sensitivity cases to demonstrate the potential effects of uncertainties on the model results. Section 4.6 compares the results to the results from a similar plant. Section 4.7 presents a summary of key insights.

4.1. Internal Flooding Scenario and Overall CDF Results

The internal flooding scenarios were quantified to estimate CDF. The truncation level for quantification was set to 10^{-12}. The internal flooding scenarios were also quantified at truncations of 10^{-11} and 10^{-13} to check for convergence of the CDF results. The change in CDF was less than 5 percent for each decade of truncation value. The minimal cut set upper bound method was used for quantifying the cut set results. The total estimated CDF result for internal flooding scenarios was calculated to be 7.9×10^{-7} per reactor-critical-year, which is less than 1 percent of the total single unit CDF for all hazards. The model was developed and quantified using the NRC's SAPHIRE software (IF- 5). The SAPHIRE version number used for the quantification is 8.1.5. The model revision number used for the quantification is SVN285. The results by internal flooding initiating event scenario are shown in Table 4.1.

Table 4.1 Internal Flooding Results by Scenario

	Scenario Name	IE frequency per reactor-critical-year	CCDP*	CDF per reactor-critical-year	% of CDF	Cut Set Count
1	1-FLI-AB_C113_LF1	2.2E-04	6.9E-04	1.6E-07	19.6	348
2	1-FLI-AB_C120_LF	1.8E-04	7.2E-04	1.3E-07	16.5	347
3	1-FLI-CB_123_SP	2.8E-04	3.7E-04	1.0E-07	12.9	1393
4	1-FLI-CB_122_SP	2.8E-04	3.7E-04	1.0E-07	12.9	1389
5	1-FLI-AB_C115_LF	1.3E-04	6.9E-04	9.2E-08	11.7	300
6	1-FLI-AB_108_SP1	2.8E-04	2.1E-04	5.9E-08	7.5	1135
7	1-FLI-AB_108_SP2	2.8E-04	2.1E-04	5.9E-08	7.5	1127
8	1-FLI-CB_A60	5.2E-05	3.6E-04	1.9E-08	2.4	493
9	1-FLI-TB_500_LF	2.2E-03	7.6E-06	1.6E-08	2.1	701
10	1-FLI-CB_A48	9.2E-05	1.5E-04	1.4E-08	1.8	332
11	1-FLI-DGB_101_LF	7.3E-06	8.5E-04	6.2E-09	0.8	70
12	1-FLI-AB_D74_FP	8.6E-06	6.9E-04	5.9E-09	0.8	89
13	1-FLI-AB_C118_LF	7.5E-06	7.3E-04	5.5E-09	0.7	75
14	1-FLI-AB_B08_LF	7.7E-06	6.9E-04	5.3E-09	0.7	72
15	1-FLI-DGB_103_LF	7.3E-06	7.0E-04	5.1E-09	0.7	79
16	1-FLI-TB_500_LF-CDS	6.3E-04	7.2E-06	4.5E-09	0.6	303
17	1-FLI-AB_B24_LF2	3.5E-06	7.1E-04	2.5E-09	0.3	74
18	1-FLI-AB_B50_JI	3.4E-06	7.3E-04	2.4E-09	0.3	56
19	1-FLI-AB_A20	2.7E-04	6.8E-06	1.8E-09	0.2	153
20	1-FLI-TB_500_HI2	9.4E-05	7.2E-06	6.7E-10	0.1	59
21	1-FLI-TB_500_HI1	9.4E-05	6.1E-06	5.7E-10	0.1	58
22	1-FLI-AB_D78_FP	3.6E-07	6.7E-04	2.4E-10	0.0	24
23	1-FLI-AB_A20_FP	2.3E-05	8.5E-06	1.9E-10	0.0	51
	Total:	**5.1E-03**		**7.9E-07**		**8728**

*CCDP – conditional core damage probability

4.2. Internal Flooding Accident Sequences

The significant internal flooding accident sequences are shown in Table 4.2. The significant accident sequences are those sequences whose summed CDF contributes more than 95 percent of the total internal flooding CDF and all sequences that individually contribute more than 1 percent to total internal flooding CDF. The top 10 sequences, each contributing more than 5 percent of the total internal flooding CDF, are described below.

1. **1-FLI-AB_C113_LF1: 1-10-1** Flood occurs in auxiliary building resulting in unavailability of train A NSCW, as described in 3.2.4 of this report. The reactor is tripped. Offsite power is lost due to consequential failures related to the plant transient. Subsequent failures or maintenance unavailabilities result in loss of emergency power train B (train A is lost due to

unavailability of NSCW). The loss of all AC power sources renders the AFW system and feed and bleed unavailable for providing core cooling (the TDAFWP is assumed to fail after battery depletion). The sequence frequency is 7.8×10^{-8} per reactor-critical-year, contributing approximately 9.9 percent to the internal flooding CDF.

2. **1-FLI-AB_C113_LF1: 1-11-08-1** Flood occurs in auxiliary building resulting in unavailability of train A NSCW, as described in 3.2.4 of this report. The reactor is tripped. Equipment and human failures contribute to the failure of all RCP seal injection and cooling. The RCP seals fail resulting in a small LOCA. High-pressure and low-pressure injection with train A emergency core cooling system (ECCS) pumps are unavailable due to the dependency on train A NSCW. Subsequent failures of train B electrical distribution equipment or train B NSCW result in unavailability of high-pressure and low-pressure injection with train B ECCS pumps. The sequence frequency is 7.7×10^{-8} per reactor-critical-year, contributing approximately 9.8 percent to the internal flooding CDF.
3. **1-FLI-AB_C120_LF1: 1-10-1** Flood occurs in auxiliary building resulting in unavailability of train A NSCW, as described in 3.2.16 of this report. The reactor is tripped. Offsite power is lost due to consequential failures related to the plant transient. Subsequent failures or maintenance unavailabilities result in loss of emergency power train B (train A is lost due to unavailability of NSCW). The loss of all AC power sources renders the AFW system and feed and bleed unavailable for providing core cooling (the TDAFWP is assumed to fail after battery depletion). The sequence frequency is 6.8×10^{-8} per reactor-critical-year, contributing approximately 8.6 percent to the internal flooding CDF.
4. **1-FLI-AB_C120_LF1: 1-11-08-1** Flood occurs in auxiliary building resulting in unavailability of train A NSCW, as described in 3.2.16 of this report. The reactor is tripped. Equipment and human failures contribute to the failure of all RCP seal injection and cooling. The RCP seals fail resulting in a small LOCA. High-pressure and low-pressure injection with train A ECCS pumps are unavailable due to the dependency on train A NSCW. Subsequent failures of train B electrical distribution equipment or train B NSCW result in unavailability of high-pressure and low-pressure injection with train B ECCS pumps. The sequence frequency is 6.2×10^{-8} per reactor-critical-year, contributing approximately 7.9 percent to the internal flooding CDF.
5. **1-FLI-AB_C115_LF1: 1-10-1** Flood occurs in auxiliary building resulting in unavailability of train A NSCW, as described in Section 3.2.14 of this report. The reactor is tripped. Offsite power is lost due to consequential failures related to the plant transient. Subsequent failures or maintenance unavailabilities result in loss of emergency power train B (train A is lost due to unavailability of NSCW). The loss of all AC power sources renders the AFW system and feed and bleed unavailable for providing core cooling (the TDAFWP is assumed to fail after battery depletion). The sequence frequency is 4.6×10^{-8} per reactor-critical-year, contributing approximately 5.9 percent to the internal flooding CDF.
6. **1-FLI-AB_C115_LF1: 1-11-08-1** Flood occurs in auxiliary building resulting in unavailability of train A NSCW, as described in Section 3.2.14 of this report. The reactor is tripped. Equipment and human failures contribute to the failure of all RCP seal injection and cooling. The RCP seals fail resulting in a small LOCA. High-pressure and low-pressure injection with train A ECCS pumps are unavailable due to the dependency on train A NSCW. Subsequent failures of train B electrical distribution equipment or train B NSCW result in unavailability of high-pressure and low-pressure injection with train B ECCS pumps. The sequence frequency is 4.6×10^{-8} per reactor-critical-year, contributing approximately 5.8 percent to the internal flooding CDF.

7. **1-FLI-AB_108_SP1: 1-11-08-1** Flood occurs in the south main steam valve room resulting in a failed open ARV on SG1, as described in Section 3.2.1 of this report. The impact of the failed ARV results in a secondary-side break upstream of the MSIV. Equipment and human failures contribute to the failure of all RCP seal injection and cooling. The RCP seals fail resulting in a small LOCA. Combinations of failures result in unavailability of high-pressure and low-pressure injection. The predominant equipment failures are related to the safety injection sequencer, NSCW, and electrical distribution equipment. The sequence frequency is 4.2×10^{-8} per reactor-critical-year, contributing approximately 5.3 percent to the internal flooding CDF.
8. **1-FLI-AB_108_SP2: 1-11-08-1** Flood occurs in the south main steam valve room resulting in a failed open ARV on SG4, as described in Section 3.2.2 of this report. The impact of the failed ARV results in a secondary-side break upstream of the MSIV. Equipment and human failures contribute to the failure of all RCP seal injection and cooling. The RCP seals fail resulting in a small LOCA. Combinations of failures result in unavailability of high-pressure and low-pressure injection. The predominant equipment failures are related to the safety injection sequencer, NSCW, and electrical distribution equipment. The sequence frequency is 4.2×10^{-8} per reactor-critical-year, contributing approximately 5.3 percent to the internal flooding CDF.
9. **1-FLI-CB_123_SP: 1-11-08-1** Flood occurs in the north main steam valve room resulting in a failed open ARV on SG2, as described in Section 3.2.6 of this report. The impact of the failed ARV results in a secondary-side break upstream of the MSIV. Equipment and human failures contribute to the failure of all RCP seal injection and cooling. The RCP seals fail resulting in a small LOCA. Combinations of failures result in unavailability of high-pressure and low-pressure injection. The predominant equipment failures are related to the safety injection sequencer, NSCW, and electrical distribution equipment. The sequence frequency is 4.1×10^{-8} per reactor-critical-year, contributing approximately 5.2 percent to the internal flooding CDF.
10. **1-FLI-CB_122_SP: 1-11-08-1** Flood occurs in the north main steam valve room resulting in a failed open ARV on SG3, as described in Section 3.2.5 of this report. The impact of the failed ARV results in a secondary-side break upstream of the MSIV. Equipment and human failures contribute to the failure of all RCP seal injection and cooling. The RCP seals fail resulting in a small LOCA. Combinations of failures result in unavailability of high-pressure and low-pressure injection. The predominant equipment failures are related to the safety injection sequencer, NSCW, and electrical distribution equipment. The sequence frequency is 4.1×10^{-8} per reactor-critical-year, contributing approximately 5.2 percent to the internal flooding CDF.

Table 4.2 Significant Internal Flooding Accident Sequences

	Scenario Name	Sequence Number	CDF/ry	% of CDF	Cumulative % of CDF	Cut Set Count
1	1-FLI-AB_C113_LF1	1-10-1	7.8E-08	9.9	9.9	177
2	1-FLI-AB_C113_LF1	1-11-08-1	7.7E-08	9.8	19.6	150
3	1-FLI-AB_C120_LF	1-10-1	6.8E-08	8.6	28.2	181

Table 4.2 Significant Internal Flooding Accident Sequences

	Scenario Name	Sequence Number	CDF/ry	% of CDF	Cumulative % of CDF	Cut Set Count
4	1-FLI-AB_C120_LF	1-11-08-1	6.2E-08	7.9	36.1	146
5	1-FLI-AB_C115_LF	1-10-1	4.6E-08	5.9	41.9	153
6	1-FLI-AB_C115_LF	1-11-08-1	4.6E-08	5.8	47.7	136
7	1-FLI-AB_108_SP1	1-11-08-1	4.2E-08	5.3	53.0	303
8	1-FLI-AB_108_SP2	1-11-08-1	4.2E-08	5.3	58.3	303
9	1-FLI-CB_123_SP	1-11-08-1	4.1E-08	5.2	63.5	292
10	1-FLI-CB_122_SP	1-11-08-1	4.1E-08	5.2	68.8	292
11	1-FLI-CB_123_SP	1-15-1	3.6E-08	4.5	73.3	105
12	1-FLI-CB_122_SP	1-15-1	3.6E-08	4.5	77.8	105
13	1-FLI-CB_122_SP	1-21-1	1.3E-08	1.7	79.5	525
14	1-FLI-CB_123_SP	1-21-1	1.3E-08	1.7	81.1	525
15	1-FLI-TB_500_LF	1-10-1	1.0E-08	1.3	82.4	401
16	1-FLI-CB_A60	1-11-08-1	7.6E-09	1.0	83.4	104
17	1-FLI-AB_108_SP2	1-21-1	7.2E-09	0.9	84.3	309
18	1-FLI-AB_108_SP1	1-21-1	7.2E-09	0.9	85.2	309
19	1-FLI-CB_A60	1-15-1	6.6E-09	0.8	86.1	51
20	1-FLI-AB_108_SP1	1-04-1	6.6E-09	0.8	86.9	111
21	1-FLI-AB_108_SP2	1-04-1	6.6E-09	0.8	87.7	105
22	1-FLI-CB_A48	2-10-1	5.7E-09	0.7	88.4	43
23	1-FLI-CB_123_SP	1-04-1	4.9E-09	0.6	89.1	69
24	1-FLI-CB_122_SP	1-04-1	4.9E-09	0.6	89.7	66
25	1-FLI-CB_A48	2-04-1	4.6E-09	0.6	90.3	142
26	1-FLI-DGB_101_LF	1-10-1	4.5E-09	0.6	90.8	41
27	1-FLI-CB_122_SP	1-14-1	4.0E-09	0.5	91.3	175
28	1-FLI-CB_123_SP	1-14-1	4.0E-09	0.5	91.8	175
29	1-FLI-AB_D74_FP	1-10-1	3.0E-09	0.4	92.2	41
30	1-FLI-TB_500_LF-CDS	1-10-1	2.9E-09	0.4	92.6	157

Table 4.2 Significant Internal Flooding Accident Sequences

	Scenario Name	Sequence Number	CDF/ry	% of CDF	Cumulative % of CDF	Cut Set Count
31	1-FLI-AB_C118_LF	1-11-08-1	2.9E-09	0.4	92.9	34
32	1-FLI-TB_500_LF	1-04-1	2.8E-09	0.4	93.3	86
33	1-FLI-CB_A48	2-07-1	2.7E-09	0.3	93.6	16
34	1-FLI-AB_B08_LF	1-10-1	2.6E-09	0.3	94.0	39
35	1-FLI-AB_B08_LF	1-11-08-1	2.6E-09	0.3	94.3	33
36	1-FLI-AB_C118_LF	1-10-1	2.6E-09	0.3	94.6	41
37	1-FLI-DGB_103_LF	1-10-1	2.6E-09	0.3	95.0	44
38	1-FLI-AB_D74_FP	1-11-10-1	2.6E-09	0.3	95.3	22

The significant sequence results identify the types of failures that are significant to the overall plant risk from internal flooding. The consequential loss of offsite power contributes to several significant sequences, including the top contributing sequence. Failures related to emergency power systems are significant contributors to these sequences. It should be noted that the modeling assumptions for these sequences may be over-estimating the actual risk. Many of these sequences involved a break in the NSCW system, and the model assumed a reactor trip occurs. An automatic reactor trip is not likely to occur, but the plant would be required to shutdown if the technical specification requirements are not met. The likelihood of a consequential loss of offsite power may be lower for this case compared to an unanticipated plant trip.

Seven of the top ten flooding sequences involve failures subsequent to the plant transient that result in loss of RCP seal cooling, leading to a small LOCA. Additional failures leading to unavailability of high-pressure and low-pressure injection result in core damage. Not reflected in this model are the improved passive shutdown RCP seals. The new seals are expected to reduce the likelihood of an RCP seal LOCA, which, in turn, would reduce the core damage frequency for these sequences.

Failures of the safety injection sequencer, NSCW, and electrical distribution equipment dominate the results due to common functional dependencies on these systems. For all significant sequences the flood-related impacts contribute directly to the failure or loss of redundancy for the functions required to prevent core damage. Some of the significant flood-related impacts include failures that result in unavailability of an NSCW train, unavailability of secondary-side cooling using the steam generators, and loss of an AC power support system.

The internal flooding event trees are structured to directly transfer to the relevant accident sequences of the internal events model. All credible equipment failures that were considered in the internal events model were also considered possible to occur coincident with the flooding events. Accordingly, the internal flooding cut set results include many of the same failures that were important to the internal events risk. The basic events important to the plant core damage risk from internal flooding and their importance measures are presented in Appendix B, Table B-2.

4.3. Internal Flooding Cut Set Results

The top 100 highest contributing cut sets are displayed in Table 4.3. The top 100 cut sets account for 75 percent of the total internal flooding CDF. The significant internal flooding cut sets include all those whose summed CDF contributes more than 95 percent of the total internal flooding CDF and all cut sets that individually contribute more than one percent to total internal flooding CDF. Per this definition, there are 996 significant internal flooding cut sets. All of these cut sets are included in Appendix B: Internal Flooding PRA Significant Cut Sets and Basic Event Importance of this report.

In accordance with ASME/ANS PRA Standard (IF- 7) requirement QU-D1, a sampling of the significant cut sets were reviewed to ensure they were reasonable and represented realistic accident sequences. In accordance with ASME/ANS PRA Standard (IF- 7) requirement QU-D5, a sampling of non-significant cut sets were also reviewed to ensure that they also represented reasonable and realistic accident sequences.

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency Probability	% of CDF	Basic Event Name	Basic Event Description
1	3.914E-8	6.65		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	3.297E-2		1-EPS-DGN-FR-G4002___	DG1B fails to run by random cause (24 hr mission)
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
2	3.145E-8	5.34		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	3.297E-2		1-EPS-DGN-FR-G4002___	DG1B fails to run by random cause (24 hr mission)
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
3	2.324E-8	3.95		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	3.297E-2		1-EPS-DGN-FR-G4002___	DG1B fails to run by random cause (24 hr mission)
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
4	1.974E-8	3.35		
	2.800E-4		1-IE-FLI-AB_108_SP2	Internal flooding in AB 108
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency Probability	% of CDF	Basic Event Name	Basic Event Description
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
5	1.974E-8	3.35		
	2.800E-4		1-IE-FLI-AB_108_SP1	Internal flooding in AB 108
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
6	1.960E-8	3.33		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
7	1.960E-8	3.33		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
8	1.595E-8	2.71		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	3.297E-2		1-EPS-DGN-FR-G4001___	DG1A fails to run by random cause (24 hr mission)
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
9	1.595E-8	2.71		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	3.297E-2		1-EPS-DGN-FR-G4001___	DG1A fails to run by random cause (24 hr mission)
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
10	1.581E-8	2.68		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	2.150E-4		1-ACP-BAC-MA-BA03____	4.16KV bus 1BA03 in maintenance
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
11	1.581E-8	2.68		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	2.150E-4		1-ACP-BAC-MA-BB16____	480V switchgear 1BB16 in maintenance
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
12	1.496E-8	2.54		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	1.260E-2		1-EPS-DGN-MA-G4002___	DG1B in maintenance
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
13	1.270E-8	2.16		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BA03____	4.16KV bus 1BA03 in maintenance
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
14	1.270E-8	2.16		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BB16____	480V switchgear 1BB16 in maintenance
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
15	1.203E-8	2.04		
	2.800E-4		1-IE-FLI-AB_108_SP1	Internal flooding in AB 108
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
16	1.203E-8	2.04		
	2.800E-4		1-IE-FLI-AB_108_SP2	Internal flooding in AB 108
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
17	1.202E-8	2.04		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	1.260E-2		1-EPS-DGN-MA-G4002___	DG1B in maintenance
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
18	1.194E-8	2.03		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
19	1.194E-8	2.03		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
20	9.632E-9	1.64		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	2.150E-4		1-ACP-BAC-MA-BA03____	4.16KV bus 1BA03 in maintenance
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
21	9.632E-9	1.64		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency Probability	% of CDF	Basic Event Name	Basic Event Description
	2.150E-4		1-ACP-BAC-MA-BB16____	480V switchgear 1BB16 in maintenance
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
22	9.386E-9	1.59		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BA03____	4.16KV bus 1BA03 in maintenance
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
23	9.386E-9	1.59		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BB16____	480V switchgear 1BB16 in maintenance
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
24	8.882E-9	1.51		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	1.260E-2		1-EPS-DGN-MA-G4002___	DG1B in maintenance
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
25	7.740E-9	1.31		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BA03____	4.16KV bus 1BA03 in maintenance
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
26	7.740E-9	1.31		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BB16____	480V switchgear 1BB16 in maintenance
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
27	6.352E-9	1.08		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	5.350E-3		1-ACP-CRB-CC-BA0301__	RAT B supply CRB randomly fails to open
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
28	6.095E-9	1.03		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	1.260E-2		1-EPS-DGN-MA-G4001___	DG1A in maintenance
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
29	6.095E-9	1.03		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	1.260E-2		1-EPS-DGN-MA-G4001___	DG1A in maintenance
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
30	5.719E-9	0.97		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BA03____	4.16KV bus 1BA03 in maintenance
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
31	5.719E-9	0.97		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-BB16____	480V switchgear 1BB16 in maintenance
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
32	5.104E-9	0.87		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	5.350E-3		1-ACP-CRB-CC-BA0301__	RAT B supply CRB randomly fails to open
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
33	4.005E-9	0.68		
	2.160E-3		1-IE-FLI-TB_500_LF	Internal flooding in TB Fire Zone 500
	3.498E-4		1-ACP-CRB-CF-A205301	CCF of switchyard AC breakers AA205 & BA301 to open
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
34	3.953E-9	0.67		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	3.330E-3		1-EPS-SEQ-FO-1821U302	Sequencer B fails to operate
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
35	3.771E-9	0.64		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	5.350E-3		1-ACP-CRB-CC-BA0301__	RAT B supply CRB randomly fails to open
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
36	3.659E-9	0.62		
	5.190E-5		1-IE-FLI-CB_A60	Internal flooding in CB A60
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
37	3.512E-9	0.60		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	4.776E-5		1-ACP-BAC-FC-BA03____	4.16KV bus 1BA03 fails
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
38	3.512E-9	0.60		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	4.776E-5		1-ACP-BAC-FC-BB16____	480V switchgear 1BB16 randomly fails
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
39	3.490E-9	0.59		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	2.940E-3		1-EPS-DGN-FS-G4002___	DG1B fails to start by random cause
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
40	3.467E-9	0.59		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	2.150E-4		1-ACP-BAC-MA-AA02____	Bus 1AA02 in maintenance
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
41	3.467E-9	0.59		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	2.150E-4		1-ACP-BAC-MA-AA02____	Bus 1AA02 in maintenance
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
42	3.229E-9	0.55		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	2.720E-3		1-DCP-BAT-MA-BD1B____	Battery 1BD1B in maintenance
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
43	3.177E-9	0.54		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	3.330E-3		1-EPS-SEQ-FO-1821U302	Sequencer B fails to operate
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
44	3.000E-9	0.51		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
	4.080E-5		1-SWS-CTF-MA-_B_1234_	All 4 NSCW train B tower fans unavailable due to maintenance
45	2.977E-9	0.51		
	5.190E-5		1-IE-FLI-CB_A60	Internal flooding in CB A60
	3.297E-2		1-EPS-DGN-FR-G4001___	DG1A fails to run by random cause (24 hr mission)
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
46	2.939E-9	0.50		
	2.800E-4		1-IE-FLI-AB_108_SP1	Internal flooding in AB 108
	3.498E-4		1-ACP-CRB-CF-A205301	CCF of switchyard AC breakers AA205 & BA301 to open
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
47	2.939E-9	0.50		
	2.800E-4		1-IE-FLI-AB_108_SP2	Internal flooding in AB 108
	3.498E-4		1-ACP-CRB-CF-A205301	CCF of switchyard AC breakers AA205 & BA301 to open

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
48	2.918E-9	0.50		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	3.498E-4		1-ACP-CRB-CF-A205301	CCF of switchyard AC breakers AA205 & BA301 to open
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
49	2.918E-9	0.50		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	3.498E-4		1-ACP-CRB-CF-A205301	CCF of switchyard AC breakers AA205 & BA301 to open
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
50	2.862E-9	0.49		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	3.000E-3		1-AFW-MDP-MA-P4002___	MDAFWP B unavailable due to test and maintenance
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
51	2.822E-9	0.48		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	4.776E-5		1-ACP-BAC-FC-BA03____	4.16KV bus 1BA03 fails
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
52	2.822E-9	0.48		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	4.776E-5		1-ACP-BAC-FC-BB16____	480V switchgear 1BB16 randomly fails
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
53	2.805E-9	0.48		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	2.940E-3		1-EPS-DGN-FS-G4002___	DG1B fails to start by random cause
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
54	2.699E-9	0.46		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	9.040E-1		1-NSCWCT-SPRAY	NSCW CTS in spray mode (fraction of time)
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
	4.060E-5		1-SWS-MOV-MA-1669ACT_	NSCW train B spray valve closed for CT maintenance
55	2.595E-9	0.44		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	2.720E-3		1-DCP-BAT-MA-BD1B____	Battery 1BD1B in maintenance
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
56	2.588E-9	0.44		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	5.350E-3		1-ACP-CRB-CC-AA0205__	RAT A supply CRB randomly fails to open
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
57	2.588E-9	0.44		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	5.350E-3		1-ACP-CRB-CC-AA0205__	RAT A supply CRB randomly fails to open
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
58	2.459E-9	0.42		
	2.160E-3		1-IE-FLI-TB_500_LF	Internal flooding in TB Fire Zone 500
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
59	2.411E-9	0.41		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
	4.080E-5		1-SWS-CTF-MA-_B_1234_	All 4 NSCW train B tower fans unavailable due to maintenance
60	2.347E-9	0.40		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	3.330E-3		1-EPS-SEQ-FO-1821U302	Sequencer B fails to operate
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
61	2.229E-9	0.38		
	5.190E-5		1-IE-FLI-CB_A60	Internal flooding in CB A60
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	1.000E+0		1-OA-NSCWFAN---H	Operator fails to start NSCW fan manually (place holder)
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
62	2.169E-9	0.37		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	9.040E-1		1-NSCWCT-SPRAY	NSCW CTS in spray mode (fraction of time)
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
	4.060E-5		1-SWS-MOV-MA-1669ACT_	NSCW train B spray valve closed for CT maintenance
63	2.140E-9	0.36		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	4.776E-5		1-ACP-BAC-FC-BA03____	4.16KV bus 1BA03 fails
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
64	2.140E-9	0.36		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	4.776E-5		1-ACP-BAC-FC-BB16____	480V switchgear 1BB16 randomly fails
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
65	2.085E-9	0.35		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	4.776E-5		1-ACP-BAC-FC-BA03____	4.16KV bus 1BA03 fails

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
66	2.085E-9	0.35		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	4.776E-5		1-ACP-BAC-FC-BB16____	480V switchgear 1BB16 randomly fails
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
67	2.072E-9	0.35		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	2.940E-3		1-EPS-DGN-FS-G4002___	DG1B fails to start by random cause
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
68	1.980E-9	0.34		
	9.210E-5		1-IE-FLI-CB_A48	Internal flooding in CB A48
	2.150E-4		1-ACP-BAC-MA-BA03____	4.16KV bus 1BA03 in maintenance
	1.000E-1		1-FLI-CB-A58A48-FP	Propagation factor for internal flooding from corridor A58 to 4160 VAC switchgear room A48
69	1.980E-9	0.34		
	9.210E-5		1-IE-FLI-CB_A48	Internal flooding in CB A48
	2.150E-4		1-ACP-BAC-MA-BB16____	480V switchgear 1BB16 in maintenance
	1.000E-1		1-FLI-CB-A58A48-FP	Propagation factor for internal flooding from corridor A58 to 4160 VAC switchgear room A48
70	1.941E-9	0.33		
	2.160E-3		1-IE-FLI-TB_500_LF	Internal flooding in TB Fire Zone 500
	1.549E-5		1-AFW-PMP-CF-RUN	CCF of AFW pumps to run (excluding driver)
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
71	1.917E-9	0.33		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	2.720E-3		1-DCP-BAT-MA-BD1B____	Battery 1BD1B in maintenance
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
72	1.852E-9	0.31		

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	2.800E-4		1-IE-FLI-AB_108_SP1	Internal flooding in AB 108
	3.000E-3		1-AFW-MDP-MA-P4002___	MDAFWP B unavailable due to test and maintenance
	3.802E-2		1-AFW-TDP-FR-P4001___	TDAFWP fails to run
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
73	1.852E-9	0.31		
	2.800E-4		1-IE-FLI-AB_108_SP2	Internal flooding in AB 108
	3.000E-3		1-AFW-MDP-MA-P4002___	MDAFWP B unavailable due to test and maintenance
	3.802E-2		1-AFW-TDP-FR-P4001___	TDAFWP fails to run
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
74	1.839E-9	0.31		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	3.000E-3		1-AFW-MDP-MA-P4003___	MDAFWP A unavailable due to test and maintenance
	3.802E-2		1-AFW-TDP-FR-P4001___	TDAFWP fails to run
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
75	1.839E-9	0.31		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	3.000E-3		1-AFW-MDP-MA-P4003___	MDAFWP A unavailable due to test and maintenance
	3.802E-2		1-AFW-TDP-FR-P4001___	TDAFWP fails to run
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
76	1.828E-9	0.31		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
	4.080E-5		1-SWS-CTF-MA-_B_1234_	All 4 NSCW train B tower fans unavailable due to maintenance
77	1.804E-9	0.31		
	2.800E-4		1-IE-FLI-AB_108_SP1	Internal flooding in AB 108
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
78	1.804E-9	0.31		
	2.800E-4		1-IE-FLI-AB_108_SP2	Internal flooding in AB 108

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
79	1.791E-9	0.30		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
80	1.791E-9	0.30		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	2.148E-4		1-EPS-SEQ-CF-FOAB	Sequencers fail from common cause to operate
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
81	1.781E-9	0.30		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs
	4.080E-5		1-SWS-CTF-MA-_B_1234_	All 4 NSCW train B tower fans unavailable due to maintenance
82	1.719E-9	0.29		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	4.776E-5		1-ACP-BAC-FC-BA03____	4.16KV bus 1BA03 fails
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
83	1.719E-9	0.29		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	4.776E-5		1-ACP-BAC-FC-BB16____	480V switchgear 1BB16 randomly fails
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
84	1.644E-9	0.28		
	2.240E-4		1-IE-FLI-AB_C113_LF1	Internal flooding in AB C113
	9.040E-1		1-NSCWCT-SPRAY	NSCW CTS in spray mode (fraction of time)
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	4.060E-5		1-SWS-MOV-MA-1669ACT_	NSCW train B spray valve closed for CT maintenance
85	1.611E-9	0.27		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	3.330E-3		1-EPS-SEQ-FO-1821U301	Sequencer A fails to operate
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
86	1.611E-9	0.27		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	3.330E-3		1-EPS-SEQ-FO-1821U301	Sequencer A fails to operate
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
87	1.609E-9	0.27		
	9.210E-5		1-IE-FLI-CB_A48	Internal flooding in CB A48
	3.297E-2		1-EPS-DGN-FR-G4002___	DG1B fails to run by random cause (24 hr mission)
	1.000E-1		1-FLI-CB-A58A48-FP	Propagation factor for internal flooding from corridor A58 to 4160 VAC switchgear room A48
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
88	1.603E-9	0.27		
	9.210E-5		1-IE-FLI-CB_A48	Internal flooding in CB A48
	3.000E-3		1-AFW-MDP-MA-P4002___	MDAFWP B unavailable due to test and maintenance
	1.000E-1		1-FLI-CB-A58A48-FP	Propagation factor for internal flooding from corridor A58 to 4160 VAC switchgear room A48
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
89	1.602E-9	0.27		
	1.330E-4		1-IE-FLI-AB_C115_LF	Internal flooding in AB C115 due to NSCW pipe failure
	9.040E-1		1-NSCWCT-SPRAY	NSCW CTS in spray mode (fraction of time)
	9.947E-1		/1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
	3.300E-1		1-RCS-XHE-XM-TRIP	Operator fails to trip RCPs

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	4.060E-5		1-SWS-MOV-MA-1669ACT_	NSCW train B spray valve closed for CT maintenance
90	1.574E-9	0.27		
	7.320E-6		1-IE-FLI-DGB_101_LF	Internal flooding in DG1B room 101 due to NSCW pipe failure
	2.150E-4		1-ACP-BAC-MA-AA02____	Bus 1AA02 in maintenance
91	1.497E-9	0.25		
	8.570E-6		1-IE-FLI-AB_D74_FP	Internal flooding in AB D74 propagates to480 VAC switchgear room D105
	3.297E-2		1-EPS-DGN-FR-G4002___	DG1B fails to run by random cause (24 hr mission)
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
92	1.469E-9	0.25		
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
	4.080E-5		1-SWS-CTF-MA-_B_1234_	All 4 NSCW train B tower fans unavailable due to maintenance
93	1.422E-9	0.24		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	2.940E-3		1-EPS-DGN-FS-G4001___	DG1A fails to start by random cause
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
94	1.422E-9	0.24		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	2.940E-3		1-EPS-DGN-FS-G4001___	DG1A fails to start by random cause
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
95	1.340E-9	0.23		
	7.670E-6		1-IE-FLI-AB_B08_LF	Internal flooding in AB B08 due to NSCW pipe failure
	3.297E-2		1-EPS-DGN-FR-G4002___	DG1B fails to run by random cause (24 hr mission)
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
96	1.321E-9	0.22		

Table 4.3 Internal Flooding Top 100 Cut Set Results

Cut Set #	Frequency / Probability	% of CDF	Basic Event Name	Basic Event Description
	1.800E-4		1-IE-FLI-AB_C120_LF	Internal flooding in AB C120 due to NSCW pipe failure
	9.040E-1		1-NSCWCT-SPRAY	NSCW CTS in spray mode (fraction of time)
	2.000E-1		1-RCS-MDP-LK-BP2	RCP seal stage 2 integrity (binding/popping open) fails
	4.060E-5		1-SWS-MOV-MA-1669ACT_	NSCW train B spray valve closed for CT maintenance
97	1.316E-9	0.22		
	2.780E-4		1-IE-FLI-CB_123_SP	Internal flooding in CB 123
	2.720E-3		1-DCP-BAT-MA-AD1B____	Battery 1AD1B in maintenance
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
98	1.316E-9	0.22		
	2.780E-4		1-IE-FLI-CB_122_SP	Internal flooding in CB 122
	2.720E-3		1-DCP-BAT-MA-AD1B____	Battery 1AD1B in maintenance
	5.800E-2		1-OAB_TR-------H	Operator fails to feed and bleed - transient
	3.000E-2		1-OEP-VCF-LP-CLOPL	Consequential loss of offsite power - LOCA
99	1.314E-9	0.22		
	7.520E-6		1-IE-FLI-AB_C118_LF	Internal flooding in AB C118 due to NSCW pipe failure
	3.297E-2		1-EPS-DGN-FR-G4001___	DG1A fails to run by random cause (24 hr mission)
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient
100	1.279E-9	0.22		
	7.320E-6		1-IE-FLI-DGB_101_LF	Internal flooding in DG1B room 101 due to NSCW pipe failure
	3.297E-2		1-EPS-DGN-FR-G4001___	DG1A fails to run by random cause (24 hr mission)
	5.300E-3		1-OEP-VCF-LP-CLOPT	Consequential loss of offsite power - transient

4.4. Internal Flooding CDF Parameter Uncertainty Analysis

The uncertainty of the IFPRA CDF results are addressed in two ways: parameter uncertainty sampling and sensitivity studies. The parameter uncertainty sampling is discussed further in this section. In Section 4.5 sources of model uncertainty are identified. The impacts of these model uncertainties are evaluated through sensitivity cases that examine how the results change if

alternate modeling assumptions are made. Both the parameter uncertainty analysis and the model uncertainty sensitivity cases are considered in evaluating the uncertainty in the model results.

The mean CDF is estimated using a Monte Carlo sampling approach using the uncertainty distributions of the contributing basic events. The state-of-knowledge correlations are addressed by assigning correlation classes to basic events with similar component types and failure modes, as described in the SAPHIRE technical reference manual (IF- 5). The CDF mean value and uncertainty results are provided in Table 4.4. The internal flooding CDF cumulative distribution function is shown in Figure 4-1, and the probability density is shown in Figure 4-2.

Table 4.4 Internal Flooding CDF Model Parameter Uncertainty Results

Point Estimate CDF	Mean CDF	5th Percentile	Median	95th Percentile	Standard Deviation
7.91E-07	7.99E-07	1.62E-07	5.67E-07	2.17E-06	7.79E-07

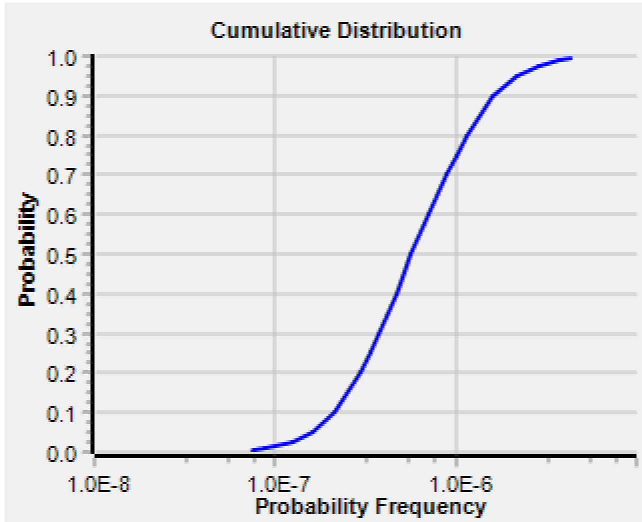

Figure 4-1 Cumulative Distribution Function for Internal Flooding CDF

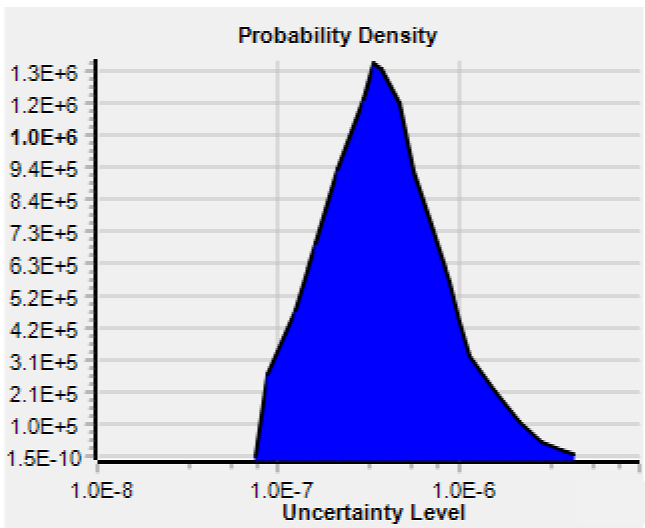

Figure 4-2 Probability Density for Internal Flooding CDF

4.5. Internal Flood PRA Model Uncertainty and Sensitivity Cases

The purpose of this section is to identify sources of model uncertainty in the NRC IFPRA and develop sensitivity cases to assess the effects of this uncertainty. The modeling approaches and related assumptions can have a significant impact on the CDF results, and the impacts of these choices are often not well characterized by the parameter uncertainty distributions. A systematic review of each technical element of the NRC IFPRA model was performed to identify sources of model uncertainty. The potential impacts on the NRC IFPRA model are discussed for each identified source of uncertainty. The technical element, as defined in the ASME/ANS PRA Standard (IF- 7), is identified for each source of uncertainty. The EPRI report, "Treatment of Parameter and Model Uncertainty for Probabilistic Risk Assessments," (Ref. IF-13), was consulted for generic sources of model uncertainty for an internal flooding PRA. The sources of model uncertainty are listed in Table 4.5.

One method to address the impacts of modeling assumptions is to develop sensitivity cases to examine how the results change if alternate assumptions are made. Several sensitivity cases are examined here to explore the impacts of modeling assumptions and sources of model uncertainty on the internal flooding CDF results. The impacts of these sensitivity cases are evaluated in the following sections, as indicated below:

- Internal flooding initiating event frequencies (Section 4.5.1)
- Human error probabilities for maintenance-induced flooding scenarios (Section 4.5.2)
- Human error probabilities for failures unrelated to flood mitigation (Section 4.5.3)
- Crediting improved RCP shutdown seals (Section 4.5.4)
- Propagation factor for flooding scenario 1-FLI-CB_A48 (Section 4.5.5)
- Potential flood propagation impacting both safety-related 4160 VAC switchgears (Section 4.5.6)
- Application of spray direction factor (Section 4.5.7)
- Credit for manual action to start service water cooling tower fans (Section 4.5.8)
- Impact of consequential loss of offsite power on internal flooding scenarios (Section 4.5.9)

A table summarizing the results of all of the sensitivity analyses is provided in Section 4.5.10.

Not all sources of model uncertainty discussed in Table 4.5 are addressed by the sensitivity cases. For some cases, the sources of uncertainty may not be easily quantifiable or able to be assessed by a sensitivity case. The potential areas for future work in Appendix C describe additional work that could be pursued that may help in understanding the impacts of model uncertainties, including those that are not addressed by sensitivity cases in this study.

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
Internal Flood Plant Partitioning (IFPP)	The flood areas are primarily defined in terms of the rooms and compartments that are physically divided with walls, curbs, doors, etc., between them. Some areas are connected via passage ways or corridors, but are deemed to be independent with respect to flooding effects.	No significant impact. The definitions of flood areas are reasonable based on available information and confirmatory walkdowns. Potential propagation between flood areas was considered.
	The modeled plant is a two-unit site with limited structures and systems that are shared between units. Shared flood areas have the potential to impact both units.	No significant impact. Confirmatory walkdowns for the NRC IFPRA did not identify any significant multi-unit internal flooding scenarios. Shared areas were qualitatively screened due to no flood sources and/or limited impact on accident initiation/mitigation equipment. Further quantitative analysis of postulated multi-unit flooding scenarios could supplement the screening analysis.

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
Internal Flood Source Identification (IFSO)	Flood areas that do not contain flood sources may be screened from further analysis. However, flood areas with no flood sources that contain accident initiation/mitigation equipment should be evaluated further if there is potential for flood water propagation from adjacent areas.	Several flood areas, including those containing risk-significant electrical equipment, were screened because they do not contain flood sources. Flood propagation from adjacent areas was considered. For example, the flood scenario FLI-CB_A48 was included in the NRC IFPRA model and considers propagation from a corridor to Class 1E 4160 KV AC switchgear room. However, flood propagation to adjacent areas does not account for the failure probabilities of flood mitigating features (e.g., curbs, doors, drains). Though this could result in the omission of some flood scenarios in the model, these scenarios should have relatively lower frequencies when accounting for the mitigating feature failure probabilities.
	The performance of flood mitigating features (e.g., drains or flood barriers) may be evaluated based on qualitative features and engineering judgment. Flood areas may be qualitatively screened based on the assumption of successful performance of flood mitigating features that would prevent flood water from reaching accident initiation/mitigation equipment. Lack of well-established method(s) for evaluating the reliability of flood mitigating features contributes to model uncertainty. In some cases, no well-established method for quantitatively estimating flood barrier reliability exists. Generic assumptions regarding expected performance of flood barriers may be used in assessing flood sources and scenario development.	Flood areas may be qualitatively screened. The screening may include implicit assumptions about the successful performance of flood mitigating features. For example, control building, spreading room train B, was screened because the area has no flood sources sufficient to fail accident initiation/mitigation equipment, including in areas where the flood can propagate. Failure of flood mitigating features may result in the flood propagating to areas that contain accident initiation/mitigation equipment. However, the assumptions applied to flood mitigating features do not necessarily result in flood prevention. For example, the presence non-water-tight doors and drains are not assumed to prevent flood propagation, but they are assumed to slow the flood progression. Water-tight doors, solid walls, and curbs are assumed to prevent flood propagation, given the maximum flood height would not exceed the height of those barriers.

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
	The flood source analysis requires characterization of failure mechanism and release including: (a) the type of breach (e.g., leak, rupture, spray), (b) flow rate, (c) capacity of source, and (d) pressure and temperature of the source. Engineering judgment and assumptions applied to the source characterization may impact the IFPRA.	No significant impact. Each flood source that was modeled in the NRC IFPRA was characterized. The modeled breach may encompass a range of break sizes and flow rates. A representative flow rate was assumed. The impacts due to the flood source breach were generally pessimistic and have limited dependence on the flow rate assumptions.
	Steam lines can be important flood source contributors. Though some steam line failures might not contribute to flooding impacts that are typically considered (e.g., submergence or spray), they can result in other potentially important impacts, such as elevated humidity and temperature, and condensation. There is generally less experience in assessing these types of impacts. Consequently, consideration of steam lines as a flooding source may rely on simplifying assumptions that lead to uncertainty in the modeling.	There are many steam lines that were identified as potential flooding sources in the IFPRA, but many were not included in the estimation of flooding frequency. First, main steam lines were excluded from the IFPRA because these are included as an initiating event in the internal events PRA. Secondly, contributions from some types of smaller steam lines are also excluded, based on qualitative assessment that the potential sources do not contribute to flood impacts. However, there may not be sufficient consideration of other flooding impacts, such as elevated humidity and temperature, and condensation. Further evaluation of these potential flood sources could result in additional contributions to the flooding scenario initiaiting event frequencies.

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
Internal Flood Scenario Development (IFSN)	Flood scenario characterization includes consideration of automatic or operator actions that have the ability to terminate or contain the flood. Simplifying assumptions regarding post-flood operator actions were used in defining flood scenarios for the NRC IFPRA model.	Automatic or operator actions that have the ability to terminate or contain the flood were identified. Post-flood operator actions to limit or prevent flood impacts were generally not credited and were not modeled. These actions were assumed to have high failure probabilities due to limited time available to prevent flood damage/accident initiation. Long-term actions to terminate or contain floods were not modeled. It is possible that long-term floods could result in extensive propagation and additional plant impacts that would hinder safe shutdown of the plant; however, this is not the case for most scenarios. The long-term flooding is likely to accumulate in areas like sumps, corridors, and stairwells, with limited impact on plant operation. It was assumed that long-term flood damage was bounded by the initial flood damage, which occurs in the area containing the flood source and those adjacent areas that are identified in flood propagation scenarios.
	Flood scenario characterization includes consideration of flood rate, time to reach SSCs, capacity of drains, and the amount of water retained by sumps, berms, dikes, and curbs. Design basis flooding calculations account for these factors in estimating flood volumes and SSC impacts. The design basis flooding calculations were used as a reference, but they do not directly define the PRA flood scenario impacts. Flood impacts were based on assumptions that were considered to be pessimistic.	Design basis flooding calculations may have different boundary conditions (e.g., postulated break type and size) than the modeled NRC IFPRA scenarios. The model assumes that all identified SSCs are failed by flood water that reaches the room. Additional scenario-specific analysis of flood water volumes is not expected to identify additional impacted equipment or higher failure probabilities, but may be able to provide a basis for equipment survivability.

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
	In developing flood scenarios, qualitative screening criteria are applied to flood areas and flood scenarios in accordance with the ASME/ANS PRA standard. In applying these qualitative criteria, analysts may rely on judgement and assumptions, which can be a source of uncertainty. In particular, the assessment of flood propagation can introduce uncertainty when there are many potential propagation paths, or if the propagation depends on the occurrence of a very large flood that is beyond the typical design basis flood analysis.	The qualitative screening criteria involve consideration of potential flood propagation. However, some potential propagation paths may be overlooked or assumed to be unlikely. For example, a past operating experience event involved charging of a fire protection sprinkler header and water from a leakoff valve propagating to the main control room from the upper cable spreading room. Sealant was applied to floor penetrations to prevent future propagation. However, it could not be confirmed that the sealant would be leak tight if a significant flooding event occurred in the room. Degradation of the sealant (e.g., developing cracks) over time might be possible. The frequency of a large flood occurring and propagating to the main control room is expected to be low.
	SSCs were evaluated for susceptibility to flood-induced failure mechanisms. Simplifying failure assumptions were made for SSCs susceptible to spray. Spraying was assumed to fail components located within a 10-foot radius and within line-of-sight of a pressurized-water source. The direction of the spray was not considered.	A spray directional factor may be applied to reduce the spatial impact of a failed flood source. The directional factor should be applied based on engineering analysis and judgment. A spray directional factor would reduce the initiating event frequency for flood scenarios involving sprays.
	Assumptions regarding equipment susceptibility to all flood-induced failure mechanisms introduce model uncertainty. For most flood scenarios, the impacts are considered to be restricted to the flood areas and propagation paths, with local effects from spray and submergence being the primary concerns. However, some flood-induced failure mechanisms (e.g., high humidity) may affect	The IFPRA considers the impacts of all flood-induced failure mechanisms. However, the flood impacts are limited to the identified flood areas and propagation paths. It is possible that some flooding mechanisms (e.g., a large steam release) could have broader impacts on plant equipment. For example, insights from the internal events PRA identify the importance of non-safety related batteries located in the turbine building for restoring offsite power. The batteries are not located on the lower level of the turbine building,

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
	equipment that is located outside the analyzed propagation path(s).	are not in an identified flood propagation path, and are not impacted by any of the modeled turbine building floods. However, a large flood or steam release in the turbine building could impact the performance of these batteries. It should be noted that the potential importance of these batteries depends on a consequential loss of offsite power (LOOP) occurring. For a non-LOOP flood scenario, the loss of the batteries would have little impact on the accident response.
	Selected high-energy line break events were excluded from the scope of the IFPRA. Secondary-side steam line break events were modeled as part of the internal events PRA, but these events do not consider impacts at the location of the break. Flood-related impacts (e.g., sprays) could fail accident mitigation equipment.	The plant response due to steam line breaks is expected to be dominated by the break itself. Accounting for local flooding impacts could increase the conditional core damage probability (CCDP) for those events, but the impacted equipment is not expected to have a significant effect on overall results. The unscreened flood areas containing steam lines were reviewed to identify potential impacts of steam line breaks. These flood areas, including the main steam valve rooms and a room containing FW control/regulator valves, were modeled in the NRC IFPRA due to other flood sources in the rooms. The impacts due to steam line breaks can be inferred from these internal flooding scenarios.
	Simplifying assumptions were made with respect to the impacts due to flood propagation. For most internal flooding scenarios, if a propagation path was identified, then the propagation was assumed to proceed unmitigated to the target flood area. One exception is the flood scenario, 1-FLI-CB_A48, where a propagation factor of 0.1 was assigned to the target flood area due to the	For most internal flood scenarios assuming unmitigated propagation was reasonable. Identified equipment in the target flood area was assumed to fail. Additional analysis of flood propagation mitigating features, timing, flood water heights, and operator actions may be able to support crediting successful operation of equipment. Additional analysis was not warranted due to the relative significance of the internal flooding scenarios. For scenario 1-FLI-CB_A48, only one of several potential propagation paths for the

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
	uncertainty of how the flood would propagate.	flood source was modeled. Propagation to room A48 depends on break size, location, and effectiveness of the flood mitigation features (e.g., floor drains). The uncertainty in the propagation factor was addressed by assigning an uncertainty distribution to this parameter.
Internal Flood-Induced Initiating Event Analysis (IFEV)	Internal flooding scenarios were modeled that include feedwater lines as a flood source. The flood areas include the main steam valve rooms and a room containing FW control/regulator valves. Feedwater line breaks were also considered as a contributor to secondary-side breaks downstream of MSIVs/upstream of MFIVs in the internal events model, under the IE-SSBO initiating event.	Feedwater line breaks contribute to the SSBO internal event initiator and as flood sources in NRC IFPRA scenarios. The inclusion of the feedwater line breaks in both studies may result in overestimating their overall contribution to plant risk. Removing the feedwater line break contribution from SSBO would reduce the frequency for that initiator, but that may result in an overall under-estimation of their contribution, since the modeled NRC IFPRA scenarios only account for a fraction of the potential feedwater line breaks. Contributions from screened or unmodeled flood areas were not included in the NRC IFPRA. The two initiating event categories as currently modeled are expected to give a small overestimation of the feedwater line break contribution.
	Internal flooding scenario 1-FLI-TB_500_LF includes circulating water piping, expansion joints, and other non-safety piping in the turbine building as potential flood sources. Some of these flood sources are also included in the estimation of the internal event initiator, Loss of Condenser Heat Sink (LOCHS).	Expansion joint failures contribute to both the loss of condenser heat sink (LOCHS) initiator in the internal event model and as a flood source in NRC IFPRA scenarios. The inclusion of expansion joint failures in both studies may result in overestimating the contribution to plant risk. The LOCHS initiating event analysis incorporates a number of expansion joint failures into the frequency estimate. Expansion joint failures were included under the subcategory "Condenser Leakage," as defined in NUREG/CR-5750. Removing the expansion joint contribution to 1-FLI-TB_500_LF would reduce the frequency for that initiator. The two initiating event categories as currently modeled are expected to give a small overestimation of

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
		the contribution from expansion joint failures.
	Internal flooding scenarios that have the same or similar impacts are subsumed into a group. The resulting grouped scenario may lose some level of modeling fidelity with respect to the subsumed scenarios.	Scenarios may be subsumed when the same flood area is affected. In most cases, the impacts for the subsumed scenarios are the same. The only differences are the flood sources and the failure mechanisms of the flood sources (e.g., spray, local flood, or flood propagation). Subsuming these scenarios does not impact the NRC IFPRA model results. For scenario 1-FLI-TB_500_LF, several potential flood sources are subsumed. The impacted equipment can vary depending on the flood source. The bounding impacts are assumed to apply to all subsumed scenarios. In this particular case, the sum of the CDF contributions from the individual flood scenarios may be less than the CDF of the grouped scenario.

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
	Internal flooding initiating event frequencies are based on generic data from EPRI's report on pipe rupture frequencies (IF- 9) and plant-specific data from the reference plant. The EPRI report provides a range of failure data for different plant systems and failure mechanisms, including sprays, floods, and major floods. Although the EPRI report provides a systematic approach for frequency estimation, there are several modeling choices that can impact the frequency results. Some examples of modeling choices include evaluation of pipe size categories and effective break sizes, estimation of total system piping length, incorporation of plant-specific failure/flooding experience, and choice of statistical models. Analyst judgment was exercised in determining the applicability and appropriateness of data and models used to support frequency estimates in the L3PRA project.	In the L3PRA project, internal flooding initiating event frequencies were based on the most recent available data sources. Additional analysis is not expected to significantly change initiating event frequency values. The uncertainty in the initiating event frequencies was addressed by performing parameter uncertainty analysis.
Internal Flood Accident Sequences and Quantification (IFQU)	The screening HEPs that are selected for maintenance-related human errors for maintenance-induced flooding scenarios represent a source of model uncertainty.	Maintenance-induced internal flooding initiating event frequencies incorporate screening HEP values in estimating the event frequencies. The frequency estimates involve a combination of human failure events: failure to properly restore system after maintenance (screening HEP of 0.01) and failure to mitigate flooding when system is returned to service (screening HEP of 0.1). To account for uncertainty in these screening HEP values, the combined HEP value is varied in sensitivity analyses.
	The internal flooding analysis identified post-flood human failure events (HFEs) that are unrelated	While there are several post-flood HFEs that are important to the model results, most are not expected to be impacted by

Table 4.5 Sources of Model Uncertainty

Technical Element	Source of NRC IFPRA Model Uncertainty	Impact on NRC IFPRA Model
	to flood mitigation. These HFEs can be influenced by stress and other factors related to the flooding scenarios. A set of HEP multiplier values to scale HEP values for flood scenarios could be developed. Such HEP multipliers were not implemented in the NRC IFPRA model due to insignificant contribution from the post-flood HFEs that are expected to be affected by the flooding.	flooding effects. Implementing the HEP multipliers would result in a small increase in the CCDP for a small number of internal flooding scenarios.

4.5.1. Internal Flooding Initiating Event Frequencies

Description – Some internal flooding scenarios can have significant impacts on important-to-safety SSCs. The risk associated with internal flooding is often limited by the relatively low frequency of flooding initiating events. However, estimates of flooding initiating event frequencies can include significant uncertainties. Limited flooding data, size of piping systems at the plant, choice of system and pipe diameter categorization, use of surrogate data, incorporation of plant-specific data, choice of prior distribution, and other factors can all influence the flooding frequency estimates. In addition, the widely-used model for internal flooding frequencies is based on a product of the length of pipe, failure rate per length of pipe, and conditional rupture probability. One can question whether this model is appropriate for all piping systems, and the choice of this model itself introduces uncertainty. The point estimate value for internal flooding CDF can be estimated with initiating events set to different values within their uncertainty distributions to explore the sensitivity to these frequencies.

Sensitivity Case – For this sensitivity case, the IFPRA is quantified using the 95th percentile upper bound estimate for all inititiating event frequencies. The 95th percentile upper bound values for each flooding initiating event are shown in Table A.1-3 of Appendix A.

Results – This sensitivity resulted in a significant increase to the overall internal flooding CDF from 7.9×10^{-7} to 2.2×10^{-6} per reactor-critical-year. The individual contribution of every flooding scenario is increased in this sensitivity case, but the relative CDF contributions of the flooding scenarios are largely unchanged from the base case.

Sensitivity Case – Another sensitivity case was quantified using the 5th percentile lower bound estimate for all inititiating event frequencies.

Results – This sensitivity resulted in a significant decrease to the overall internal flooding CDF from 7.9×10^{-7} to 1.0×10^{-7} per reactor-critical-year.

4.5.2. Human Error Probabilities for Maintenance-Induced Flooding Scenarios

Description – Maintenance-induced internal flooding initiating event frequencies incorporate screening HEP values in estimating the event frequency. The selection of these screening

values introduces uncertainty in the model. The HEP values are intended to be conservative screening values; however, considering variations in the conditions associated with the failure evnets could drive these failure probabilities to be either higher or lower than the screening values. The frequency estimates involve a combination of human failure events: failure to properly restore system after maintenance (screening HEP of 0.01) and failure to mitigate flooding when system is returned to service (screening HEP of 0.1). The combined HEP values are varied higher and lower by a factor of 10 to account for uncertainty in these screening HEP values.

Sensitivity Case – The combined HEP values for the maintenance-induced flooding scenarios are increased by a factor of 10.

Results – This sensitivity case has a small impact on the overall internal flooding CDF. The CDF increased from 7.9×10^{-7} to 8.0×10^{-7} per reactor-critical-year. The two maintenance-induced flooding scenarios, 1-FLI-TB_500_HI1 and 1-FLI-TB_500_HI2, do not contribute significantly to the base case CDF results. With this sensitivity case, the two scenarios show increased CDF values, but both are still under 1 percent of the total internal flooding CDF. The CDF for scenario 1-FLI-TB_500_HI1 increased from 5.7×10^{-10} to 6.9×10^{-9} per reactor-critical-year. The CDF for scenario 1-FLI-TB_500_HI2 increased from 6.7×10^{-10} to 7.8×10^{-9} per reactor-critical-year.

Sensitivity Case – The combined HEP values for the maintenance-induced flooding scenarios are decreased by a factor of 10.

Results – This sensitivity case has minimal impact on the overall internal flooding CDF. The CDF is unchanged from 7.9×10^{-7}, though the number of cut sets is slightly reduced from 8728 to 8630. The CDF for scenario 1-FLI-TB_500_HI1 decreased from 5.7×10^{-10} to 4.3×10^{-11} per reactor-critical-year. The CDF for scenario 1-FLI-TB_500_HI2 decreased from 6.7×10^{-10} to 5.3×10^{-11} per reactor-critical-year.

4.5.3. Human Error Probabilities for Failures Unrelated to Flood Mitigation

Description – For evaluation of post-flood human failure events in the portion of the plant response not related to flood mitigation, the flooding impacts should be taken into consideration in the performance shaping factors that influence these failures. For the areas that are impacted by the flood, it is assumed that local actions are not possible. For actions that are not located in areas affected by the flood, the impacts on human performance can vary depending on the specific performance shaping factors that are present. For actions in the main control room, increased stress due to the flooding event is the primary concern for influencing actions. For actions outside the main control room, accessibility and additional time required to perform actions can influence the failure events. This sensitivity case is developed to explore the impacts on HEP values for human failures unrelated to the flood mitigation.

Sensitivity Case – All HEP values are set to 10 times their nominal values. If the HEP is 0.1 or higher, then the value is set to 0.9. For one of the modeled human failure events (basic event 1-OA-NSCWFAN---H), the basic event is assigned a failure probability of 1.0 (i.e., the event is failed) in the base model. That event failure probability is also set to 1.0 in this sensitivity case.

Results – For this sensitivity case the CDF increased from 7.9×10^{-7} to 2.4×10^{-6} per reactor-critical-year. The resulting cut sets show that human failure events associated with operator failure to initiate feed and bleed (basic event 1-OAB_TR-------H) and operator failure to trip reactor coolant pumps (basic event 1-RCS-XHE-XM-TRIP) are significant contributors to CDF. For many of the significant human failure events, the actions take place in the main control room. Also, the baseline HEP estimate for most events assumes high stress level. The increased stress associated with the flooding event is expected to have a small impact on the

HEP value. Therefore, this sensitivity case is expected to overestimate the impacts of flooding on HEP values. A second sensitivity case is developed to focus only on actions performed outside of the main control room.

Sensitivity Case – All the modeled HFEs in the IFPRA were reviewed to identify the locations of where the actions are performed. Only four HFEs were identified that represent actions performed outside the main control room. Several other ex-control room actions were considered, but ultimately only these four events were modeled in the internal events and internal flooding models. For these HFEs, the HEP values are set to 10 times their nominal values. The adjustments to the HEP values for internal flooding events are shown in Table 4.6

Table 4.6 Internal Flooding Adjustments to HEP Values for Actions Outside the Control Room

Basic Event Name	Description	Base HEP	Location for Operator Action	HEP Used for Flooding
1-OA-ALIGNPW-01HR	OPERATOR FAILS TO ALIGN PLANT WILSON TO 4.16KV BUS WITHIN 1 HR AFTER SBO	9.2E-02	Switchyard	9.2E-01
1-OA-ALIGNPW-02HR	OPERATOR FAILS TO ALIGN PLANT WILSON TO 4.16KV BUS WITHIN 2 HR AFTER SBO	1.2E-02	Switchyard	1.2E-01
1-OA-HURGXFMR--H	OPERATOR FAILS LOCAL CHANGE 120VAC SUPPLY FROM INVERTER TO RGXFMR	3.4E-03	Control Building	3.4E-02
1-OA-NSCWCT-MV-H	OPERATOR FAILS TO LOCALLY OPEN NSCW CT SPRAY MOV NO SI	1.1E-02	Service Water Pump House	1.1E-01

Results – This sensitivity case has minimal impact on the overall internal flooding CDF. The CDF is unchanged from 7.9×10^{-7}, though the number of cut sets is slightly increased from 8728 to 8984.

4.5.4. Crediting Improved RCP Shutdown Seals

Description – To assess the impact on risk from improvements in RCP Shutdown seals, a sensitivity study was done based on low leakage RCP seals (Westinghouse SHIELD® Passive Shutdown Seal). For these seals, RCP seal leakage was assumed to be 1 gpm per RCP after seal actuation. The inclusion of these seals can have a significant effect on the model results.

Sensitivity Case – To evaluate the effect of the RCP shutdown RCP seals on the Level 1 IFPRA model results, basic event 1-RCS-SDS-FC-ACTUATE (*shutdown seals fail to actuate*), which is set to TRUE in the base model, was assigned a failure probability.[10] This basic event was located in the 1-SDS (*shutdown seal actuation*), 1-RCPSC (*RCP seal cooling/integrity*), 1-

[10] The failure probability for the low leakage RCP seals was taken from the Final Safety Evaluation by the Office Of Nuclear Reactor Regulation, PWROG-14001-P, Revision 1, "PRA Model for the Generation III Westinghouse Shutdown Seal," (Ref. IF- 15). The failure probability is proprietary and is redacted from the public version of the safety evaluation report.

RCPSC-BP (*RCP seal integrity–binding/popping*), and 1-OPR-RCPS (*RCP seal integrity lost during SBO*) fault trees. In addition to the failure of the shutdown seals to actuate, there was potential that the seals may not remain sealed. Therefore, an additional basic event, 1-RCS-SDS-SEALED (*shutdown seals fail to remain sealed*), was added under the same OR gates (1-SDS, 1-RCPSC2223, 1-RCPS-BP21, and 1-OPR-RCPS-02, respectively) with basic event 1-RCS-SDS-FC-ACTUATE. The assumed hourly failure rate is based on NRC's evaluation of the improved RCP seal (Ref. IF- 15).

The station blackout (SBO) event tree was also modified to account for the RCP shutdown seals. The changes are consistent with the sensitivity case discussed in Section 10.8 of the internal events Level 1 PRA model report (Ref. IF- 16). However, the SBO event tree does not contribute to any of the significant accident sequences for the IFPRA. Refer to the internal events Level 1 PRA report for more information on the SBO changes.

<u>Results</u> – This sensitivity resulted in a decrease of the overall internal flooding CDF from 7.9×10^{-7} to 6.4×10^{-7} per reactor-critical-year (an approximately 19 percent decrease). In the base model, seven of the top ten accident sequences involve RCP seal failures resulting in small LOCAs (sequences identified by sequence number 1-11-08-1). In the sensitivity case, these sequences are still significant contributors to overall CDF, though to a lesser extent than the base model. The top 20 accident sequences for the sensitivity case are shown in Table 4.7. After accounting for the reduced failure rate of the shutdown seals, the highest contribution to the RCP seal failure is due to the human error associated with failing to trip the running RCPs (basic event 1-RCS-XHE-XM-TRIP). In some of the significant flood scenarios, the flood intiator impacts the availability of service water, and this impacts the likelihood of reactor coolant system (RCS) injection failure after the small LOCA occurs. This is another factor that contributes to the importance of these sequences.

Table 4.7 Internal Flooding Accident Sequences with RCP Shutdown Seals

	Scenario Name	Sequence Number	CDF/ry	% of CDF	Cumulative % of CDF	Cut Set Count
1	1-FLI-AB_C113_LF1	1-10-1	7.8E-08	12.1	12.1	177
2	1-FLI-AB_C120_LF	1-10-1	6.8E-08	10.6	22.7	181
3	1-FLI-AB_C113_LF1	1-11-08-1	4.7E-08	7.4	30.1	91
4	1-FLI-AB_C115_LF	1-10-1	4.6E-08	7.2	37.3	153
5	1-FLI-AB_C120_LF	1-11-08-1	3.8E-08	5.9	43.2	84
6	1-FLI-CB_122_SP	1-15-1	3.6E-08	5.5	48.7	105
7	1-FLI-CB_123_SP	1-15-1	3.6E-08	5.5	54.3	105
8	1-FLI-AB_C115_LF	1-11-08-1	2.8E-08	4.4	58.6	82
9	1-FLI-AB_108_SP1	1-11-08-1	2.6E-08	4.0	62.6	167
10	1-FLI-AB_108_SP2	1-11-08-1	2.6E-08	4.0	66.6	167
11	1-FLI-CB_123_SP	1-11-08-1	2.5E-08	3.9	70.5	167
12	1-FLI-CB_122_SP	1-11-08-1	2.5E-08	3.9	74.4	167
13	1-FLI-CB_123_SP	1-21-1	1.3E-08	2.1	76.5	525
14	1-FLI-CB_122_SP	1-21-1	1.3E-08	2.1	78.6	525
15	1-FLI-TB_500_LF	1-10-1	1.0E-08	1.6	80.2	401
16	1-FLI-AB_108_SP1	1-21-1	7.2E-09	1.1	81.3	309
17	1-FLI-AB_108_SP2	1-21-1	7.2E-09	1.1	82.4	309

	Scenario Name	Sequence Number	CDF/ry	% of CDF	Cumulative % of CDF	Cut Set Count
18	1-FLI-CB_A60	1-15-1	6.6E-09	1.0	83.4	51
19	1-FLI-AB_108_SP1	1-04-1	6.6E-09	1.0	84.5	111
20	1-FLI-AB_108_SP2	1-04-1	6.6E-09	1.0	85.5	105
	Total CDF		**6.4E-07**			**7510**

4.5.5. Propagation Factor for Flooding Scenario 1-FLI-CB_A48

Description – The potential for flood propagation from a corridor to the train A safety-related 4.16 KV AC switchgear room is modeled in flooding scenario 1-FLI-CB_A48. A propagation factor was assumed that represents the likelihood of flood sources propagating to the switchgear room. The likelihood of propagation to the switchgear room depends on break size, location, and effectiveness of the flood mitigation features (e.g., floor drains).

Sensitivity Case – To address uncertainty in the likelihood of propagation, the propagation factor is set to 1.0 from the base case value of 0.1.

Results – This sensitivity resulted in an increase of the overall internal flooding CDF from 7.9×10^{-7} to 9.2×10^{-7} per reactor-critical-year (an approximately 16% increase). The increase in CDF is attributed to the increased contribution from flooding scenario 1-FLI-CB_A48. The CDF of flood scenario 1-FLI-CB_A48 increased from 1.4×10^{-8} to 1.4×10^{-7} per reactor-critical-year.

4.5.6. Potential Flood Propagation Impacting Both Safety-Related 4160 VAC Switchgears

Description – Given the importance of the 4160 VAC essential switchgear rooms, additional evaluation of flood propagation that could impact both safety-related trains may be warranted. Flood propagation to the train A switchgear room is described in scenario 1-FLI-CB_A48. The train B switchgear room is located adjacent to the train A room, but there are several features in place that inhibit flood propagation. Neither of the switchgear rooms contain any flood sources. There are no direct propagation paths between the two rooms. The flood scenario would have to initiate in the adjoining corridor and then propagate to both rooms. The train B switchgear room is protected by a 6-inch high curb at the door, and the equipment in the room is mounted on a 6-inch high pedestal. There are multiple flood propagation paths and drains that would slow the flood height increase and would likely prevent overtopping the 6-inch curb. As such, flood propagation to both switchgear rooms is very unlikely.

Sensitivity Case – Flooding scenario 1-FLI-CB_A48 is modified to address the potential for flood propagation to both safety-related 4160 VAC switchgear rooms. The probability of flood propagation to both rooms is assumed to be 1×10^{-2}. This is considered to be a conservative estimate, since the propagation to the train B room is unlikely due to the protection from a curb at the door and the presence of several other potential propagation paths and floor drains. Even if such a flood were to occur, then plant staff would be expected to have time to pursue flood mitigating actions (e.g., isolating the flood source) before the train B room was impacted. These flood mitigating actions are not credited in the sensitivity case. Also, the impacts of the flood are assumed to fail all switchgears in both rooms. A more detailed analysis of the flood height may support less severe flooding impacts. If the flooding does cause loss of power to both safety-related 4160 VAC buses, then power will be unavailable to safety-related equipment required for core cooling (e.g., AFW and ECCS motor-driven pumps). No credit is given for continued operation of the turbine-driven AFW pump after battery depletion (4-hour battery life). No credit

is given to recovering the safety-related loads after the switchgear equipment is failed. If the flood impacts both switchgear rooms, then core damage is assumed.

Results – This sensitivity resulted in a significant increase to the internal flooding CDF from 7.9×10^{-7} to 1.7×10^{-6} per reactor-critical-year. In this sensitivity case, the flooding scenario impacting both safety-related 4160 VAC switchgear rooms (scenario 1-FLI-CB_A48) contributes more than half of the total internal flooding CDF. This is expected to be a bounding assessment of the scenario for the reasons discussed above. The individual flooding scenario contributions for this sensitivity study are shown in Table 4.8.

Table 4.8 Internal Flooding Scenario Results With Propagation to Both Safety-Related 4160 VAC Switchgear Rooms

	Scenario Name	IE frequency per reactor-critical-year	CCDP	CDF per reactor-critical-year	% of CDF	Cut Set Count
1	1-FLI-CB_A48	9.2E-05	1.0E-02	9.2E-07	54.2	1
2	1-FLI-AB_C113_LF1	2.2E-04	6.9E-04	1.6E-07	9.2	348
3	1-FLI-AB_C120_LF	1.8E-04	7.2E-04	1.3E-07	7.7	347
4	1-FLI-CB_123_SP	2.8E-04	3.7E-04	1.0E-07	6.0	1393
5	1-FLI-CB_122_SP	2.8E-04	3.7E-04	1.0E-07	6.0	1389
6	1-FLI-AB_C115_LF	1.3E-04	6.9E-04	9.2E-08	5.4	300
7	1-FLI-AB_108_SP1	2.8E-04	2.1E-04	5.9E-08	3.5	1135
8	1-FLI-AB_108_SP2	2.8E-04	2.1E-04	5.9E-08	3.5	1127
9	1-FLI-CB_A60	5.2E-05	3.6E-04	1.9E-08	1.1	493
10	1-FLI-TB_500_LF	2.2E-03	7.6E-06	1.6E-08	1.0	701
11	1-FLI-DGB_101_LF	7.3E-06	8.5E-04	6.2E-09	0.4	70
12	1-FLI-AB_D74_FP	8.6E-06	6.9E-04	5.9E-09	0.3	89
13	1-FLI-AB_C118_LF	7.5E-06	7.3E-04	5.5E-09	0.3	75
14	1-FLI-AB_B08_LF	7.7E-06	6.9E-04	5.3E-09	0.3	72
15	1-FLI-DGB_103_LF	7.3E-06	7.0E-04	5.1E-09	0.3	79
16	1-FLI-TB_500_LF-CDS	6.3E-04	7.2E-06	4.5E-09	0.3	303
17	1-FLI-AB_B24_LF2	3.5E-06	7.1E-04	2.5E-09	0.1	74
18	1-FLI-AB_B50_JI	3.4E-06	7.3E-04	2.4E-09	0.1	56
19	1-FLI-AB_A20	2.7E-04	6.8E-06	1.8E-09	0.1	153
20	1-FLI-TB_500_HI2	9.4E-05	7.2E-06	6.7E-10	0.0	59
21	1-FLI-TB_500_HI1	9.4E-05	6.1E-06	5.7E-10	0.0	58
22	1-FLI-AB_D78_FP	3.6E-07	6.7E-04	2.4E-10	0.0	24
23	1-FLI-AB_A20_FP	2.3E-05	8.5E-06	1.9E-10	0.0	51
	Total:	**5.1E-03**		**1.7E-06**		**8397**

4.5.7. Application of Spray Direction Factor

Description – In some PRA studies, a spray direction factor that accounts for the spray's direction with respect to the pipe's circumference is applied when supported by a detailed

engineering evaluation. Spray events are generally characterized as having small through-wall pipe failures and low break flow rates. Accordingly, the impacts on nearby equipment can be expected to be less severe than those of larger flooding events. The equipment impacted by spray events are assumed to be within a direct line-of-sight of the pipe failure and result in spraying or splashing on the affected component(s). The approach for estimating spray frequency does not account for the direction of the spray. Applying a spray direction factor has the effect of reducing the spray frequency to account for the fraction of spray events that would be directed toward the impacted equipment. This assumes that some spray events would be directed away from the equipment and would not result in equipment failure.

Sensitivity Case – To evaluate the effect of the spray direction a factor of 1/8 is multiplied by the initiating event frequency for flooding scenarios that model impacts from sprays or jet impingment..[11] The spray direction factor is applied to the following internal flooding scenarios: 1-FLI-AB_108_SP1, 1-FLI-AB_108_SP2, 1-FLI-CB_122_SP, 1-FLI-CB_123_SP, and 1-FLI-AB_B50_JI.

Results – This sensitivity resulted in a decrease to the internal flooding CDF from 7.9×10^{-7} to 5.0×10^{-7} per reactor-critical-year (an approximately 37 percent decrease). The individual flooding scenario contributions for this sensitivity study are shown in Table 4.9.

Table 4.9 Internal Flooding Scenario Results With Spray Direction Factor

	Scenario Name	IE frequency per reactor-critical-year	CCDP	CDF per reactor-critical-year	% of CDF	Cut Set Count
1	1-FLI-AB_C113_LF1	2.2E-04	6.9E-04	1.6E-07	30.8	348
2	1-FLI-AB_C120_LF	1.8E-04	7.2E-04	1.3E-07	25.8	347
3	1-FLI-AB_C115_LF	1.3E-04	6.9E-04	9.2E-08	18.3	300
4	1-FLI-CB_A60	5.2E-05	3.6E-04	1.9E-08	3.7	493
5	1-FLI-TB_500_LF	2.2E-03	7.6E-06	1.6E-08	3.2	701
6	1-FLI-CB_A48	9.2E-05	1.5E-04	1.4E-08	2.8	332
7	1-FLI-CB_123_SP	3.5E-05	3.6E-04	1.2E-08	2.5	400
8	1-FLI-CB_122_SP	3.5E-05	3.6E-04	1.2E-08	2.5	399
9	1-FLI-AB_108_SP1	3.5E-05	2.0E-04	7.1E-09	1.4	230
10	1-FLI-AB_108_SP2	3.5E-05	2.0E-04	7.1E-09	1.4	229
11	1-FLI-DGB_101_LF	7.3E-06	8.5E-04	6.2E-09	1.2	70
12	1-FLI-AB_D74_FP	8.6E-06	6.9E-04	5.9E-09	1.2	89
13	1-FLI-AB_C118_LF	7.5E-06	7.3E-04	5.5E-09	1.1	75
14	1-FLI-AB_B08_LF	7.7E-06	6.9E-04	5.3E-09	1.0	72
15	1-FLI-DGB_103_LF	7.3E-06	7.0E-04	5.1E-09	1.0	79
16	1-FLI-TB_500_LF-CDS	6.3E-04	7.2E-06	4.5E-09	0.9	303
17	1-FLI-AB_B24_LF2	3.5E-06	7.1E-04	2.5E-09	0.5	74

[11] The authors are not aware of any rigorous analyses that have been performed to justify a particular spray direction factor. For this sensitivity case, a spray direction factor of 1/8 was selected based on engineering judgment and its use in at least one other internal flooding PRA.

Table 4.9 Internal Flooding Scenario Results With Spray Direction Factor

	Scenario Name	IE frequency per reactor-critical-year	CCDP	CDF per reactor-critical-year	% of CDF	Cut Set Count
18	1-FLI-AB_A20	2.7E-04	6.8E-06	1.8E-09	0.4	153
19	1-FLI-TB_500_HI2	9.4E-05	7.2E-06	6.7E-10	0.1	59
20	1-FLI-TB_500_HI1	9.4E-05	6.1E-06	5.7E-10	0.1	58
21	1-FLI-AB_B50_JI	4.2E-07	7.0E-04	2.9E-10	0.1	26
22	1-FLI-AB_D78_FP	3.6E-07	6.7E-04	2.4E-10	0.1	24
23	1-FLI-AB_A20_FP	2.3E-05	8.5E-06	1.9E-10	0.0	51
	Total:	**4.2E-03**		**5.0E-07**		**4912**

4.5.8. Credit for Manual Action to Start Service Water Cooling Tower Fans

Description – One of the significant basic events in the IFPRA model involves an operator failure to manually start service water cooling tower fans following a safety injection or loss of offsite power signal (basic event 1-OA-NSCWFAN---H). In the base model, no credit is given for this action, which is consistent with the modeling approach in the reference plant PRA. The basic event is included in the model with failure probability set to 1.0. The event is present in several significant cut sets. The Fussell-Vesely importance measure for this basic event indicates an approximately 21 percent contribution to internal flooding CDF. The accident sequences that contain these cut sets involve a secondary-side break upstream of the MSIVs that is induced by the flooding initiating event, resulting in a reactor trip, main steamline isolation, and safety injection actuation. Subsequent failures result in an RCP seal LOCA. The success criterion requires 3 out of 4 service water cooling tower fans for successful operation during safety injection. The relevant cut sets include combinations of the fans failure to start and operator failure to manually start the fans. These cut sets are potentially conservative because there is no credit given for the manual actions. Also, the safety injection can be terminated after RCS level has been recovered and is stable. At that time, the success criterion is 1 out of 4 service water cooling tower fans for successful operation.

Sensitivity Case – To evaluate the effect of applying credit for manual action to start service water cooling tower fans, the basic event failure probability is set to 0.1.

Results – This sensitivity resulted in a decrease to the internal flooding CDF from 7.9×10^{-7} to 6.4×10^{-7} per reactor-critical-year (an approximately 19 percent decrease). The contributions from accident sequences that involve a flood-related secondary-side break resulting in an RCP seal LOCA are significantly reduced. The flooding scenarios that include these sequences are 1-FLI-AB_108_SP1, 1-FLI-AB_108_SP2, 1-FLI-CB_122_SP, 1-FLI-CB_123_SP, and 1-FLI-CB_A60. The CDF contributions from all these scenarios are reduced with this sensitivity case. The flooding scenario contributions to CDF are shown in Table 4.10.

Table 4.10 Internal Flooding Scenario Results With Credit for Manual Action to Start Service Water Cooling Tower Fans

	Scenario Name	IE frequency per reactor-critical-year	CCDP	CDF per reactor-critical-year	% of CDF	Cut Set Count
1	1-FLI-AB_C113_LF1	2.2E-04	6.9E-04	1.6E-07	24.4	348
2	1-FLI-AB_C120_LF	1.8E-04	7.2E-04	1.3E-07	20.4	347
3	1-FLI-AB_C115_LF	1.3E-04	6.9E-04	9.2E-08	14.5	300
4	1-FLI-CB_123_SP	2.8E-04	2.3E-04	6.6E-08	10.3	1105
5	1-FLI-CB_122_SP	2.8E-04	2.3E-04	6.6E-08	10.3	1101
6	1-FLI-AB_108_SP1	2.8E-04	8.1E-05	2.3E-08	3.6	824
7	1-FLI-AB_108_SP2	2.8E-04	8.1E-05	2.3E-08	3.6	816
8	1-FLI-TB_500_LF	2.2E-03	7.6E-06	1.6E-08	2.6	697
9	1-FLI-CB_A48	9.2E-05	1.5E-04	1.4E-08	2.2	300
10	1-FLI-CB_A60	5.2E-05	2.3E-04	1.2E-08	1.9	385
11	1-FLI-DGB_101_LF	7.3E-06	8.5E-04	6.2E-09	1.0	70
12	1-FLI-AB_D74_FP	8.6E-06	6.9E-04	5.9E-09	0.9	89
13	1-FLI-AB_C118_LF	7.5E-06	7.3E-04	5.5E-09	0.9	75
14	1-FLI-AB_B08_LF	7.7E-06	6.9E-04	5.3E-09	0.8	72
15	1-FLI-DGB_103_LF	7.3E-06	7.0E-04	5.1E-09	0.8	79
16	1-FLI-TB_500_LF-CDS	6.3E-04	7.2E-06	4.5E-09	0.7	302
17	1-FLI-AB_B24_LF2	3.5E-06	7.1E-04	2.5E-09	0.4	74
18	1-FLI-AB_B50_JI	3.4E-06	7.3E-04	2.4E-09	0.4	56
19	1-FLI-AB_A20	2.7E-04	6.8E-06	1.8E-09	0.3	153
20	1-FLI-TB_500_HI2	9.4E-05	7.2E-06	6.7E-10	0.1	59
21	1-FLI-TB_500_HI1	9.4E-05	6.1E-06	5.7E-10	0.1	58
22	1-FLI-AB_D78_FP	3.6E-07	6.7E-04	2.4E-10	0.0	24
23	1-FLI-AB_A20_FP	2.3E-05	8.5E-06	1.9E-10	0.0	51
	Total:	**5.2E-03**		**6.4E-07**		**7385**

4.5.9. Impact of Consequetial Loss of Offsite Power on Internal Flooding Scenarios

Description – A consequential loss of offsite power (LOOP) can occur in response to a reactor trip or other plant transients as electrical loads are transferred to power sources supplied from the offsite grid. The consequential LOOP modeling approach is described in the internal events Level 1 PRA model report (Ref. IF- 16), and the same approach is adopted for the IFPRA model. Consequential LOOPs are a significant contributor to the internal flooding CDF, as can be seen in the discussion of significant accident sequences in Section 4.2. However, many of the flooding scenarios would not result in an immediate plant trip. Operators may initiate a manual reactor trip or a controlled plant shutdown. If a controlled plant shutdown is initiated,

then this would not have the same impacts on the electrical distribution system as a reactor trip or other plant transients.

Sensitivity Case – To evaluate the impacts of the consequential LOOP modeling, a sensitivity case is developed to suppress the consequential LOOP failures in the internal flooding scenarios that do not result in an immediate plant trip. The internal flooding scenarios that do not result in an immediate plant trip are:

- 1-FLI-AB_B24_LF2
- 1-FLI-AB_B50_JI
- 1-FLI-AB_C113_LF1
- 1-FLI-AB_C115_LF
- 1-FLI-AB_C118_LF
- 1-FLI-AB_C120_LF
- 1-FLI-AB_D74_FP
- 1-FLI-AB_D78_FP
- 1-FLI-DGB_101_LF
- 1-FLI-DGB_103_LF

The basic event used to model the consequential LOOP probability (basic event 1-OEP-VCF-LP-CLOPT) is ignored in these flooding scenarios.

Results – This sensitivity resulted in a decrease to the internal flooding CDF from 7.9×10^{-7} to 5.9×10^{-7} per reactor-critical-year (an approximately 25 percent decrease). The contribution from accident sequences involving consequtial LOOPs are significantly reduced. In the base model, one of the significant accident sequences involves a failure of NSCW piping and a subsequent LOOP. The sequence is identified by sequence number 1-10-1 (see base model accident sequence results in Table 4.2). For the sensitivity case, the CDF contributions from sequence number 1-10-1 are significantly reduced. The top 20 accident sequences for the sensitivity case are shown in Table 4.11. Sequence number 1-10-1 does not appear in the top 20 accident sequences for any of the flooding scenarios that would not result in an immediate plant trip.

Table 4.11 Internal Flooding Accident Sequences Suppressing Consequential LOOP for Flooding Scenarios Not Causing Plant Trip

	Scenario Name	Sequence Number	CDF/ry	% of CDF	Cumulative % of CDF	Cut Set Count
1	1-FLI-AB_C113_LF1	1-11-08-1	7.8E-08	13.2	13.2	150
2	1-FLI-AB_C120_LF	1-11-08-1	6.2E-08	10.6	23.8	146
3	1-FLI-AB_C115_LF	1-11-08-1	4.6E-08	7.8	31.6	136
4	1-FLI-AB_108_SP1	1-11-08-1	4.2E-08	7.1	38.6	303
5	1-FLI-AB_108_SP2	1-11-08-1	4.2E-08	7.1	45.7	303
6	1-FLI-CB_123_SP	1-11-08-1	4.1E-08	7.0	52.7	292
7	1-FLI-CB_122_SP	1-11-08-1	4.1E-08	7.0	59.8	292
8	1-FLI-CB_122_SP	1-15-1	3.6E-08	6.0	65.8	105
9	1-FLI-CB_123_SP	1-15-1	3.6E-08	6.0	71.9	105
10	1-FLI-CB_123_SP	1-21-1	1.3E-08	2.3	74.1	525
11	1-FLI-CB_122_SP	1-21-1	1.3E-08	2.3	76.4	525
12	1-FLI-TB_500_LF	1-10-1	1.0E-08	1.8	78.1	401

Table 4.11 Internal Flooding Accident Sequences Suppressing Consequential LOOP for Flooding Scenarios Not Causing Plant Trip

	Scenario Name	Sequence Number	CDF/ry	% of CDF	Cumulative % of CDF	Cut Set Count
13	1-FLI-CB_A60	1-11-08-1	7.6E-09	1.3	79.4	104
14	1-FLI-AB_108_SP2	1-21-1	7.2E-09	1.2	80.6	309
15	1-FLI-AB_108_SP1	1-21-1	7.2E-09	1.2	81.9	309
16	1-FLI-CB_A60	1-15-1	6.6E-09	1.1	83.0	51
17	1-FLI-AB_108_SP1	1-04-1	6.6E-09	1.1	84.1	111
18	1-FLI-AB_108_SP2	1-04-1	6.6E-09	1.1	85.2	105
19	1-FLI-CB_A48	2-10-1	5.7E-09	1.0	86.2	43
20	1-FLI-CB_123_SP	1-04-1	4.9E-09	0.8	87.0	69
	Total CDF		**5.9E-07**			**8116**

4.5.10. Summary of Sensitivity Analysis Results

A summary of the results of the sensitivity cases documented in this report is provided below. As evident from the table, the largest increases in CDF occur in the following cases:

- Increasing the HEPs for all human failure events unrelated to flood mitigation (204 percent increase in internal flooding CDF)
- Using the 95^{th} percentile upper bound estimate for all flooding initiating event frequencies (178 percent increase in internal flooding CDF)
- Assuming a safety-related 4160 VAC switchgear room flood propagates to the room for the other train of safety-related 4160 VAC switchgear (115 percent increase in internal flooding CDF)

In the first case above, most of the impact comes from the failure of operator actions in the main control room (MCR). Since the baseline HEPs for most of these human failure events already assume a high stress level, the increased stress associated with a flooding event is not expected to have a significant impact on the HEPs. A follow-up sensitivity analysis showed that if operator actions in the MCR are excluded, there is virtually no increase in internal flooding CDF.

In the second case above, it is clear that the total internal flooding CDF is very sensitive to the flooding initiating event frequencies. In fact, using the 5^{th} percentile lower bound estimate for all flooding initiating event frequencies results in the greatest decrease in internal flooding CDF of all of the sensitivity analyses performed. As such, estimation of flooding initiating event frequencies is a prime candidate for future research.

In the last case above, it is clear that a flood that can propagate and damage both trains of safety-related 4160 VAC switchgear will have a severe impact on plant safety (in the sensitivity case, this situation was assumed to lead directly to core damage). However, as discussed in Section 4.5.6, the likelihood of such an occurrence is extremely low.

Table 4.12 Summary of Sensitivity Cases Results

#	Description	Base CDF (per ry)	Sensitivity CDF (per ry)	Percent Change
1	Internal flooding initiating event frequencies • Use 95th percentile frequencies • Use 5th percentile frequencies	7.9E-07 7.9E-07	2.2E-06 1.0E-07	+178% -87%
2	Human error probabilities for maintenance-induced flooding scenarios • Increased HEPs (x10) • Decreased HEPs (x10)	7.9E-07 7.9E-07	8.0E-07 7.9E-07	+1% —
3	Human error probabilities for failures unrelated to flood mitigation • All HEPs increased (x10) • Ex-MCR HEPs increased (x10)	7.9E-07 7.9E-07	2.4E-06 7.9E-07	+204% —
4	Crediting improved RCP shutdown seals	7.9E-07	6.4E-07	-19%
5	Propagation factor for flooding scenario 1-FLI-CB_A48	7.9E-07	9.2E-07	+16%
6	Potential flood propagation impacting both safety-related 4160 VAC switchgears	7.9E-07	1.7E-06	+115%
7	Application of spray direction factor	7.9E-07	5.0E-07	-37%
8	Credit for manual action to start service water cooling tower fans	7.9E-07	6.4E-07	-19%
9	Impact of consequential loss of offsite power on internal flooding scenarios	7.9E-07	5.9E-07	-25%

4.6. Comparison of Results to Similar Plant

The NRC IFPRA results were compared to the flooding results from the SPAR model and IPE[12] of a similar four-loop PWR plant. The comparison plant's internal events and internal flooding PRA results were reviewed. The internal flooding scenarios contribute approximately 0.5 percent of the total internal events and internal flooding CDF for the comparison plant. The top 100 cut sets from the comparison plant's internal flooding scenarios were reviewed to identify similarities and differences compared to the NRC IFPRA.

Notable similarities between the NRC IFPRA and the comparison plant internal flooding results are observed:

- Both internal flooding PRAs have significant contributions from service water flood sources. These flood scenarios limit the availability of service water that is used to support the mitigating systems needed to respond to the plant transient.

[12] The Standardized Plant Analysis Risk (SPAR) models are SAPHIRE-based nuclear power plant PRA models primary used by the NRC to support risk assessments performed as part of the Significance Determination Process (SDP), Accident Sequence Precursor (ASP) Program, Management Directive (MD) 8.3, "Incident Investigation Program," and evaluation of notices of enforcement discretion (NOEDs). The individual plant evaluation (IPE) models are nuclear power plant PRA models for internal events and internal floods prepared by licensees in response to Generic Letter (GL) 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities - 10 CFR 50.54(f)," dated November, 23, 1988.

- Both internal flooding PRAs have significant contributions from accident sequences that initiate with a flood event and subsequent failure(s) resulting in RCP seal LOCA.

The comparison plant's internal flooding CDF is similar to that of NRC IFPRA. The comparison plant's internal flooding CDF is 3.4×10^{-7} per reactor-critical-year compared to the NRC IFPRA value of 7.9×10^{-7} per reactor-critical-year. While both plants have similar overall internal flooding results and both have significant contributions form service water pipe failures, the contributions due to other types of flooding scenarios are different. The following differences are noted:

- Other significant internal flooding contributors to the NRC IFPRA are scenarios involving pipe failures in the main steam valve rooms resulting in spurious operation of an atmospheric relief valve. The comparison plant does not include any type of similar internal flooding scenario.
- After the service water-related flooding scenarios, the next highest contributing scenarios in the comparison plant's internal flooding PRA is a failure of ECCS-related piping in the auxiliary building resulting in unavailability of the RWST and other ECCS equipment. This is comparable to the NRC IFPRA flooding scenario 1-FLI-AB_D78_FP, which involves failure of RHR system piping in the auxiliary building. The biggest difference between the comparison plant scenario and the NRC IFPRA scenario is the initiating event frequency. The NRC IFPRA has a significantly lower frequency for the similar scenario (3.6×10^{-7} per reactor-critical-year versus 2.7×10^{-3} per reactor-critical-year for the comparison plant). However, this comparison does not evaluate the many factors that can influence the initiating event frequency estimates (e.g., size of the flood source piping system or plant-specific operating experience). This level of detail was beyond the scope of this comparison of model results.
- Both the NRC IFPRA and the comparison plant modeled turbine building internal flooding scenarios. The CDF results for turbine building flooding is similar for both models. In both models the turbine building floods are characterized by high initiating event frequencies and low conditional core damage probabilities. This results in a modest contribution to overall internal flooding CDF. The modeled impacts of the flooding scenario are also similar in both models. The turbine building floods result in unavailability of the main condenser and loss of instrument air.
- The NRC IFPRA appears to include a broader range of internal flooding scenarios with different flooding sources, locations and impacts. The NRC IFPRA includes 23 modeled internal flooding scenarios and many other scenarios that were assessed quantitatively and screened. The comparison plant's internal flooding PRA includes eight modeled flood scenarios with five of the eight involving floods related to service water pipe failures.
- The comparison plant's initiating event frequencies for similar types of flooding scenarios are greater than those for the NRC IFPRA. The comparison plant's significant cut sets include flooding scenarios with frequencies of 2.7×10^{-3} per year and 1.0×10^{-3} per year. Similar scenarios in the NRC IFPRA model have frequencies of less than 3×10^{-4} per year.

The differences in the internal flooding PRA results for the comparison plant and NRC IFPRA results appear to be reasonable given the differences in the models' scopes. The two models include service water failure flooding and turbine building flooding scenarios that show similar impacts and similar CDF results. Both models have significant contributions from RCP seal failures that occur after the flooding initiating event. The two models have differences in the other types of internal flooding scenarios that are modeled. The differences in screening of flood areas and flood sources, initiating event frequencies, and modeling of flooding impacts

may be driven by many factors, including: locations and lengths of piping at the plants, equipment locations, physical layout of plant rooms, and flood mitigation features (i.e., curbs, drains, doors, etc.). Confirmation of these plant differences is beyond the scope of the NRC IFPRA study.

4.7. Key Insights

This section discusses the key insights obtained from the L3PRA Level 1 model for internal flooding (i.e., the IFPRA model).

The total internal flooding CDF results show that internal flooding scenarios are not a dominant risk contributor for the reference plant, compared to other internal and external hazards. The total internal flooding CDF is approximately 1 percent of the internal events CDF (as reported in Ref. IF- 16). Both failure of RCP seal cooling and consequential LOOP events contribute significantly to the dominant internal flooding accident sequences. Other important contributors to the internal flooding results are service water failures, which act as a flooding source and also impact the availability of accident mitigating equipment to respond to the event. Additional key insights are discussed below. Note that many of these insights are not solely relevant to this project, but likely affect internal flooding PRAs at other plants.

Consequential Loss of Offsite Power

A consequential LOOP can occur in response to a reactor trip or other plant transients as electrical loads are transferred to power sources supplied from the offsite grid. The IFPRA model adopts the same consequential LOOP modeling approach as described in the internal events Level 1 PRA model report (Ref. IF- 16). The basic event representing consequential LOOP following a reactor trip (basic event 1-OEP-VCF-LP-CLOPT) contributes approximately 28 percent to the total internal flooding CDF. As discussed in the sensitivity analysis in Section 4.5.9, the consequential LOOP modeling may overestimate the risk for flooding scenarios that would not result in an immediate plant trip. If operators initiate a controlled plant shutdown, then this would not cause the same stresses on the electrical system as a reactor trip or other plant transients. Assuming a reactor trip occurs for these flooding scenarios is a modeling simplification. The same simplifying assumption is used in the reference plant's internal flooding PRA. While most PRAs rely on some simplifying assumptions, as the impacts of these assumptions become significant, it is important to reevaluate the assumptions and strive for realism in the modeling.

Reactor Coolant Pump Seal Failure

Failures that result in loss of RCP seal cooling and lead to a small LOCA are significant contributors to the internal flooding CDF. However, not reflected in this model are the improved passive shutdown RCP seals at the reference plant. The inclusion of these seals can have a significant effect on the model results, decreasing the total internal flooding CDF by approximately 19 percent. The impacts of the improved RCP seals are discussed in the sensitivity case in Section 4.5.4.

Service Water Failures as a Flood Source

Several of the significant internal flooding scenarios involve failures of service water piping. The service water failures have important contributions both as a flood initiator and impacting accident mitigation capabilities. Several safety significant systems (e.g., ECCS and emergency diesel generators) depend on service water for successful operation. Also, the evaluation in EPRI's report on pipe rupture frequencies (Ref. IF- 9) suggests that service water pipe failure rates tend to be relatively high compared to those of other piping systems.

Internal Flooding Initiating Event Frequencies and Uncertainty

The internal flood initiating event frequency estimates are a significant factor in assessing the uncertainty of the internal flooding CDF results. Section 4.5.1 discusses sensitivity cases performed to evaluate the impacts of initiating event frequency uncertainty. The approach for estimating internal flooding initiating event frequencies is discussed in Appendix A.

The frequency analysis is based on the approach described in EPRI's pipe rupture frequency report (Ref. IF- 9). That report provides a systematic approach for estimating flooding frequencies based on system type, pipe size, failure mechanism, and other attributes. The report also provides a thorough assessment of industry-wide pipe failure and flooding operating experience; however, this operating experience is limited to the time frame available when the report was published. At the time of this study, Revision 3 of the EPRI report was available. Revision 3 evaluates piping operating experience through 2008 for most systems, though some systems include data through portions of years 2009 and 2010. For circulating water expansion joints, an important flooding source, the data are limited to 2004 and earlier. Revision 3 of the EPRI report shows comparisons of the failure rates for different piping systems that were calculated in the 2010 study and those calculated in an earlier revision in 2006. Many significant flooding sources show increased failure rates over this time frame. An ongoing piping data collection and analysis arrangement would be helpful to ensure that the most relevant data are being used in initiating event frequency analysis. This ongoing analysis of piping failure data is important, not only for the industry-wide results that are reported by EPRI, but also for incorporating plant-specific experience into the failure rate and flood frequency estimates.

There are many modeling choices in the initiating event frequency analysis that can introduce uncertainty. The evaluation of plant-specific data can have important impacts on the frequency estimates. Several modeling questions can arise. Are there consistent approaches for how the plant-specific data are defined as pipe failures and flood occurrences? Are there consistent approaches for evaluating pipe size categories, effective break sizes, and the total feet of system piping at the plant? How is uncertainty in these choices being incorporated into the frequency estimates? Other areas of uncertainty can include the choices of prior data to use for plant-specific updates and the statistical models used to represent the frequency distributions. Overall there are several modeling choices that introduce uncertainty in the frequency estimates. Although the EPRI report lays out a systematic framework for evaluating flooding frequencies, a plant-specific application of that framework involves many modeling choices that contribute to uncertainty.

Impact of Intiating Event Frequency Analysis on Internal Flooding Results

As discussed above, the initating event frequency analysis is an important part of the IFPRA model. An example of the impact that the initiating event frequency analysis has on the model results can be seen by the importance of the flooding scenarios involving spray events in the main steam valve rooms (scenarios 1-FLI-AB_108_SP1, 1-FLI-AB_108_SP2, 1-FLI-CB_122_SP, and 1-FLI-CB_123_SP). These scenarios have significant contributions to the overall internal flooding CDF.

These spray scenarios have relatively large initiating event frequencies compared to other internal flooding scenarios. Three key areas are identified that influence the initiating event frequency analysis for these scenarios:

- The scenarios model spray events, which are associated with small break sizes and small break flow rates. These scenarios generally have higher failure rates compared to larger flood events.

- In some internal flooding analyses, a spray direction factor is applied to reduce spray frequency. This approach assumes that some sprays will be directed away from susceptible equipment and cause no damage. For the spray scenarios modeled in the NRC IFPRA, there was not sufficient information available to support the application of a spray direction factor. However, the impact of a spray direction factor is assessed in a sensitivity study (Section 4.5.7).
- Plant-specific operating experience is incorporated, which results in a failure rate that is higher than the generic failure rate reported in the EPRI pipe rupture frequency report (Ref. IF-9). A summary of the approach for incorporating plant-specific experience is provided in Appendix A.

These factors combine to result in relatively large initiating event frequencies for the main steam valve room spray scenarios.

Electrical Power Distribution Equipment in Flooding Scenarios

Safety-related electrical distribution equipment (e.g., switchgears, breakers, and motor control centers) are often important risk contributors in PRA models. Protecting this equipment from flooding impacts is an important aspect of internal flooding risk. This study identifies five internal flooding scenarios where safety-related electrical equipment is impact by flooding (scenarios 1-FLI-CB_A48, 1-FLI-AB_D74_FP, 1-FLI-AB_D78_FP, 1-FLI-DGB_101_LF, and 1-FLI-DGB_103_LF). The risk significance of these scenarios is relatively low compared to other internal flooding and internal event accident scenarios. These results suggest the flood mitigation features at the reference plant are generally effective in limiting the flooding impacts to electrical equipment. However, the impacts could be more significant if more pressimistic assumptions are made regarding flood propagation. These alternative assumptions are explored in the sensitivity cases discussed in Section 4.5.5 and Section 4.5.6. Also, the internal flooding risk associated with impacting electrical equipment can be significant at other plants, if good flood mititgation features are not present. Examples of good flood mitigation features include (1) separation of flood sources from risk-significant equipment; (2) separation of redundant trains; and (3) the use of curbs and drains, and mounting equipment on raised pedestals, to limit impacts from flood propagation.

Turbine Building Flooding

The turbine building can be an important contributor to internal flooding risk. The flood sources located in this area (e.g., circulating water system, main steam lines, feedwater lines) have the potential to produce very large floods, and there are many flood sources in the area. One of the highest flood initiating event frequencies in this study is associated with a turbine building flood scenario (1-FLI-TB_500_LF). Despite the high initiating event frequency, the CDF results of the turbine building flood scenarios are relatively low compared to other internal flooding and internal event accident scenarios. The CCDP values for turbine building flood scenarios are lower than the CCDP values for other internal flooding scenarios, as is shown in Table 4.1. Yet, the turbine building flood sources may be more important for internal flooding PRAs for other plants. The impacts on equipment that is located in the turbine building, or equipment that can be impacted by flood propagation, will depend on the specific plant design and layout.

5. REFERENCES

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IF- 13 Electric Power Research Institute, *Treatment of Parameter and Model Uncertainty for Probabilistic Risk Assessments*, Technical Report 1016737, December 2008.

IF- 14 Electric Power Research Institute, *Guidelines for Performance of Internal Flooding Probabilistic Risk Assessment*, Technical Report 1019194, December 2009.

IF- 15 U.S. Nuclear Regulatory Commission, *Final Safety Evaluation by the Office of Nuclear Reactor Regulation PWROG-14001-P, Revision 1, “PRA Model for the Generation III Westinghouse Shut-Down Seal,”* August 23, 2017, ADAMS Accession No. ML17200C876.

IF- 16 U.S. Nuclear Regulatory Commission, *Level 3 PRA Project, Volume 3a: Reactor, At-Power, Level 1 PRA for Internal Events,* April 2022, ADAMS Accession No. ML22067A211.

APPENDIX A: FLOOD INITIATING EVENT FREQUENCY ANALYSIS

A.1. Initiating Event Frequency Analysis Approach

The initiating event frequency analysis was based on the approach described in EPRI's "Pipe Rupture Frequencies for Internal Flooding PRAs, Revision 3" (IF- 9). The initiating event frequency, f, for a given pipe break flooding scenario is given by the following expression,

$$f = l \times \lambda_{pipe} \times P_{pipe}(R|F) \quad [1]$$

where, l is the length of pipe (in feet) located in the flood area.

λ_{pipe} is the failure rate of the pipe per feet-critical reactor year.

$P_{pipe}(R/F)$ is the conditional rupture probability given pipe failure.

Similarly, the initiating event frequency can be expressed in terms of component failures that may be relevant to a flood scenario (e.g., failure of rubber expansion joints.)

$$f = n \times \lambda_{component} \times P_{component}(R|F) \quad [2]$$

where, n is the number of components located in the flood area.

$\lambda_{component}$ is the failure rate per component-critical reactor year.

$P_{component}(R/F)$ is the conditional rupture probability given component failure.

The EPRI report provides generic failure data for different types of plant systems. The data were further categorized in terms of the severity of pipe failure (e.g., wall thinning, pinhole leak, leak, major structural failure) and pipe size. The category definitions may vary depending on the type of system. The generic data and failure rates in the report were used to develop prior distributions for the pipe (or component) failure rates and conditional rupture probabilities.

The prior distributions were updated with plant-specific data. The plant-specific data considered for the NRC IFPRA cover the period from January 1, 1990 through December 31, 2012. The plant-specific flooding date are shown in Table A.1-1. The plant-specific data were taken from the following sources:

- Plant-specific operating experience submitted to the CODAP international database (Ref. IF-10) covering data collected and analyzed through December 2012.
- Search of plant-specific Licensee Event Reports (LERs) for events including "leak", "leakage", or "flood" in the title through December 2012.
- INL's NROD site, which includes plant-specific EPIX records through December 2012 (Ref. IF- 11).

Table A.1-1 Plant-Specific Flooding Events

System	Nominal Pipe Size / Diameter (in.)	Non Through Wall	Spray (≤ 100 gpm)	Flooding (100-2000 gpm)	Major Flooding (> 2000 gpm
NSCW	NPS ≤ 2	0	0	0	0
	2 < NPS ≤ 4	5	1	0	0
	4 < NPS ≤ 10	0	0	0	0
	NPS > 10	0	0	0	0
Fire protection	NPS ≤ 4	0	1	0	0
	4 < NPS ≤ 6	0	0	0	0
	NPS > 6	0	0	0	0
Circulating water pipe	NPS ≥ 24	0	0	0	0
Circulating water expansion joints	≥ 24	0	0	0	0
Component cooling water; applicable to other closed, low temp., low-pressure water systems	NPS ≤ 2	0	0	0	0
	2 < NPS ≤ 6	0	0	0	0
	NPS > 6	0	1	0	0
RWST piping (includes CVCS, SI, CS, and RHR piping outside containment)	2 < NPS ≤ 6	0	1	0	0
	6 < NPS ≤ 10	0	0	0	0
	NPS > 10	0	0	0	0
(PWR) Condensate and feedwater	NPS ≤ 2	2	0	0	0
	2 < NPS ≤ 10	3	1	0	0
	NPS > 10	0	0	0	0

Another input into the plant-specific update of flood data was the plant's system pipe length for the various pipe size categories defined in Table A.1-1 above. For this study, generic pipe lengths are used based on the generic system sizes given in References IF- 8 and IF- 9. The system pipe lengths are given in Table A.1-2. A lognormal distribution with an error factor of 3 was assumed for the system pipe lengths to account for uncertainty in the generic estimates.

Table A.1-2 Generic Pipe Lengths Used for Reference Plant Systems

System	Nominal Pipe Size / Diameter (in.)	5th percentile	Median pipe length	Mean pipe length	95th percentile
NSCW	NPS ≤ 2	311	933	1166	2799
	2 < NPS ≤ 4	138	414	517	1242
	4 < NPS ≤ 10	451	1354	1692	4062
	NPS > 10	2103	6307	7883	18919
Fire protection	NPS ≤ 4	1004	3012	3765	9035
	4 < NPS ≤ 6	640	1920	2400	5759
	NPS > 6	463	1390	1737	4170
Circulating water pipe	NPS ≥ 24	333	1000	1250	3000
Circulating water expansion joints	≥ 24	12 expansion joints			

System	Nominal Pipe Size / Diameter (in.)	5th percentile	Median pipe length	Mean pipe length	95th percentile
Component cooling water; applicable to other closed, low temp., low-pressure water systems	NPS ≤ 2	not estimated(1)			
	2 < NPS ≤ 6	366	1099	1374	3297
	NPS > 6	2844	8532	10664	25593
RWST piping (includes CVCS, SI, CS, and RHR piping outside containment)	2 < NPS ≤ 6	1340	4020	5024	12059
	6 < NPS ≤ 10	4467	13400	16748	40196
	NPS > 10	3127	9380	11723	28137
(PWR) Condensate and feedwater	NPS ≤ 2	not estimated(2)			
	2 < NPS ≤ 10	1520	4560(3)	5699	13679
	NPS > 10	4679	14037	17544	42107

Notes:

(1) Data for 2” < NPS ≤ 6” are used as a surrogate for CCW pipe sizes ≤ 2”.

(2) This pipe size category is not estimated and does not contribute to frequency estimates in this study.

(3) The most recent available estimate for pipe lengths for PWR feedwater and condensate systems was obtained from Table 5-3 of IF- 9. The median length for pipes > 10 in. diameter is given as 14,037 ft. This length is also estimated to be the upper bound for pipe sizes between 2 and 10 in. An estimated length for all feedwater and condensate pipes > 2 in. is given as 18,597 ft. in a previous revision (IF- 8, Table 4-22). For this study the median length for sizes between 2 and 10 in. is given by 18,597 ft – 14,037 ft = 4,560 ft. Assuming an error factor of 3 gives an upper bound for this size range that is similar to the upper bound indicated in Table 5-3 of IF- 9.

Analyst judgment was exercised to determine the appropriate statistical models to use for the initiating event frequencies in the NRC IFPRA. The NRC’s “Handbook of Parameter Estimation for Probabilistic Risk Assessment”, NUREG/CR-6823 (IF- 12), was referenced for guidance in selecting distributions and performing Bayesian updates. Failure rates were assumed to have a gamma uncertainty distribution. The failure rate data were assumed to be exponential. A Poisson likelihood function was used. A constrained noninformative prior distribution was used with the prior mean taken from the generic estimates in the EPRI report (IF- 9). Conditional rupture probabilities were assumed to have a beta uncertainty distribution. The data were assumed to be binomially distributed. A beta prior distribution was used with parameters selected based on analyst judgment.

A Gibbs sampling process was used to generate the combined initiating event frequency posterior distributions. The sampling was performed using the OpenBUGS version 3.2.2 software. For each frequency estimate, 10,000 samples were run. Sampling simulations were performed for two separate chains. Trace history plots of the two sampling chains were reviewed for evidence of parameter convergence. The sampling process produces an empirical posterior distribution. The resulting empirical distribution was expected to resemble a gamma distribution based on the choice of prior distribution for the failure rates. Also, gamma distributions are routinely used to model initiating event frequency uncertainty distributions. Gamma function parameters were fit to the empirical distribution using a maximum likelihood estimate approach. The fit was performed using the R statistical computing environment (64-bit version 2.15.2) with the MASS function package. The fitted gamma distribution parameters were used to specify the mean initiating event frequencies and shape parameters in the NRC IFPRA model.

The plant-specific reactor years of operation were estimated for the operating period from January 1, 1990 to December 31, 2012, based on a capacity factor of 0.9078 to estimate critical years for the NRC IFPRA. This yielded a combined estimate of 41.76 critical years for units 1 and 2. If an estimate of frequency per calendar year was desired, then the capacity factor can be used to scale the frequency estimate. Assume that *F* is a random variable representing the initiating event frequency that has a gamma distribution and is estimated based on number of critical reactor years. The distribution is characterized by two parameters: the mean value and the shape parameter, α. The capacity factor, *c*, can be applied to scale the initiating event frequency distribution as shown below. The mean value is scaled by *c* and the shape parameter is unchanged.

$$F \sim \text{gamma}(\alpha,\beta)$$
$$\text{mean}(F) = \alpha/\beta$$

Applying a capacity factor, *c*, yields:

$$cF \sim \text{gamma}(\alpha,\beta/c)$$
$$\text{mean}(cF) = c\alpha/\beta = c \times \text{mean}(F)$$

Two of the modeled internal flooding scenarios (scenario TB_500_HI1 and TB_500_HI2) use initiating event frequencies that were based on a combination of human error probabilities using the assumptions of the reference plant's internal flooding PRA model. For these scenarios the uncertainty distribution parameters were selected based on the authors' judgment and common practices used for HEP uncertainty analysis. See A.9 for additional details.

The results of the NRC IFPRA initiating event frequency analysis are shown in Table A.1-3.

Table A.1-3 Internal Flooding Scenario Initiating Event Frequencies

Scenario Name	Mean IE frequency per reactor-critical-year	Shape parameter or error factor	5^{th} percentile	Median value	95^{th} percentile
1-FLI-AB_108_SP1	2.8E-04	2.8	7.3E-05	2.5E-04	6.0E-04
1-FLI-AB_108_SP2	2.8E-04	2.8	7.3E-05	2.5E-04	6.0E-04
1-FLI-AB_A20	2.7E-04	2.6	6.3E-05	2.4E-04	5.9E-04
1-FLI-AB_A20_FP	2.3E-05	2.3	4.6E-06	1.9E-05	5.2E-05
1-FLI-AB_B08_LF	7.7E-06	0.38	5.3E-09	2.5E-06	3.2E-05
1-FLI-AB_B24_LF2	3.5E-06	0.35	1.5E-09	1.1E-06	1.5E-05
1-FLI-AB_B50_JI	3.4E-06	0.67	4.8E-08	1.9E-06	1.1E-05
1-FLI-AB_C113_LF1	2.2E-04	0.95	9.9E-06	1.5E-04	6.9E-04
1-FLI-AB_C115_LF	1.3E-04	0.89	4.7E-06	8.7E-05	4.2E-04
1-FLI-AB_C118_LF	7.5E-06	0.38	4.7E-09	2.6E-06	3.2E-05
1-FLI-AB_C120_LF	1.8E-04	0.93	7.6E-06	1.2E-04	5.5E-04
1-FLI-AB_D74_FP	8.6E-06	0.43	1.4E-08	3.4E-06	3.5E-05
1-FLI-AB_D78_FP	3.6E-07	0.35	1.7E-10	1.1E-07	1.6E-06
1-FLI-CB_122_SP	2.8E-04	2.8	7.1E-05	2.5E-04	5.9E-04
1-FLI-CB_123_SP	2.8E-04	2.8	7.1E-05	2.5E-04	5.9E-04
1-FLI-CB_A48	9.2E-05	0.98	4.8E-06	6.4E-05	2.8E-04
1-FLI-CB_A60	5.2E-05	0.97	2.3E-06	3.5E-05	1.6E-04
1-FLI-DGB_101_LF	7.3E-06	0.37	4.1E-09	2.2E-06	3.2E-05

Table A.1-3 Internal Flooding Scenario Initiating Event Frequencies

Scenario Name	Mean IE frequency per reactor-critical-year	Shape parameter or error factor	5th percentile	Median value	95th percentile
1-FLI-DGB_103_LF	7.3E-06	0.37	4.1E-09	2.2E-06	3.2E-05
1-FLI-TB_500_HI1	9.4E-05	12.5	2.3E-06	2.9E-05	3.6E-04
1-FLI-TB_500_HI2	9.4E-05	12.5	2.3E-06	2.9E-05	3.6E-04
1-FLI-TB_500_LF	2.2E-03	0.75	4.9E-05	1.3E-03	7.2E-03
1-FLI-TB_500_LF-CDS	6.3E-04	2.3	1.4E-04	5.5E-04	1.4E-03

A.2. Initiating Event Frequencies for Scenarios 1-FLI-CB_122_SP and 1-FLI-CB_123_SP

Both rooms CB_122 and CB_123 contain the same contributing flood source pipes and the same length of pipe. The only piping in these rooms that contributes to the flooding estimate was a 10-inch diameter FW pipe with a length of 75 feet. Steam lines located in these rooms were not considered to contribute to the spray in this flooding scenario. Impacts due to main steam line breaks were modeled as separate initiating events. The flood sources used to estimate the initiating event frequencies for scenarios 1-FLI-CB_122_SP and 1-FLI-CB_123_SP are summarized in Table A.2-1. The initiating event frequency that was quantified in this section was applied to both rooms.

Table A.2-1 Flood Sources 1-FLI-CB_122_SP and 1-FLI-CB_123_SP

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet)
CB	122	CB_122_SP	FW	10	75
CB	123	CB_123_SP	FW	10	75

The conditional rupture probability was estimated from data provided in Table 5-1 of Ref. IF- 9. The data from the period 1988-2008 were selected for this estimate because the period aligns closely to the reference plant's operating history, and it was the most recent data available for feedwater and condensate piping. A rupture in this flooding scenario can include spray events resulting from effective break sizes that were less than the nominal pipe size of 10 in. The conditional rupture probability includes both rupture events and leak events as both types of events were deemed relevant for the sprays considered in this scenario. The parameters used to estimate the conditional rupture probability for scenarios 1-FLI-CB_122_SP and 1-FLI-CB_123_SP are summarized in Table A.2-2.

Table A.2-2 Conditional Rupture Probability Parameters 1-FLI-CB_122_SP and 1-FLI-CB_123_SP

Beta prior distribution	alpha prior	beta prior	Reference	Notes
	1	9		Based on judgment of the analyst.
Evidence	ruptures	failures		
	24	57	IF- 9 Table 5-1	Data for FWC 2" < NPS ≤ 10", 1988-2008, includes leaks and ruptures

The failure rate for feedwater and condensate piping was estimated in IF- 9 in Table 5-6 for pipe sizes ≤ 10 in. The mean value of the failure rate prior distribution was assigned the value 3.16×10^{-6}, which was given for pipe sizes ≤ 10 in. A constrained noninformative gamma distribution, as defined in IF- 12, is used as the prior. The estimated feet of condensate and feedwater piping was taken from Table A.1-2 above. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above.

A review of reference plant operating experience identified four failures that were relevant to this scenario. Ultrasonic thickness measurements were performed on selected feedwater and condensate components in 2000. Twenty-three large-bore components were identified to have wall thickness measurements that indicated possible wear due to flow-accelerated corrosion. Based on these measurements and measurements during prior outages, the wall thickness degradations in three components were determined to be significant enough to require replacement. All other measured large-bore components were determined to be acceptable for continued service. The three components that required replacement included:

- A portion of heater drain pump 1B discharge piping
- FW heater 6A shell wall
- Additional portion of heater drain pump 1B discharge piping

These three wall thickness degradations are considered failures for this analysis. The parameters used to estimate the failure rate for scenarios 1-FLI-CB_122_SP and 1-FLI-CB_123_SP are summarized in Table A.2-3.

Table A.2-3 Failure Rate Parameters 1-FLI-CB_122_SP and 1-FLI-CB_123_SP

Gamma CNI prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	158228	IF- 9 Table 5-6	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Evidence	**failures**	**feet - critical years**		
	4	1.904E+05	Tables A.1-1 and A.1-2, CODAP database	4,560 ft of FW/Cond piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenarios 1-FLI-CB_122_SP and 1-FLI-CB_123_SP is shown in Table A.2-4.

Table A.2-4 Initiating Event Frequency Estimate for 1-FLI-CB_122_SP and 1-FLI-CB_123_SP

Mean value	Shape parameter	5th percentile	Median value	95th percentile
2.78E-04	2.82	7.12E-05	2.47E-04	5.91E-04

A.3. Initiating Event Frequencies for Scenarios 1-FLI-AB_108_SP1 and 1-FLI-AB_108_SP2

For room AB_108 due to a wall partition spray can only impact the SG1 or SG4 valves. It is assumed that half of the time the source pipe rupture will result in spray scenario 1 (impacting the SG1 valves) and the other half will result in spray scenario 2 (impacting the SG4 valves), that is, the initiating event frequency for each scenario is one-half of the total pipe rupture

frequency. Steam lines located in these rooms were not considered to contribute to the spray in this flooding scenario. Impacts due to main steam line breaks were modeled as separate initiating events. The flood sources used to estimate the initiating event frequencies for scenarios 1-FLI-AB_108_SP1 and 1-FLI-AB_108_SP2 are summarized in Table A.3-1. The initiating event frequency that is quantified in this section was applied to both rooms.

Table A.3-1 Flood Sources 1-FLI-AB_108_SP

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet)
AB	108	AB_108_SP	ACCW	10	50
			ACCW	8	20
			FW	10	150

The conditional rupture probability for feedwater and condensate piping was estimated from data provided in Table 5-1 of IF- 9. The data from the period 1988-2008 were selected for this estimate because the period aligns closely to the reference plant's operating history, and it is the most recent data available for feedwater and condensate piping. The data for feedwater and condensate nominal pipe sizes between 2 and 10 in. were used. The conditional rupture probability for auxiliary CCW piping was estimated from data provided in Table 4-2 of EPRI's flooding frequency report (IF- 9). The failure data in EPRI's flooding frequency report span the period from January 1970 through March 2010. Data for all CCW pipe sizes greater than 6 in. were selected. The conditional rupture probability includes both rupture events and leak events as both types of events were deemed relevant for the sprays considered in this scenario. The parameters used to estimate the conditional rupture probability for scenarios 1-FLI-AB_108_SP1 and 1-FLI- AB_108_SP2 are summarized in Table A.3-2.

Table A.3-2 Conditional Rupture Probability Parameters 1-FLI-AB_108_SP

FW Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst.
FW Evidence	**ruptures**	**failures**		
	24	57	IF- 9 Table 5-1	Data for FWC 2" < NPS ≤ 10", 1988-2008, includes leaks and ruptures
ACCW beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	99		Based on judgment of the analyst.
ACCW Evidence	**ruptures**	**failures**		
	0	7	IF- 9 Table 4-2	Data for all CCW pipe sizes > 6", 1970-2010.

The failure rate for feedwater and condensate piping was estimated in IF- 9 in Table 5-6 for pipe sizes ≤ 10 in. The failure rate for CCW piping was estimated in IF- 9 in Table 4-7 for nominal pipe size of 24 in., which was consistent with the > 6 in. size category. For both systems a constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of piping for condensate and feedwater and CCW systems were taken from Table A.1-2 above. A lognormal distribution with an error factor of 3 was assumed for the feet of

piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above.

A review of reference plant operating experience has identified four failures that were relevant to this scenario. Ultrasonic thickness measurements were performed on selected feedwater and condensate components in 2000. Twenty-three large-bore components were identified to have wall thickness measurements that indicated possible wear due to flow-accelerated corrosion. Based on these measurements and measurements during prior outages, the wall thickness degradations in three components were determined to be significant enough to require replacement. All other measured large-bore components were determined to be acceptable for continued service. The three components that required replacement included:

- A portion of heater drain pump 1B discharge piping
- FW heater 6A shell wall
- Additional portion of heater drain pump 1B discharge piping

These three wall thickness degradations are considered failures for this analysis. In addition, one CCW failure is identified by the reference plant. The parameters used to estimate the failure rate for scenarios 1-FLI-AB_108_SP1 and 1-FLI- AB_108_SP2 are summarized in Table A.3-3.

Table A.3-3 Failure Rate Parameters 1-FLI-AB_108_SP

FW Gamma CNI prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	158228	IF- 9 Table 5-6	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
FW Evidence	**failures**	**feet - critical years**		
	4	1.904E+05	Tables A.1-1 and A.1-2, CODAP database	4,560 ft of FW/Cond piping, 41.76 critical years
CCW Gamma CNI prior dist.	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	694444	Ref. IF- 9 Table 4-7	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
CCW Evidence	**failures**	**feet - critical years**		
	1	3.563E+05	Reference plant identified	8,532 ft of CCW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenarios 1-FLI-AB_108_SP1 and 1-FLI-AB_108_SP2 is shown in Table A.3-4.

Table A.3-4 Initiating Event Frequency Estimate for 1-FLI-AB_108_SP

Mean value	Shape parameter	5th percentile	Median value	95th percentile
2.80E-04	2.83	7.34E-05	2.45E-04	5.95E-04

A.4. Initiating Event Frequency for Scenario 1-FLI-AB_A20 and 1-FLI-AB_A20_FP

Scenario 1-FLI-AB_A20 subsumes two reference plant scenarios that impact the feedwater control and regulating valves located in room A20. The flood sources in room A20 can impact

the valves by spray or local flooding, but only spray was modeled in scenario 1-FLI-AB_A20. The flood sources in room A06 can propagate to room A20. Sprays from sources in room A06 do not contribute to the propagation to room A20 and were not applicable to this scenario.

Scenario 1-FLI-AB_A20_FP subsumes two reference plant scenarios related to local flooding from room A20 sources impacting equipment in room A20 and propagating to rooms A11 and A12.

Steam lines located in these rooms were not considered to contribute to the flooding scenario. Impacts due to main steam line breaks being modeled as separate initiating events. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_A20 are summarized in Table A.4-1.

Table A.4-1 Flood Sources 1-FLI-AB_ A20

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet)
AB	A20	AB_A20	FW	8	20
			FW	20	40
AB	A06	AB_A06_FP	Condensate	4	100
			Condensate	3	30
			Cond Sample Cooler	3	30
			Cond Sample Cooler	6	40

The conditional rupture probability for feedwater and condensate piping was estimated from data provided in Table 5-1 of IF- 9. The data from the period 1988-2008 were selected for this estimate because the period aligns closely to the reference plant's operating history, and it is the most recent data available for feedwater and condensate piping. For room A20 sources the 8-in. pipe uses feedwater and condensate pipe data in the 2 to 10 in. size category. The 20-in. pipe uses data in the greater than 10 in. size category. The conditional rupture probabilities for room A20 sources were separated into sprays and local flooding. The data for leak events were relevant for sprays, and the data for rupture events were relevant for local flooding. For room A06 sources (pipe sizes between 3 and 6 in.), the data for nominal pipe sizes between 2 and 10 in. were used. The conditional rupture probability for room A06 sources includes only rupture events (sprays were not relevant for this room). The parameters used to estimate the conditional rupture probability for scenarios 1-FLI-AB_A20 and 1-FLI-AB_A20_FP are summarized in Table A.4-2.

Table A.4-2 Conditional Rupture Probability Parameters 1-FLI-AB_A20 and 1-FLI-AB_A20_FP

Room A20 Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Room A20 Spray Evidence 2”<NPS<=10”	**ruptures**	**failures**		
	18	57	IF- 9 Table 5-1	Data for FWC 2” < NPS < 10”, 1988-2008, includes leaks only

Room A20 LF Evidence 2”<NPS<=10”	**ruptures**	**failures**		
	6	57	IF- 9 Table 5-1	Data for FWC 2” < NPS < 10”, 1988-2008, includes ruptures only
Room A20 Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Room A20 Spray Evidence NPS > 10”	**ruptures**	**failures**		
	23	155	IF- 9 Table 5-1	Data for all FWC pipe sizes > 10", 1988-2008, includes leaks only
Room A20 LF Evidence NPS > 10”	**ruptures**	**failures**		
	6	155	IF- 9 Table 5-1	Data for all FWC pipe sizes > 10", 1988-2008, includes ruptures only
Room A06 beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Room A06 Evidence	**ruptures**	**failures**		
	6	57	IF- 9 Table 5-1	Data for FWC 2” < NPS < 10”, 1988-2008

The failure rate for feedwater and condensate piping was estimated in IF- 9 in Table 5-6 for pipe sizes ≤ 10 in. and in Table 5-7 for pipe sizes > 10 in. The mean value of the failure rate prior distribution was 3.16×10^{-6} for pipe sizes ≤ 10 in. and 5.72×10^{-6} for pipe sizes > 10 in. The estimated feet of piping for the feedwater and condensate systems for > 10 inch pipes was given in Table 5-3 of IF- 9 as 14,037 ft. For pipe sizes from 2 in. to ≤ 10 in., Table 5-3 of IF- 9 indicates that 14,037 ft was an upper bound. The median length for 2 in. to ≤ 10 in. pipes was estimated to be 4,560 ft, as described in Table A.1-2 above.

A review of reference plant operating experience identified four feedwater and condensate failures that are relevant to this scenario. The four failures are identified in Table A.1-1 above. The parameters used to estimate the failure rates for scenarios 1-FLI-AB_A20 and 1-FLI-AB_A20_FP are summarized in Table A.4-3.

Table A.4-3 Failure Rate Parameters 1-FLI-AB_A20 and 1-FLI-AB_A20_FP

Gamma CNI prior distribution NPS<=10”	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	158228	IF- 9 Table 5-6	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Evidence NPS<=10”	**failures**	**feet - critical years**		
	4	1.904E+05	Tables A.1-1 and A.1-2, CODAP database	4560 ft of FW/Cond piping, 41.76 critical years
Gamma CNI prior distribution NPS>10”	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	87413	IF- 9 Table 5-7	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value

Evidence NPS>10”	failures	feet - critical years		
	0	5.862E+05	Tables A.1-1 and A.1-2, IF- 9 Table 5-3	14,037 ft of FW/Cond piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_A20 is shown in Table A.4-4.

Table A.4-4 Initiating Event Frequency Estimate for 1-FLI-AB_A20

Mean value	Shape parameter	5th percentile	Median value	95th percentile
2.71E-04	2.63	6.31E-05	2.38E-04	5.93E-04

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_A20_FP is shown in Table A.4-5.

Table A.4-5 Initiating Event Frequency Estimate for 1-FLI-AB_A20_FP

Mean value	Shape parameter	5th percentile	Median value	95th percentile
2.27E-05	2.27	4.59E-06	1.93E-05	5.16E-05

A.5. Initiating Event Frequency for Scenario 1-FLI-CB_A60

Scenario CB_A60 subsumes three reference plant scenarios that impact the atmospheric relief valve signal converters located in room A60. The flood sources in room A60 can impact the signal converters by spray or local flooding. The flood sources in room A59 can propagate to room A60. Sprays from sources in room A59 do not contribute to the propagation to room A60 and were not applicable to this scenario. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-CB_A60 are summarized in Table A.5-1.

Table A.5-1 Flood Sources 1-FLI-CB_ A60

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet)
CB	A59	CB_A59_FP	Fire protection	4	100
CB	A60	AB_A60	Fire protection	2	60
			Utility water	1	40

The conditional rupture probability for fire protection piping was estimated from data provided in Table 3-43 of IF- 9. The data for fire protection nominal pipe sizes less than or equal to 4 in. were used. The data were based on service experience from 1970 through March 31, 2009. The conditional rupture probability estimate for room A59 sources includes only major structural failures. The conditional rupture probability for room A60 sources includes both major structural failures and leak events as both types of events were deemed relevant for the sprays considered in this room. The data for fire protection systems includes water hammer events.

The NRC IFPRA uses the service data and frequency estimates for the component cooling water system for other closed water systems with low temperature and pressure conditions, such as utility water. The data provided in Table 4-2 of IF- 9 were used to estimate the conditional rupture probability for utility water piping. The estimate was based on data for pipe

diameters less than 2 in. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-CB_A60 are summarized in Table A.5-2.

Table A.5-2 Conditional Rupture Probability Parameters 1-FLI-CB_ A60

Room A59 Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Room A59 Evidence	**ruptures**	**failures**		
	1	35	IF- 9 Table 3-43	Data for NPS <= 4", only MSF events are considered ruptures
Rm A60 FP beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Rm A60 FP Evidence	**ruptures**	**failures**		
	6	35	IF- 9 Table 3-43	Data for NPS <= 4", includes MSF and leak events
Rm A60 UW beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Rm A60 UW Evidence	**ruptures**	**failures**		
	1	49	IF- 9 Table 4-2	Data for pipe dia. <= 2", includes MSF and leak events

The failure rate for fire protection piping was estimated in IF- 9 in Table 3-47 for nominal pipe size of 4 in. All pipe sizes were considered applicable for this scenario. The mean value of the failure rate prior distributions were assigned the value 1.23×10^{-5} for fire protection piping (4 in.). The failure rate prior distribution for utility water piping uses the CCW failure rate reported in Table 4-6 of IF- 9. The failure rate for the smallest nominal pipe size (6 in.) was used, 4.84×10^{-6}. The estimated feet of piping for fire protection piping was given in IF- 9 Table 3-42. The feet of CCW piping reported in IF- 9 Table 4-3 was used as a surrogate for utility water. The parameters used to estimate the failure rate for scenario 1-FLI-CB_A60 are summarized in Table A.5-3.

Table A.5-3 Failure Rate Parameters 1-FLI-CB_ A60

Rm A59 Gamma CNI prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	40650	IF- 9 Tables 3-47	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Rm A59 Evidence	**failures**	**feet - critical years**		
	0	1.26E+05	IF- 9 Table 3-42	3012 ft of FP piping, 41.76 critical years
Rm A60 FP Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	40650	IF- 9 Tables 3-47	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value

Table A.5-3 Failure Rate Parameters 1-FLI-CB_ A60

Rm A60 FP Evidence	**failures**	**feet - critical years**		
	0	1.26E+05	IF- 9 Table 3-42	3,012 ft of FP piping, 41.76 critical years
Rm A60 UW Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	103306	IF- 9 Table 4-6	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Rm A60 UW Evidence	**failures**	**feet - critical years**		
	0	45894	IF- 9 Table 4-3	1,099 ft of CCW was used as a surrogate estimate, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-CB_A60 is shown in Table A.5-4.

Table A.5-4 Initiating Event Frequency Estimate for 1-FLI-CB_A60

Mean value	Shape parameter	5th percentile	Median value	95th percentile
5.19E-05	0.971	2.33E-06	3.49E-05	1.55E-4

A.6. Initiating Event Frequency for Scenario 1-FLI-TB_500_LF and 1-FLI-TB_500_LF-CDS

Scenario 1-FLI-TB_500_LF subsumes two reference plant scenarios that models impacts from local flooding. Sprays were not applicable to this scenario. The flood area contains 10 different flood sources. These can be condensed into six flood source categories. The two TPCW piping sources were grouped, and their failure was based on operating experience for service water systems with river water intake sources. The demineralized water source was a clean closed water system with low temperature and pressure conditions. The service data for component cooling water were used to estimate the flood frequency for demineralized water. The circulating water and fire protection sources were each estimated from generic and plant-specific data for those respective systems. The circulating water expansion joints were treated as a separate flood source. The failure rate for expansion joints is estimated in terms of component-critical years, rather than feet-critical years.

The condensate and heater drain piping was grouped as a single flood source category, and this category was addressed in a separate scenario, 1-FLI-TB_500_LF-CDS. All other flood sources in the area were included in scenario 1-FLI-TB_500_LF.

The flood sources used to estimate the initiating event frequency for scenarios 1-FLI-TB_500_LF and 1-FLI-TB_500_LF-CDS are summarized in Table A.6-1.

Table A.6-1 Flood Sources 1-FLI-TB_500_LF and 1-FLI-TB_500_LF-CDS

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
TB	Fire Zone 500	TB_500_LF	Circulating water	72	1000
			Condensate	24	250
			Condensate	48	140
			Condensate	10	350
			Demin water	10	200
			Fire protection	10	900
			Heater drain	8	250
			TPCW	14	500
			TPCW	18	200
			Circulating water expansion joints	72	12

The conditional rupture probability for all piping systems was estimated from data provided in IF-9. Refer to Table A.6-2 for additional details on the data used for these estimates. The most recent revision of the EPRI internal flooding frequency report (IF- 9) does not include an update for failure of expansion joints. The failure estimates were based on data provided in the first revision of the report (IF- 8). The parameters used to estimate the conditional rupture probability for scenarios 1-FLI-TB_500_LF and 1-FLI-TB_500_LF-CDS are summarized in Table A.6-2.

Table A.6-2 Conditional Rupture Probability Parameters 1-FLI-TB_500_LF and 1-FLI-TB_500_LF-CDS

CW Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
CW Evidence	**ruptures**	**failures**		
	6	20	IF- 9 Table 3-61	Includes all CW data (NPS>30”) from 1970 through March 2010
Cond/HD beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Cond/HD Evidence 2”<NPS≤10”	**ruptures**	**failures**		
	6	57	IF- 9 Table 5-1	Includes all FWC 2” < pipe size <= 10”, 1988-2008
Cond/HD beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Cond/HD	**ruptures**	**failures**		

Table A.6-2 Conditional Rupture Probability Parameters 1-FLI-TB_500_LF and 1-FLI-TB_500_LF-CDS

Evidence NPS > 10"	6	155	IF- 9 Table 5-1	Includes all FWC pipe sizes > 10", 1988-2008
Demin water beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	99		Based on judgment of the analyst
Demin water Evidence	**ruptures**	**failures**		
	0	7	IF- 9 Table 4-2	Data for CCW pipe sizes > 6" were used as a surrogate. 1970-2010
FP Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	99		Based on judgment of the analyst
FP Evidence	**ruptures**	**failures**		
	1	74	IF- 9 Table 3-43	Includes data for FP NPS > 6"
TPCW beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	99		Based on judgment of the analyst
TPCW Evidence	**ruptures**	**failures**		
	0	74	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with river water intake. Data for NPS > 10" was used.
Exp Joints beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
Exp Joints Evidence	**ruptures**	**failures**		
	3	36	IF- 8 Table 4-12	Ruptures include all events resulting in leakage flow > 2000 gpm.

The piping failure rates are estimated using a prior distribution base on the generic mean value reported in Ref. IF- 9. The prior is updated with plant-specific failure data. The plant-specific failures relevant to this flood area were obtained from the reference plant, the CODAP database (IF- 10), and a reference-plant-specific Licensee Event Report that describes failures of NSCW pump discharge pipes that were relevant to the TPCW failure rate estimate.

The failure rate for expansion joints was taken from IF- 8 Table A-35. The rate for sprays was used as the generic failure rate for expansion joints. The parameters used to estimate the failure rate for scenarios 1-FLI-TB_500_LF and 1-FLI-TB_500_LF-CDS are summarized in Table A.6-3.

Table A.6-3 Failure Rate Parameters 1-FLI-TB_ 500_LF and 1-FLI-TB_500_LF-CDS

CW Gamma CNI prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	25253	IF- 9 Table 3-64	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
CW Evidence	**failures**	**feet - critical years**		
	0	41760	Reference plant data	1000 ft of CW piping is reference-plant-specific estimate, 41.76 critical years
FWC 2"-10" Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	158228	IF- 9 Table 5-6	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Cond/HD Evidence 2"<NPS≤10"	**failures**	**feet - critical years**		
	4	1.904E+05	Tables A.1-1 and A.1-2	4560 ft of FW/Cond piping, 41.76 critical years
Cond >10" Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	94877	IF- 9 Table 5-7	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Cond/HD Evidence NPS>10"	**failures**	**feet - critical years**		
	0	5.862E+05	Tables A.1-1 and A.1-2, IF- 9 Table 5-3	14,037 ft of FW/Cond piping, 41.76 critical years
Demin water Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	103306	IF- 9, Table 4-6	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Demin water Evidence	**failures**	**feet - critical years**		
	1	3.563E+05	Reference plant data	8,532 ft of CCW was used as a surrogate estimate, 41.76 critical years
FP Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	8834	IF- 9 Table 3-49	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
FP Evidence	**failures**	**feet - critical years**		
	0	5.8E+04	IF- 9 Table 3-42, reference plant data	1,390 ft of FP piping for NPS>6", 41.76 critical years
TPCW Gamma	**alpha prior**	**beta prior**		

Table A.6-3 Failure Rate Parameters 1-FLI-TB_ 500_LF and 1-FLI-TB_500_LF-CDS

CNI prior distribution				
	0.5	30675	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
TPCW Evidence	**failures**	**feet - critical years**		
	0	2.63E+05	IF- 9 Table 3-2	6,037 ft of SW piping, 41.76 critical years
Exp Joints Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	3571	IF- 8 Table A-35	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
Exp Joints Evidence	**failures**	**feet - critical years**		
	0	501	Reference plant data	12 expansion joints, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-TB_500_LF is shown in Table A.6-4.

Table A.6-4 Initiating Event Frequency Estimate for 1-FLI-TB_ 500_LF

Mean value	Shape parameter	5th percentile	Median value	95th percentile
2.16E-03	7.49E-01	4.87E-05	1.28E-03	7.18E-03

The initiating event frequency estimate for internal flooding scenario 1-FLI-TB_500_LF-CDS is shown in Table A.6-5.

Table A.6-5 Initiating Event Frequency Estimate for 1-FLI-TB_ 500_LF-CDS

Mean value	Shape parameter	5th percentile	Median value	95th percentile
6.32E-04	2.33	1.37E-04	5.48E-04	1.42E-03

A.7. Initiating Event Frequency for Scenario 1-FLI-AB_C113_LF1

Scenario 1-FLI-AB_C113_LF1 models impacts from local flooding. Sprays were not applicable to this scenario. The flood sources applicable to this scenario were the NSCW pipes located in the room. Other potential flood sources were located in the room, but those sources were addressed in other flooding scenarios and were not modeled here. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_C113_LF1 are summarized in Table A.7-1.

Table A.7-1 Flood Sources 1-FLI-AB_ C113_LF1

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components

AB	C113	AB_C113_LF1	NSCW	1.5	120
			NSCW	4	120

The conditional rupture probability for all piping systems was estimated from generic data for PWR raw water service water systems provided in IF- 9. Table 3-5 of IF- 9 identifies the number of failure events for PWR plants with lake suction source. The lake suction source was deemed applicable to the NSCW system that take suction from cooling towers with makeup water provided from underground wells. Data was provided for pipe sizes less than 2 in. and sizes between 2 and 4 in. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_C113_LF1 are summarized in Table A.7-2.

Table A.7-2 Conditional Rupture Probability Parameters 1-FLI-AB_ C113_LF1

NSCW < 2" Beta prior distribution	alpha prior	beta prior	Reference	Notes
	1	99		Based on judgment of the analyst
NSCW < 2" Evidence	ruptures	failures		
	0	90	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for NPS ≤ 2" was used.
NSCW 2"-4" Beta prior distribution	alpha prior	beta prior		
	1	99		Based on judgment of the analyst
NSCW 2"-4" Evidence	ruptures	failures		
	0	71	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for 2" < NPS ≤ 4" was used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 3-9 for pipe sizes ≤ 2 in. and for pipe sizes > 2 in. and ≤ 4 in. A constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. Six plant-specific NSCW failures were identified as discussed in a Licensee Event Report. The failures involved welds where a 4-in. bypass line joins an 18-in. pump discharge line. The failures were deemed applicable to the NSCW pipe sizes from 2 to 4 in. The estimated feet of PWR service water piping was taken from Table 3-2 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_C113_LF1 are summarized in Table A.7-3.

Table A.7-3 Failure Rate Parameters 1-FLI-AB_ C113_LF1

NSCW < 2" Gamma CNI prior distribution	alpha prior	beta prior	Reference	Notes
	0.5	4505	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW < 2" Evidence	failures	feet - critical years		

	0	38962	IF- 9 Table 3-2	0 failures identified, 933 ft of SW piping, 41.76 critical years
NSCW 2”-4” Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	2538	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW 2”-4” Evidence	**failures**	**feet - critical years**		
	6	17289	IF- 9 Table 3-2, LER	6 failures identified, 414 ft of SW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_C113_LF1 is shown in Table A.7-4.

Table A.7-4 Initiating Event Frequency Estimate for 1-FLI-AB_ C113_LF1

Mean value	Shape parameter	5th percentile	Median value	95th percentile
2.24E-04	9.45E-01	9.88E-06	1.52E-04	6.88E-04

A.8. Initiating Event Frequency for Scenario 1-FLI-CB_A48

Scenario 1-FLI-CB_A48 models impacts on room A48 from flood water propagating from adjacent corridor A58. Switchgear room A48 contains no flood sources. All flood sources applicable to this scenario wre located in corridor A58. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-CB_A48 are summarized in Table A.8-1.

Table A.8-1 Flood Sources 1-FLI-CB_ A48

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
CB	A58	CB_A58_FP	Fire Protection	2	60
			Fire Protection	4	290
			Fire Protection	6	60
			Utility water	1	200

The conditional rupture probability for fire protection piping systems was estimated from generic data in IF- 9. Table 3-43 of IF- 9 identifies the number of failure events fire protection pipes with nominal pipe sizes less than 4 in. and between 4 and 6 in. The service data for component cooling water were used to estimate the flood frequency for utility water, which was a clean closed water system with low temperature and pressure conditions. The failure data for component cooling water was taken from Table 4-2 of IF- 9. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-CB_A48 are summarized in Table A.8-2.

Table A.8-2 Conditional Rupture Probability Parameters 1-FLI-CB_A48

FP < 4" Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	9		Based on judgment of the analyst
FP < 4" Evidence	**ruptures**	**failures**		
	1	35	IF- 9 Table 3-43	Data for NPS ≤ 4" was used.
FP 4"-6" Beta prior distribution	**alpha prior**	**beta prior**		
	1	9		Based on judgment of the analyst
FP 4"-6" Evidence	**ruptures**	**failures**		
	1	29	IF- 9 Table 3-43	Data for 4" < NPS ≤ 6" was used.
CCW < 2" Beta prior distribution	**alpha prior**	**beta prior**		
	1	9		Based on judgment of the analyst
CCW < 2" Evidence	**ruptures**	**failures**		
	1	49	IF- 9 Table 4-2	Data for NPS ≤ 2" was used.

The failure rates for fire protection piping are estimated in IF- 9 in Tables 3-47 and 3-48 for nominal pipe sizes of 4 in. and 6 in. The failure rate prior distribution for utility water piping uses the CCW failure rate reported in Table 4-6 of IF- 9. The failure rate for the smallest nominal pipe size (6 in.) was used, 4.84×10^{-6}. A constrained non-informative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of piping for fire protection piping was given in IF- 9 Table 3-42. The feet of CCW piping reported in IF- 9 Table 4-3 was used as a surrogate for utility water. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-CB_A48 are summarized in Table A.8-3.

Table A.8-3 Failure Rate Parameters 1-FLI-CB_A48

FP < 4" Gamma CNI prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	40650	IF- 9 Tables 3-47	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
FP < 4" Evidence	**failures**	**feet - critical years**		
	0	1.26E+05	IF- 9 Table 3-42	3,012 ft of FP piping, 41.76 critical years
FP 4"-6" Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	31447	IF- 9 Tables 3-48	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
FP 4"-6" Evidence	**failures**	**feet - critical years**		
	0	80179	IF- 9 Table 3-42	1,920 ft of FP piping, 41.76 critical years
	alpha prior	**beta prior**		

CCW < 2" Gamma CNI prior distribution	0.5	103306	IF- 9 Table 4-6	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
CCW < 2" Evidence	**failures**	**feet - critical years**		
	1	45894	Reference plant information, IF- 9 Table 4-3	1,099 ft of CCW was used as a surrogate estimate, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-CB_A48 is shown in Table A.8-4.

Table A.8-4 Initiating Event Frequency Estimate for 1-FLI-CB_A48

Mean value	Shape parameter	5th percentile	Median value	95th percentile
9.21E-05	0.979	4.77E-06	6.42E-05	2.80E-04

A.9. Initiating Event Frequency for Scenarios 1-FLI-TB_500_HI1 and 1-FLI-TB_500_HI2

The initiating event frequency for scenarios 1-FLI-TB_500_HI1 and 1-FLI-TB_500_HI2 were based on analysis of human error(s) that induce a flooding event. The uncertainty distributions were assigned based on analyst's judgment and common practices for HEP uncertainty.

The frequency of the human induced flood scenario 1-FLI-TB_500_HI1 was estimated by assuming the occurrence of all three of the following events:

- Condenser water box maintenance during plant operation
- Maintenance crew failure to properly secure the manway cover(s)
- Operator failure to mitigate the flood scenario

A lognormal distribution was assumed for each event. The mean values and error factors used for each event is shown in Table A.9-1 below.

Table A.9-1 Events Contributing to Flood Frequency for Scenario 1-FLI-TB_500_HI1

Failure Event	Uncertainty Distribution	Mean Value	Error Factor
Condenser maintenance occurs during plant operation	Lognormal	9.4E-02	3
Failure to secure manway cover(s)	Lognormal	1.0E-02	5
Failure to mitigate flood	Lognormal	1.0E-01	5

The frequency of the human induced flood scenario 1-FLI-TB_500_HI2 was estimated by assuming the occurrence of all three of the following events:

- TPCCW heat exchanger maintenance during plant operation
- Maintenance crew failure to properly secure the heat exchanger
- Maintenance crew failure to mitigate the flood scenario

A lognormal distribution was assumed for each event. The mean values and error factors used for each event is shown in Table A.9-2 below.

Table A.9-2 Events Contributing to Flood Frequency for Scenario 1-FLI-TB_500_HI2

Failure Event	Uncertainty Distribution	Mean Value	Error Factor
TPCCW heat exchanger maintenance occurs during plant operation	Lognormal	9.4E-02	3
Failure to secure heat exchanger	Lognormal	1.0E-02	5
Failure to mitigate flood	Lognormal	1.0E-01	5

The frequency of the human induced flooding scenario was estimated by the product of the three events discussed above. As both scenarios were using the same input distribution, the same resulting frequency distribution was used for both scenarios. The product distribution was also lognormal. The product distribution is characterized by mean value and error factor given in Table A.9-3.

Table A.9-3 Initiating Event Frequency Estimate for 1-FLI-TB_500_HI1 and 1-FLI-TB_500_HI2

Mean value	Error factor	5^{th} percentile	Median value	95^{th} percentile
9.4E-05	12.5	2.3E-06	2.9E-05	3.6E-04

A.10. Initiating Event Frequency for Scenario 1-FLI-AB_C120_LF

Scenario 1-FLI-AB_C120_LF models impacts from local flooding. Sprays were not applicable to this scenario. The flood sources applicable to this scenario were the NSCW pipes located in the room. Other potential flood sources were located in the room, but those sources were addressed in other flooding scenarios and were not modeled here. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_C120_LF are summarized in Table A.10-1.

Table A.10-1 Flood Sources 1-FLI-AB_C120_LF

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
AB	C120	AB_C120_LF	NSCW	1.5	70
			NSCW	3	100

The conditional rupture probability for NSCW piping system was estimated from generic data for PWR raw water service water systems provided in IF- 9. Table 3-5 of IF- 9 identifies the number of failure events for PWR plants with lake suction source. The lake suction source was deemed applicable to the NSCW system that take suction from cooling towers with makeup water provided from underground wells. Data was provided for pipe sizes less than 2 in. and sizes between 2 and 4 in. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_C120_LF are summarized in Table A.10-2.

Table A.10-2 Conditional Rupture Probability Parameters 1-FLI-AB_C120_LF

	alpha prior	beta prior	Reference	Notes

NSCW < 2" Beta prior distribution	1	99		Based on judgment of the analyst
NSCW < 2" Evidence	**ruptures**	**failures**		
	0	90	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for NPS ≤ 2" was used.
NSCW 2"-4" Beta prior distribution	**alpha prior**	**beta prior**		
	1	99		Based on judgment of the analyst
NSCW 2"-4" Evidence	**ruptures**	**failures**		
	0	71	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for 2" < NPS ≤ 4" was used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 3-9 for pipe sizes ≤ 2 in. and for pipe sizes > 2 in. and ≤ 4 in. A constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. Six plant-specific NSCW failures were identified as discussed in a Licensee Event Report. The failures involved welds where a 4-in. bypass line joins an 18-in. pump discharge line. The failures were deemed applicable to the NSCW pipe sizes from 2 to 4 in. The estimated feet of PWR service water piping was taken from Table 3-2 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_C120_LF are summarized in Table A.10-3.

Table A.10-3 Failure Rate Parameters 1-FLI-AB_C120_LF

NSCW < 2" Gamma CNI prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	4505	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW < 2" Evidence	**failures**	**feet - critical years**		
	0	38962	IF- 9 Table 3-2	0 failures identified, 933 ft of SW piping, 41.76 critical years
NSCW 2"-4" Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	2538	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW 2"-4" Evidence	**failures**	**feet - critical years**		
	6	17289	IF- 9 Table 3-2, LER	6 failures identified, 414 ft of SW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_C120_LF is shown in Table A.10-4.

Table A.10-4 Initiating Event Frequency Estimate for 1-FLI-AB_C120_LF

Mean value	Shape parameter	5th percentile	Median value	95th percentile
1.80E-04	9.26E-01	7.65E-06	1.20E-04	5.49E-04

A.11. Initiating Event Frequency for Scenario 1-FLI-AB_C115_LF

Scenario 1-FLI-AB_C115_LF models impacts from local flooding. Sprays were not applicable to this scenario. The flood sources applicable to this scenario awere the NSCW pipes located in the room. Other potential flood sources were located in the room, but those sources were addressed in other flooding scenarios and were not modeled here. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_C115_LF are summarized in Table A.11-1.

Table A.11-1 Flood Sources 1-FLI-AB_C115_LF

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
AB	C115	AB_C115_LF	NSCW	2.5	80

The conditional rupture probability for NSCW piping system was estimated from generic data for PWR raw water service water systems provided in IF- 9. Table 3-5 of IF- 9 identifies the number of failure events for PWR plants with lake suction source. The lake suction source was deemed applicable to the NSCW system that take suction from cooling towers with makeup water provided from underground wells. Data was provided for pipe sizes between 2 and 4 in. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_C115_LF are summarized in Table A.11-2.

Table A.11-2 Conditional Rupture Probability Parameters 1-FLI-AB_C115_LF

NSCW 2”-4” Beta prior distribution	**alpha prior**	**beta prior**		
	1	99		Based on judgment of the analyst
NSCW 2”-4” Evidence	**ruptures**	**failures**		
	0	71	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for 2” < NPS ≤ 4” is used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 3-9 for pipe sizes > 2 in. and ≤ 4 in. A constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. Six plant-specific NSCW failures were identified as discussed in a Licensee Event Report. The failures involved welds where a 4-in. bypass line joins an 18-in. pump discharge line. The failures were deemed applicable to the NSCW pipe sizes from 2 to 4 in. The estimated feet of PWR service water piping was taken from Table 3-2 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_C115_LF are summarized in Table A.11-3.

Table A.11-3 Failure Rate Parameters 1-FLI-AB_C115_LF

NSCW 2"-4" Gamma CNI prior distribution	**alpha prior**	**beta prior**		
	0.5	2538	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW 2"-4" Evidence	**failures**	**feet - critical years**		
	6	17289	IF- 9 Table 3-2, LER	6 failures identified, 414 ft of SW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_C115_LF is shown in Table A.11-4.

Table A.11-4 Initiating Event Frequency Estimate for 1-FLI-AB_C115_LF

Mean value	Shape parameter	5^{th} percentile	Median value	95^{th} percentile
1.33E-04	8.90E-01	4.69E-06	8.66E-05	4.21E-04

A.12. Initiating Event Frequency for Scenario 1-FLI-AB_C118_LF

Scenario 1-FLI-AB_C118_LF models impacts from local flooding. Sprays were not applicable to this scenario. The flood sources applicable to this scenario were the NSCW pipes located in the room. Other potential flood sources were located in the room, but those sources were addressed in other flooding scenarios and were not modeled here. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_C118_LF were summarized in Table A.12-1.

Table A.12-1 Flood Sources 1-FLI-AB_C118_LF

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
AB	C118	AB_C118_LF	NSCW	2	80

The conditional rupture probability for NSCW piping system was estimated from generic data for PWR raw water service water systems provided in IF- 9. Table 3-5 of IF- 9 identifies the number of failure events for PWR plants with lake suction source. The lake suction source was deemed applicable to the NSCW system that take suction from cooling towers with makeup water provided from underground wells. Data was provided for pipe sizes less than or equal to 2 in. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_C118_LF are summarized in Table A.12-2.

Table A.12-2 Conditional Rupture Probability Parameters 1-FLI-AB_C118_LF

NSCW ≤ 2" Beta prior distribution	alpha prior	beta prior	Reference	Notes
	1	99		Based on judgment of the analyst
NSCW ≤ 2" Evidence	ruptures	failures		
	0	90	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for NPS ≤ 2" is used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 3-9 for pipe sizes ≤ 2 in. A constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of PWR service water piping was taken from Table 3-2 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_C118_LF are summarized in Table A.12-3.

Table A.12-3 Failure Rate Parameters 1-FLI-AB_C118_LF

NSCW ≤ 2" Gamma CNI prior distribution	alpha prior	beta prior	Reference	Notes
	0.5	4505	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW ≤ 2" Evidence	failures	feet - critical years		
	0	38962	IF- 9 Table 3-2	0 failures identified, 933 ft of SW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_C118_LF is shown in Table A.12-4.

Table A.12-4 Initiating Event Frequency Estimate for 1-FLI-AB_C118_LF

Mean value	Shape parameter	5th percentile	Median value	95th percentile
7.52E-06	3.76E-01	4.72E-09	2.55E-06	3.22E-05

A.13. Initiating Event Frequency for Scenario 1-FLI-AB_B08_LF

Scenario 1-FLI-AB_B08_LF models impacts from local flooding. Sprays were not applicable to this scenario. The flood sources applicable to this scenario were the NSCW pipes located in the room. Other potential flood sources were located in the room, but those sources were addressed in other flooding scenarios and were not modeled here. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_B08_LF are summarized in Table A.13-1.

Table A.13-1 Flood Sources 1-FLI-AB_B08_LF

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
AB	B08	AB_B08_LF	NSCW	8	110

The conditional rupture probability for NSCW piping system was estimated from generic data for PWR raw water service water systems provided in IF- 9. Table 3-5 of IF- 9 identifies the number of failure events for PWR plants with lake suction source. The lake suction source was deemed applicable to the NSCW system that take suction from cooling towers with makeup water provided from underground wells. Data was provided for pipe sizes between 4 and 10 in. The prior was based on the EPRI model described in Table 3-12 of IF- 9. The prior rupture probability for flood events was used. A more specific, informed prior could not be justified for this case given the sparse service data for the pipe category. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_B08_LF are summarized in Table A.13-2.

Table A.13-2 Conditional Rupture Probability Parameters 1-FLI-AB_B08_LF

NSCW 4”-10” Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	99	IF- 9 Table 3-12	Based on generic flood rupture probability of 0.01.
NSCW 4”-10” Evidence	**ruptures**	**failures**		
	0	60	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for NPS 4”-10” was used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 3-9 for pipe sizes 4 to 10 in. A constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of PWR service water piping was taken from Table 3-2 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_B08_LF are summarized in Table A.13-3.

Table A.13-3 Failure Rate Parameters 1-FLI-AB_B08_LF

NSCW 4”-10” Gamma CNI prior distribution	alpha prior	beta prior	Reference	Notes
	0.5	9804	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW 4”-10” Evidence	**failures**	**feet - critical years**		
	0	56543	IF- 9 Table 3-2	0 failures identified, 1354 ft of SW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_B08_LF is shown in Table A.13-4.

Table A.13-4 Initiating Event Frequency Estimate for 1-FLI-AB_B08_LF

Mean value	Shape parameter	5th percentile	Median value	95th percentile
7.67E-06	3.84E-01	5.34E-09	2.49E-06	3.25E-05

A.14. Initiating Event Frequency for Scenario 1-FLI-AB_B24_LF2

Scenario 1-FLI-AB_B24_LF2 models impacts from local flooding. Sprays were not applicable to this scenario. The flood sources applicable to this scenario were the NSCW pipes located in the room. Other potential flood sources were located in the room, but those sources were addressed in other flooding scenarios and were not modeled here. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_B24_LF2 are summarized in Table A.14-1.

Table A.14-1 Flood Sources 1-FLI-AB_B24_LF2

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
AB	C118	AB_B24_LF2	NSCW	1.5	40

The conditional rupture probability for NSCW piping system was estimated from generic data for PWR raw water service water systems provided in IF- 9. Table 3-5 of IF- 9 identifies the number of failure events for PWR plants with lake suction source. The lake suction source was deemed applicable to the NSCW system that takes suction from cooling towers with makeup water provided from underground wells. Data was provided for pipe sizes less than or equal to 2 in. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_B24_LF2 are summarized in Table A.14-2.

Table A.14-2 Conditional Rupture Probability Parameters 1-FLI-AB_B24_LF2

NSCW ≤ 2" Beta prior distribution	alpha prior	beta prior	Reference	Notes
	1	99		Based on judgment of the analyst
NSCW ≤ 2" Evidence	ruptures	failures		
	0	90	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for NPS ≤ 2" was used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 3-9 for pipe sizes ≤ 2 in. A constrained noninformative gamma distribution, as defined in Ref. IF- 12, was used as the prior. The estimated feet of PWR service water piping was taken from Table 3-2 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_B24_LF2 are summarized in Table A.14-3.

Table A.14-3 Failure Rate Parameters 1-FLI-AB_B24_LF2

NSCW ≤ 2" Gamma CNI prior distribution	alpha prior	beta prior	Reference	Notes
	0.5	4505	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW ≤ 2" Evidence	failures	feet - critical years		
	0	38962	IF- 9 Table 3-2	0 failures identified, 933 ft of SW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_B24_LF2 is shown in Table A.14-4.

Table A.14-4 Initiating Event Frequency Estimate for 1-FLI-AB_B24_LF2

Mean value	Shape parameter	5th percentile	Median value	95th percentile
3.53E-06	3.53E-01	1.54E-09	1.12E-06	1.52E-05

A.15. Initiating Event Frequency for Scenario 1-FLI-AB_B50_JI

Scenario 1-FLI-AB_B50_JI models impacts from jet impingement. The frequency for spray events was used for the jet impingement scenario. The flood sources applicable to this scenario were the Safety Injection/Recirculation system pipes located in the room, referred to as RWST piping. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_B50_JI are summarized in Table A.15-1.

Table A.15-1 Flood Sources 1-FLI-AB_B50_JI

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components

AB	B50	AB_B50_JI	RWST	3	50

The conditional rupture probability for RWST piping was estimated from generic data for safety injection and recirculation systems provided in IF- 9. Table 4-1 of IF- 9 identifies the number of failure events for PWR safety injection system piping. The prior was based on the EPRI model described in Table 3-12 of IF- 9. The prior rupture probability for spray events was used. A more specific, informed prior was not developed for this case due the sparse service data for the pipe category. Data was provided for pipe sizes less than or equal to 2 in. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_B50_JI are summarized in Table A.15-2.

Table A.15-2 Conditional Rupture Probability Parameters 1-FLI-AB_B50_JI

RWST 2"- 6" Beta prior distribution	alpha prior	beta prior	Reference	Notes
	1	9	IF- 9 Table 3-12	Based on generic spray rupture probability of 0.1.
RWST 2"- 6" Evidence	ruptures	failures		
	0	31	IF- 9 Table 4-1	Based on SI/recirc operating experience. Data for 2" < NPS ≤ 6" is used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 4-8 for nominal pipe size of 6 in. A constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of RWST piping was taken from Table 4-3 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_B50_JI are summarized in Table A.15-3.

Table A.15-3 Failure Rate Parameters 1-FLI-AB_B50_JI

RWST 2"- 6" Gamma CNI prior distribution	alpha prior	beta prior	Reference	Notes
	0.5	320513	IF- 9 Table 4-8	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
RWST 2"- 6" Evidence	failures	feet - critical years		
	1	167875	IF- 9 Table 4-3, reference plant information	1 failure identified, 4,020 ft of RWST piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_B50_JI is shown in Table A.15-4.

Table A.15-4 Initiating Event Frequency Estimate for 1-FLI-AB_B50_JI

Mean value	Shape parameter	5th percentile	Median value	95th percentile
3.35E-06	6.69E-01	4.75E-08	1.87E-06	1.14E-05

A.16. Initiating Event Frequency for Scenarios 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF

Scenarios 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF both model the impacts from NSCW pipes located in the rooms. The contributing pipes in each room were from the same system, same size, and same length. Therefore, the same initiating event frequency was used for both scenarios. The scenarios model impacts from local flooding. Sprays were not applicable to these scenarios. Other potential flood sources besides the NSCW pipes were located in the rooms, but those sources were addressed in other flooding scenarios and were not modeled here. The flood sources used to estimate the initiating event frequency for scenarios 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF are summarized in Table A.16-1.

Table A.16-1 Flood Sources 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
DGB	101	DGB_101_LF	NSCW	10	120
DGB	103	DGB_103_LF	NSCW	10	120

The conditional rupture probability for NSCW piping system was estimated from generic data for PWR raw water service water systems provided in IF- 9. Table 3-5 of IF- 9 identifies the number of failure events for PWR plants with lake suction source. The lake suction source was deemed applicable to the NSCW system that take suction from cooling towers with makeup water provided from underground wells. Data was provided for pipe sizes between 4 and 10 in. The prior was based on the EPRI model described in Table 3-12 of IF- 9. The prior rupture probability for flood events was used. A more specific, informed prior could not be justified for this case given the sparse service data for the pipe category. The parameters used to estimate the conditional rupture probability for scenarios 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF are summarized in Table A.16-2.

Table A.16-2 Conditional Rupture Probability Parameters 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF

NSCW 4”-10” Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	99	IF- 9 Table 3-12	Based on generic flood rupture probability of 0.01.
NSCW 4”-10” Evidence	**ruptures**	**failures**		
	0	60	IF- 9 Table 3-5	Based on PWR operating experience for SW systems with lake water intake. Data for NPS 4”-10” was used.

The failure rate for PWR service water piping was estimated in IF- 9 in Table 3-9 for pipe sizes 4 to 10 in. A constrained noninformative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of PWR service water piping was taken from Table 3-2 of IF- 9. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenarios 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF are summarized in Table A.16-3.

Table A.16-3 Failure Rate Parameters 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF

NSCW 4”-10” Gamma CNI prior distribution	alpha prior	beta prior	Reference	Notes
	0.5	9804	IF- 9 Table 3-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
NSCW 4”-10” Evidence	**failures**	**feet - critical years**		
	0	56543	IF- 9 Table 3-2	0 failures identified, 1,354 ft of SW piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenarios 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF is shown in Table A.16-4.

Table A.16-4 Initiating Event Frequency Estimate for 1-FLI-DGB_101_LF and 1-FLI-DGB_103_LF

Mean value	Shape parameter	5th percentile	Median value	95th percentile
7.32E-06	3.66E-01	4.06E-09	2.24E-06	3.19E-05

A.17. Initiating Event Frequency for Scenario 1-FLI-AB_D74_FP

Scenario 1-FLI-AB_D74_FP models impacts on auxiliary building switchgear room D105 from flood water propagating from adjacent room D74. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_D74_FP are summarized in Table A.17-1.

Table A.17-1 Flood Sources 1-FLI-AB_D74_FP

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
AB	D74	AB_D74_FP	Fire Protection	4	35
			Fire Protection	2	20

The conditional rupture probability for fire protection piping systems was estimated from generic data in IF- 9. Table 3-43 of IF- 9 identifies the number of failure events fire protection pipes with nominal pipe sizes less than or equal to 4 in. According to the simple EPRI model used to inform the choice for prior conditional rupture probabilities (Table 3-12 of IF- 9), flood events were assigned a mean conditional rupture probability of 0.01. However, a review of the fire protection service data suggests that a higher conditional rupture probability may be appropriate for this system. The data in Table 3-43 of IF- 9 show three major structural failures (out of 138 total failures) and several significant leakage events. The susceptibility of fire protection piping to water hammer events also contributes to a higher likelihood of significant failures in comparison to other system piping. For these reasons a mean value of 0.1 was selected for the prior conditional rupture probability. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_D74_FP are summarized in Table A.17-2.

Table A.17-2 Conditional Rupture Probability Parameters 1-FLI-AB_D74_FP

FP ≤ 4" Beta prior distribution	alpha prior	beta prior	Reference	Notes
	1	9		Based on review of FP system service data.
FP ≤ 4" Evidence	ruptures	failures		
	1	35	IF- 9 Table 3-43	Data for NPS ≤ 4" is used.

The failure rates for fire protection piping were estimated in IF- 9 in Table 3-47 for nominal pipe size of 4 in. A constrained non-informative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of piping for fire protection piping was given in IF- 9 Table 3-42. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_D74_FP are summarized in Table A.17-3.

Table A.17-3 Failure Rate Parameters 1-FLI-AB_D74_FP

FP ≤ 4" Gamma CNI prior distribution	alpha prior	beta prior	Reference	Notes
	0.5	40650	IF- 9 Tables 3-47	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
FP ≤ 4" Evidence	failures	feet - critical years		
	0	1.26E+05	IF- 9 Table 3-42	3,012 ft of FP piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_D74_FP is shown in Table A.17-4.

Table A.17-4 Initiating Event Frequency Estimate for 1-FLI-AB_D74_FP

Mean value	Shape parameter	5th percentile	Median value	95th percentile
8.57E-06	4.28E-01	1.39E-08	3.45E-06	3.52E-05

A.18. Initiating Event Frequency for Scenario 1-FLI-AB_D78_FP

Scenario 1-FLI-AB_D78_FP models impacts on auxiliary building switchgear room D105 from flood water propagating from adjacent rooms D78 and D79. The flood sources used to estimate the initiating event frequency for scenario 1-FLI-AB_D78_FP are summarized in Table A.18-1.

Table A.18-1 Flood Sources 1-FLI-AB_D78_FP

Building	Flood Area	Designator	Flood Source	Pipe Size (inch)	Pipe Length (feet) or # components
AB	D78	AB_D78_FP	RHR	8	20
			RHR	10	20
			RWST	8	15
AB	D79	AB_D79_FP	RWST	8	25

The conditional rupture probability for the RHR and RWST piping was estimated from generic safety injection piping data in IF- 9. Table 4-1 of IF- 9 identifies the number of failure events safety injection pipes with nominal pipe sizes greater than 6 in. and less than or equal to 10 in. According to the simple EPRI model used to inform the choice for prior conditional rupture probabilities (Table 3-12 of IF- 9), flood events were assigned a mean conditional rupture probability of 0.01. A mean value of 0.01 was selected for the prior conditional rupture probability. The parameters used to estimate the conditional rupture probability for scenario 1-FLI-AB_D78_FP are summarized in Table A.18-2.

Table A.18-2 Conditional Rupture Probability Parameters 1-FLI-AB_D78_FP

6" < SI ≤ 10" Beta prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	1	99		Based on review of FP system service data.
6" < SI ≤ 10" Evidence	**ruptures**	**failures**		
	0	31	IF- 9 Table 4-1	Data for 6" < NPS ≤ 10" was used.

The failure rates for safety injection piping were estimated in IF- 9 in Table 4-9 for nominal pipe size of 10 in. A constrained non-informative gamma distribution, as defined in IF- 12, was used as the prior. The estimated feet of piping for safety injection piping was given in IF- 9 Table 4-3. A lognormal distribution with an error factor of 3 was assumed for the feet of piping to account for uncertainty in the estimate. The reactor-critical-years were estimated as described in A.1 above. The parameters used to estimate the failure rate for scenario 1-FLI-AB_D78_FP are summarized in Table A.18-3.

Table A.18-3 Failure Rate Parameters 1-FLI-AB_D78_FP

FP ≤ 4" Gamma CNI prior distribution	**alpha prior**	**beta prior**	**Reference**	**Notes**
	0.5	1061571	IF- 9 Tables 4-9	For CNI prior, alpha prior = 0.5, beta prior = 0.5/mean value
FP ≤ 4" Evidence	**failures**	**feet - critical years**		
	0	559584	IF- 9 Table 4-3	13,400 ft of SI piping, 41.76 critical years

The initiating event frequency estimate for internal flooding scenario 1-FLI-AB_D78_FP is shown in Table A.18-4.

Table A.18-4 Initiating Event Frequency Estimate for 1-FLI-AB_D78_FP

Mean value	Shape parameter	5th percentile	Median value	95th percentile
3.55E-07	3.55E-01	1.73E-10	1.12E-07	1.57E-06

APPENDIX B: INTERNAL FLOODING PRA SIGNIFICANT CUT SETS AND BASIC EVENT IMPORTANCE

Appendix B contains the significant results from the Internal Flooding PRA (IFPRA). The significant cut sets are provided in B.1 Internal Flooding PRA Significant Cut Set Results and the importance measures for all significant basic events are provided in B.2 Internal Flooding PRA Basic Event Importance Measures.

B.1 Internal Flooding PRA Significant Cut Set Results

The significant cut sets contributing to IFPRA core damage frequency (CDF) are provided in Table B-1. The significant internal flooding cut sets include all those whose summed CDF contributes more than 95 percent of the total internal flooding CDF and all cut sets that individually contribute more than 1 percent to total internal flooding CDF.

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
1	3.914E-8	5.21	1-IE-FLI-AB_C113_LF1,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
2	3.145E-8	4.19	1-IE-FLI-AB_C120_LF,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
3	2.324E-8	3.09	1-IE-FLI-AB_C115_LF,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
4	1.974E-8	2.63	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
5	1.974E-8	2.63	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
6	1.960E-8	2.61	1-IE-FLI-CB_123_SP,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
7	1.960E-8	2.61	1-IE-FLI-CB_122_SP,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
8	1.595E-8	2.12	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
9	1.595E-8	2.12	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
10	1.581E-8	2.10	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
11	1.581E-8	2.10	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
12	1.496E-8	1.99	1-IE-FLI-AB_C113_LF1,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-CLOPT
13	1.270E-8	1.69	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
14	1.270E-8	1.69	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
15	1.203E-8	1.60	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
16	1.203E-8	1.60	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
17	1.202E-8	1.60	1-IE-FLI-AB_C120_LF,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-CLOPT
18	1.194E-8	1.59	1-IE-FLI-CB_122_SP,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
19	1.194E-8	1.59	1-IE-FLI-CB_123_SP,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
20	9.632E-9	1.28	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP2

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
21	9.632E-9	1.28	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP2
22	9.386E-9	1.25	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
23	9.386E-9	1.25	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
24	8.882E-9	1.18	1-IE-FLI-AB_C115_LF,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-CLOPT
25	7.740E-9	1.03	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP2
26	7.740E-9	1.03	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP2
27	6.352E-9	0.85	1-IE-FLI-AB_C113_LF1,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
28	6.095E-9	0.81	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
29	6.095E-9	0.81	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
30	5.719E-9	0.76	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP2
31	5.719E-9	0.76	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP2
32	5.104E-9	0.68	1-IE-FLI-AB_C120_LF,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
33	4.005E-9	0.53	1-IE-FLI-TB_500_LF,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
34	3.953E-9	0.53	1-IE-FLI-AB_C113_LF1,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
35	3.771E-9	0.50	1-IE-FLI-AB_C115_LF,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
36	3.659E-9	0.49	1-IE-FLI-CB_A60,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
37	3.512E-9	0.47	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
38	3.512E-9	0.47	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
39	3.490E-9	0.46	1-IE-FLI-AB_C113_LF1,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-CLOPT
40	3.467E-9	0.46	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AA02____,1-OAB_TR-------H
41	3.467E-9	0.46	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AA02____,1-OAB_TR-------H
42	3.229E-9	0.43	1-IE-FLI-AB_C113_LF1,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
43	3.177E-9	0.42	1-IE-FLI-AB_C120_LF,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
44	3.000E-9	0.40	1-IE-FLI-AB_C113_LF1,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_
45	2.977E-9	0.40	1-IE-FLI-CB_A60,1-EPS-DGN-FR-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
46	2.939E-9	0.39	1-IE-FLI-AB_108_SP1,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPL
47	2.939E-9	0.39	1-IE-FLI-AB_108_SP2,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPL
48	2.918E-9	0.39	1-IE-FLI-CB_122_SP,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPL
49	2.918E-9	0.39	1-IE-FLI-CB_123_SP,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPL
50	2.862E-9	0.38	1-IE-FLI-AB_C120_LF,1-AFW-MDP-MA-P4002___,1-OEP-VCF-LP-CLOPT
51	2.822E-9	0.38	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
52	2.822E-9	0.38	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
53	2.805E-9	0.37	1-IE-FLI-AB_C120_LF,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-CLOPT

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
54	2.699E-9	0.36	1-IE-FLI-AB_C113_LF1,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
55	2.595E-9	0.35	1-IE-FLI-AB_C120_LF,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
56	2.588E-9	0.34	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
57	2.588E-9	0.34	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
58	2.459E-9	0.33	1-IE-FLI-TB_500_LF,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
59	2.411E-9	0.32	1-IE-FLI-AB_C120_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_
60	2.347E-9	0.31	1-IE-FLI-AB_C115_LF,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
61	2.229E-9	0.30	1-IE-FLI-CB_A60,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
62	2.169E-9	0.29	1-IE-FLI-AB_C120_LF,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
63	2.140E-9	0.28	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP2
64	2.140E-9	0.28	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP2
65	2.085E-9	0.28	1-IE-FLI-AB_C115_LF,1-ACP-BAC-FC-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
66	2.085E-9	0.28	1-IE-FLI-AB_C115_LF,1-ACP-BAC-FC-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
67	2.072E-9	0.28	1-IE-FLI-AB_C115_LF,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-CLOPT
68	1.980E-9	0.26	1-IE-FLI-CB_A48,1-ACP-BAC-MA-BA03____,1-FLI-CB-A58A48-FP
69	1.980E-9	0.26	1-IE-FLI-CB_A48,1-ACP-BAC-MA-BB16____,1-FLI-CB-A58A48-FP
70	1.941E-9	0.26	1-IE-FLI-TB_500_LF,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
71	1.917E-9	0.26	1-IE-FLI-AB_C115_LF,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
72	1.852E-9	0.25	1-IE-FLI-AB_108_SP1,1-AFW-MDP-MA-P4002___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
73	1.852E-9	0.25	1-IE-FLI-AB_108_SP2,1-AFW-MDP-MA-P4002___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
74	1.839E-9	0.24	1-IE-FLI-CB_122_SP,1-AFW-MDP-MA-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
75	1.839E-9	0.24	1-IE-FLI-CB_123_SP,1-AFW-MDP-MA-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
76	1.828E-9	0.24	1-IE-FLI-AB_C113_LF1,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_B_1234_
77	1.804E-9	0.24	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPL
78	1.804E-9	0.24	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPL
79	1.791E-9	0.24	1-IE-FLI-CB_122_SP,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPL
80	1.791E-9	0.24	1-IE-FLI-CB_123_SP,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPL
81	1.781E-9	0.24	1-IE-FLI-AB_C115_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_
82	1.719E-9	0.23	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP2
83	1.719E-9	0.23	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP2
84	1.644E-9	0.22	1-IE-FLI-AB_C113_LF1,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1669ACT_
85	1.611E-9	0.21	1-IE-FLI-CB_123_SP,1-EPS-SEQ-FO-1821U301,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
86	1.611E-9	0.21	1-IE-FLI-CB_122_SP,1-EPS-SEQ-FO-1821U301,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
87	1.609E-9	0.21	1-IE-FLI-CB_A48,1-EPS-DGN-FR-G4002___,1-FLI-CB-A58A48-FP,1-OEP-VCF-LP-CLOPT
88	1.603E-9	0.21	1-IE-FLI-CB_A48,1-AFW-MDP-MA-P4002___,1-FLI-CB-A58A48-FP,1-OAB_TR-------H
89	1.602E-9	0.21	1-IE-FLI-AB_C115_LF,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
90	1.574E-9	0.21	1-IE-FLI-DGB_101_LF,1-ACP-BAC-MA-AA02____
91	1.497E-9	0.20	1-IE-FLI-AB_D74_FP,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
92	1.469E-9	0.20	1-IE-FLI-AB_C120_LF,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_B_1234_
93	1.422E-9	0.19	1-IE-FLI-CB_123_SP,1-EPS-DGN-FS-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
94	1.422E-9	0.19	1-IE-FLI-CB_122_SP,1-EPS-DGN-FS-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
95	1.340E-9	0.18	1-IE-FLI-AB_B08_LF,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
96	1.321E-9	0.18	1-IE-FLI-AB_C120_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1669ACT_
97	1.316E-9	0.18	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-AD1B____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
98	1.316E-9	0.18	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-AD1B____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
99	1.314E-9	0.17	1-IE-FLI-AB_C118_LF,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPT
100	1.279E-9	0.17	1-IE-FLI-DGB_101_LF,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPT
101	1.279E-9	0.17	1-IE-FLI-DGB_103_LF,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
102	1.270E-9	0.17	1-IE-FLI-AB_C115_LF,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP2
103	1.270E-9	0.17	1-IE-FLI-AB_C115_LF,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP2
104	1.172E-9	0.16	1-IE-FLI-TB_500_LF-CDS,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
105	1.138E-9	0.15	1-IE-FLI-CB_A60,1-EPS-DGN-MA-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
106	1.122E-9	0.15	1-IE-FLI-AB_C113_LF1,1-ACP-TFW-FC-BB16X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
107	1.085E-9	0.14	1-IE-FLI-AB_C115_LF,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_B_1234_
108	1.019E-9	0.14	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
109	1.019E-9	0.14	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
110	1.012E-9	0.13	1-IE-FLI-CB_123_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
111	1.012E-9	0.13	1-IE-FLI-CB_122_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
112	9.763E-10	0.13	1-IE-FLI-AB_C115_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1669ACT_
113	9.632E-10	0.13	1-IE-FLI-AB_108_SP1,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FS-ALL
114	9.632E-10	0.13	1-IE-FLI-AB_108_SP2,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FS-ALL
115	9.563E-10	0.13	1-IE-FLI-CB_122_SP,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FS-ALL
116	9.563E-10	0.13	1-IE-FLI-CB_123_SP,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FS-ALL

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
117	9.540E-10	0.13	1-IE-FLI-AB_C120_LF,1-AFW-MDP-FS-P4002___,1-OEP-VCF-LP-CLOPT
118	9.540E-10	0.13	1-IE-FLI-AB_C120_LF,1-OA-MISPAF5094H,1-OEP-VCF-LP-CLOPT
119	9.019E-10	0.12	1-IE-FLI-AB_C120_LF,1-ACP-TFW-FC-BB16X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
120	8.325E-10	0.11	1-IE-FLI-AB_108_SP2,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
121	8.325E-10	0.11	1-IE-FLI-AB_108_SP2,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
122	8.325E-10	0.11	1-IE-FLI-AB_108_SP1,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
123	8.325E-10	0.11	1-IE-FLI-AB_108_SP1,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
124	8.265E-10	0.11	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
125	8.265E-10	0.11	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
126	8.265E-10	0.11	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
127	8.265E-10	0.11	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
128	8.248E-10	0.11	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
129	8.248E-10	0.11	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
130	8.248E-10	0.11	1-IE-FLI-CB_123_SP,1-CVC-MDP-MA-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
131	8.248E-10	0.11	1-IE-FLI-CB_122_SP,1-CVC-MDP-MA-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
132	7.701E-10	0.10	1-IE-FLI-CB_122_SP,1-ACP-BAC-FC-AA02____,1-OAB_TR-------H
133	7.701E-10	0.10	1-IE-FLI-CB_123_SP,1-ACP-BAC-FC-AA02____,1-OAB_TR-------H
134	7.517E-10	0.10	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
135	7.517E-10	0.10	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
136	7.464E-10	0.10	1-IE-FLI-CB_122_SP,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
137	7.464E-10	0.10	1-IE-FLI-CB_123_SP,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
138	7.194E-10	0.10	1-IE-FLI-TB_500_LF-CDS,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
139	6.838E-10	0.09	1-IE-FLI-AB_C113_LF1,1-ACP-TFW-FC-BB16X___,1-RCS-MDP-LK-BP2
140	6.791E-10	0.09	1-IE-FLI-CB_123_SP,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
141	6.791E-10	0.09	1-IE-FLI-CB_122_SP,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
142	6.664E-10	0.09	1-IE-FLI-AB_C115_LF,1-ACP-TFW-FC-BB16X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
143	6.472E-10	0.09	1-IE-FLI-CB_A60,1-ACP-BAC-MA-AA02____,1-OAB_TR-------H
144	6.210E-10	0.08	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
145	6.210E-10	0.08	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
146	6.174E-10	0.08	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FR-P4001___,1-OA-MISPAF5094H,1-OAB_TR-------H
147	6.174E-10	0.08	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FR-P4001___,1-OA-MISPAF5094H,1-OAB_TR-------H
148	6.174E-10	0.08	1-IE-FLI-AB_108_SP1,1-AFW-MDP-FS-P4002___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
149	6.174E-10	0.08	1-IE-FLI-AB_108_SP2,1-AFW-MDP-FS-P4002___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
150	6.168E-10	0.08	1-IE-FLI-AB_B24_LF2,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
151	6.165E-10	0.08	1-IE-FLI-CB_123_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
152	6.165E-10	0.08	1-IE-FLI-CB_122_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
153	6.150E-10	0.08	1-IE-FLI-CB_A48,1-EPS-DGN-MA-G4002___,1-FLI-CB-A58A48-FP,1-OEP-VCF-LP-CLOPT
154	6.130E-10	0.08	1-IE-FLI-CB_122_SP,1-AFW-TDP-FR-P4001___,1-OA-MISPAF5095H,1-OAB_TR-------H
155	6.130E-10	0.08	1-IE-FLI-CB_123_SP,1-AFW-TDP-FR-P4001___,1-OA-MISPAF5095H,1-OAB_TR-------H
156	6.130E-10	0.08	1-IE-FLI-CB_122_SP,1-AFW-MDP-FS-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
157	6.130E-10	0.08	1-IE-FLI-CB_123_SP,1-AFW-MDP-FS-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
158	6.106E-10	0.08	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FR-P4001___,1-EPS-DGN-FR-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
159	6.106E-10	0.08	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FR-P4001___,1-EPS-DGN-FR-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
160	6.048E-10	0.08	1-IE-FLI-AB_D74_FP,1-ACP-BAC-MA-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
161	6.048E-10	0.08	1-IE-FLI-AB_D74_FP,1-ACP-BAC-MA-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
162	6.020E-10	0.08	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP1
163	6.020E-10	0.08	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP1
164	5.869E-10	0.08	1-IE-FLI-AB_108_SP1,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FS-ALL
165	5.869E-10	0.08	1-IE-FLI-AB_108_SP2,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FS-ALL
166	5.853E-10	0.08	1-IE-FLI-AB_B50_JI,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPT
167	5.827E-10	0.08	1-IE-FLI-CB_122_SP,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FS-ALL
168	5.827E-10	0.08	1-IE-FLI-CB_123_SP,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FS-ALL
169	5.723E-10	0.08	1-IE-FLI-AB_D74_FP,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-CLOPT
170	5.678E-10	0.08	1-IE-FLI-TB_500_LF-CDS,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
171	5.495E-10	0.07	1-IE-FLI-AB_C120_LF,1-ACP-TFW-FC-BB16X___,1-RCS-MDP-LK-BP2
172	5.447E-10	0.07	1-IE-FLI-CB_A60,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPL
173	5.413E-10	0.07	1-IE-FLI-AB_B08_LF,1-ACP-BAC-MA-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
174	5.413E-10	0.07	1-IE-FLI-AB_B08_LF,1-ACP-BAC-MA-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
175	5.342E-10	0.07	1-IE-FLI-CB_A48,1-AFW-MDP-FS-P4002___,1-FLI-CB-A58A48-FP,1-OAB_TR-------H

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
176	5.342E-10	0.07	1-IE-FLI-CB_A48,1-FLI-CB-A58A48-FP,1-OA-MISPAF5094H,1-OAB_TR-------H
177	5.307E-10	0.07	1-IE-FLI-AB_C118_LF,1-ACP-BAC-MA-AA02____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
178	5.307E-10	0.07	1-IE-FLI-AB_C118_LF,1-ACP-BAC-MA-AB15____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
179	5.166E-10	0.07	1-IE-FLI-DGB_103_LF,1-ACP-BAC-MA-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
180	5.166E-10	0.07	1-IE-FLI-DGB_103_LF,1-ACP-BAC-MA-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
181	5.166E-10	0.07	1-IE-FLI-DGB_101_LF,1-ACP-BAC-MA-AB15____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
182	5.122E-10	0.07	1-IE-FLI-AB_B08_LF,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-CLOPT
183	5.072E-10	0.07	1-IE-FLI-AB_108_SP2,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
184	5.072E-10	0.07	1-IE-FLI-AB_108_SP1,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
185	5.072E-10	0.07	1-IE-FLI-AB_108_SP2,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
186	5.072E-10	0.07	1-IE-FLI-AB_108_SP1,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
187	5.036E-10	0.07	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
188	5.036E-10	0.07	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
189	5.036E-10	0.07	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
190	5.036E-10	0.07	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
191	5.025E-10	0.07	1-IE-FLI-AB_A20,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
192	5.022E-10	0.07	1-IE-FLI-AB_C118_LF,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPT
193	4.921E-10	0.07	1-IE-FLI-CB_123_SP,1-CVC-MDP-FS-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
194	4.921E-10	0.07	1-IE-FLI-CB_122_SP,1-CVC-MDP-FS-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
195	4.888E-10	0.07	1-IE-FLI-DGB_101_LF,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPT
196	4.888E-10	0.07	1-IE-FLI-DGB_103_LF,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-CLOPT
197	4.837E-10	0.06	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP1
198	4.837E-10	0.06	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP1
199	4.831E-10	0.06	1-IE-FLI-CB_A60,1-ACP-CRB-CC-AA0205__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
200	4.749E-10	0.06	1-IE-FLI-AB_C113_LF1,1-EPS-TNK-MA-DFOSTKB_,1-OEP-VCF-LP-CLOPT
201	4.748E-10	0.06	1-IE-FLI-AB_C113_LF1,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-RLOOP
202	4.508E-10	0.06	1-IE-FLI-AB_108_SP1,1-RPS-BME-CF-RTBAB
203	4.508E-10	0.06	1-IE-FLI-AB_108_SP2,1-RPS-BME-CF-RTBAB
204	4.476E-10	0.06	1-IE-FLI-CB_122_SP,1-RPS-BME-CF-RTBAB
205	4.476E-10	0.06	1-IE-FLI-CB_123_SP,1-RPS-BME-CF-RTBAB
206	4.399E-10	0.06	1-IE-FLI-CB_A48,1-ACP-BAC-FC-BA03____,1-FLI-CB-A58A48-FP
207	4.399E-10	0.06	1-IE-FLI-CB_A48,1-ACP-BAC-FC-BB16____,1-FLI-CB-A58A48-FP
208	4.271E-10	0.06	1-IE-FLI-AB_108_SP1,1-DCP-BCH-FC-AAABBABB-CC

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
209	4.271E-10	0.06	1-IE-FLI-AB_108_SP2,1-DCP-BCH-FC-AAABBABB-CC
210	4.262E-10	0.06	1-IE-FLI-CB_123_SP,1-ACP-INV-MA-AD1I11__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
211	4.262E-10	0.06	1-IE-FLI-CB_122_SP,1-ACP-INV-MA-AD1I11__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
212	4.241E-10	0.06	1-IE-FLI-CB_122_SP,1-DCP-BCH-FC-AAABBABB-CC
213	4.241E-10	0.06	1-IE-FLI-CB_123_SP,1-DCP-BCH-FC-AAABBABB-CC
214	4.153E-10	0.06	1-IE-FLI-AB_C113_LF1,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
215	4.060E-10	0.05	1-IE-FLI-AB_C115_LF,1-ACP-TFW-FC-BB16X___,1-RCS-MDP-LK-BP2
216	3.971E-10	0.05	1-IE-FLI-AB_C113_LF1,1-ACP-CRB-CO-BA0309__,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
217	3.971E-10	0.05	1-IE-FLI-AB_C113_LF1,1-ACP-CRB-CO-BB1601__,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
218	3.825E-10	0.05	1-IE-FLI-TB_500_LF,1-RPS-BME-CF-RTBAB,1-UET2-NOPORV-BLK
219	3.816E-10	0.05	1-IE-FLI-AB_C120_LF,1-EPS-TNK-MA-DFOSTKB_,1-OEP-VCF-LP-CLOPT
220	3.815E-10	0.05	1-IE-FLI-AB_C120_LF,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-RLOOP
221	3.788E-10	0.05	1-IE-FLI-AB_C113_LF1,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-CC-1669A___
222	3.685E-10	0.05	1-IE-FLI-AB_D74_FP,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP2
223	3.685E-10	0.05	1-IE-FLI-AB_D74_FP,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP2
224	3.574E-10	0.05	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP1
225	3.574E-10	0.05	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP1
226	3.496E-10	0.05	1-IE-FLI-DGB_101_LF,1-ACP-BAC-FC-AA02____
227	3.433E-10	0.05	1-IE-FLI-CB_A60,1-AFW-MDP-MA-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
228	3.388E-10	0.05	1-IE-FLI-AB_108_SP1,1-RPS-ROD-CF-RCCAS
229	3.388E-10	0.05	1-IE-FLI-AB_108_SP2,1-RPS-ROD-CF-RCCAS
230	3.368E-10	0.04	1-IE-FLI-AB_C120_LF,1-AFW-MOV-OO-FV5154__,1-OEP-VCF-LP-CLOPT
231	3.364E-10	0.04	1-IE-FLI-CB_122_SP,1-RPS-ROD-CF-RCCAS
232	3.364E-10	0.04	1-IE-FLI-CB_123_SP,1-RPS-ROD-CF-RCCAS
233	3.344E-10	0.04	1-IE-FLI-CB_A60,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPL
234	3.337E-10	0.04	1-IE-FLI-AB_C120_LF,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
235	3.298E-10	0.04	1-IE-FLI-AB_B08_LF,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP2
236	3.298E-10	0.04	1-IE-FLI-AB_B08_LF,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP2
237	3.277E-10	0.04	1-IE-FLI-TB_500_LF,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
238	3.234E-10	0.04	1-IE-FLI-AB_C118_LF,1-ACP-BAC-MA-AA02____,1-RCS-MDP-LK-BP2
239	3.234E-10	0.04	1-IE-FLI-AB_C118_LF,1-ACP-BAC-MA-AB15____,1-RCS-MDP-LK-BP2
240	3.191E-10	0.04	1-IE-FLI-AB_C120_LF,1-ACP-CRB-CO-BA0309__,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
241	3.191E-10	0.04	1-IE-FLI-AB_C120_LF,1-ACP-CRB-CO-BB1601__,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
242	3.148E-10	0.04	1-IE-FLI-DGB_101_LF,1-ACP-BAC-MA-AB15____,1-RCS-MDP-LK-BP2
243	3.148E-10	0.04	1-IE-FLI-DGB_103_LF,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP2
244	3.148E-10	0.04	1-IE-FLI-DGB_103_LF,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP2
245	3.085E-10	0.04	1-IE-FLI-AB_A20,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
246	3.044E-10	0.04	1-IE-FLI-AB_C120_LF,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-CC-1669A___
247	3.028E-10	0.04	1-IE-FLI-CB_123_SP,1-EPS-TNK-MA-DFOSTKA_,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
248	3.028E-10	0.04	1-IE-FLI-CB_122_SP,1-EPS-TNK-MA-DFOSTKA_,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
249	3.007E-10	0.04	1-IE-FLI-CB_A60,1-EPS-SEQ-FO-1821U301,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
250	2.889E-10	0.04	1-IE-FLI-AB_108_SP1,1-AFW-MDP-MA-P4002___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
251	2.889E-10	0.04	1-IE-FLI-AB_108_SP2,1-AFW-MDP-MA-P4002___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
252	2.875E-10	0.04	1-IE-FLI-TB_500_LF,1-RPS-ROD-CF-RCCAS,1-UET2-NOPORV-BLK
253	2.868E-10	0.04	1-IE-FLI-CB_122_SP,1-AFW-MDP-MA-P4003___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
254	2.868E-10	0.04	1-IE-FLI-CB_123_SP,1-AFW-MDP-MA-P4003___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
255	2.820E-10	0.04	1-IE-FLI-AB_C115_LF,1-EPS-TNK-MA-DFOSTKB_,1-OEP-VCF-LP-CLOPT
256	2.819E-10	0.04	1-IE-FLI-AB_C115_LF,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-RLOOP
257	2.749E-10	0.04	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-LPI-MDP-FS-RHRB____,1-OEP-VCF-LP-CLOPL
258	2.749E-10	0.04	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-LPI-MDP-FS-RHRB____,1-OEP-VCF-LP-CLOPL
259	2.696E-10	0.04	1-IE-FLI-AB_108_SP2,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
260	2.696E-10	0.04	1-IE-FLI-AB_108_SP1,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
261	2.677E-10	0.04	1-IE-FLI-CB_123_SP,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
262	2.677E-10	0.04	1-IE-FLI-CB_122_SP,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
263	2.655E-10	0.04	1-IE-FLI-CB_A60,1-EPS-DGN-FS-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
264	2.611E-10	0.03	1-IE-FLI-CB_A48,1-ACP-CRB-CC-BA0301__,1-FLI-CB-A58A48-FP,1-OEP-VCF-LP-CLOPT
265	2.596E-10	0.03	1-IE-FLI-CB_123_SP,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPL
266	2.596E-10	0.03	1-IE-FLI-CB_122_SP,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPL
267	2.552E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BA03____,1-OEP-VCF-LP-CLOPT
268	2.552E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BB07____,1-OEP-VCF-LP-CLOPT
269	2.552E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BB16____,1-OEP-VCF-LP-CLOPT
270	2.552E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-MCCBBB__,1-OEP-VCF-LP-CLOPT
271	2.552E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-MCCBBF__,1-OEP-VCF-LP-CLOPT

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
272	2.550E-10	0.03	1-IE-FLI-AB_C113_LF1,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
273	2.550E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-INV-FC-BD1I12__,1-OEP-VCF-LP-CLOPT
274	2.516E-10	0.03	1-IE-FLI-AB_108_SP1,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
275	2.516E-10	0.03	1-IE-FLI-AB_108_SP2,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
276	2.498E-10	0.03	1-IE-FLI-CB_122_SP,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
277	2.498E-10	0.03	1-IE-FLI-CB_123_SP,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
278	2.491E-10	0.03	1-IE-FLI-AB_B24_LF2,1-ACP-BAC-MA-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
279	2.491E-10	0.03	1-IE-FLI-AB_B24_LF2,1-ACP-BAC-MA-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
280	2.466E-10	0.03	1-IE-FLI-AB_C115_LF,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
281	2.456E-10	0.03	1-IE-FLI-CB_A60,1-DCP-BAT-MA-AD1B____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
282	2.446E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-INV-MA-BD1I12__,1-OEP-VCF-LP-CLOPT
283	2.435E-10	0.03	1-IE-FLI-AB_A20,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
284	2.430E-10	0.03	1-IE-FLI-AB_D74_FP,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
285	2.419E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-CRB-CO-BA0309__,1-RCS-MDP-LK-BP2
286	2.419E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-CRB-CO-BB1601__,1-RCS-MDP-LK-BP2
287	2.404E-10	0.03	1-IE-FLI-AB_108_SP2,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPL
288	2.404E-10	0.03	1-IE-FLI-AB_108_SP1,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPL
289	2.391E-10	0.03	1-IE-FLI-TB_500_LF,1-AFW-MDP-CF-START,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
290	2.387E-10	0.03	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPL
291	2.387E-10	0.03	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPL
292	2.364E-10	0.03	1-IE-FLI-AB_B50_JI,1-ACP-BAC-MA-AA02____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
293	2.364E-10	0.03	1-IE-FLI-AB_B50_JI,1-ACP-BAC-MA-AB15____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
294	2.357E-10	0.03	1-IE-FLI-AB_C115_LF,1-ACP-CRB-CO-BA0309__,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
295	2.357E-10	0.03	1-IE-FLI-AB_C115_LF,1-ACP-CRB-CO-BB1601__,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
296	2.357E-10	0.03	1-IE-FLI-AB_B24_LF2,1-EPS-DGN-MA-G4002___,1-OEP-VCF-LP-CLOPT
297	2.334E-10	0.03	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FR-P4001___,1-EPS-DGN-MA-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
298	2.334E-10	0.03	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FR-P4001___,1-EPS-DGN-MA-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
299	2.315E-10	0.03	1-IE-FLI-TB_500_LF,1-NSCW-CT-NEED-SWAP,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-SWT-FC-TY16689B-CC
300	2.307E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-BYB1____,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT
301	2.249E-10	0.03	1-IE-FLI-AB_C115_LF,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-CC-1669A___
302	2.237E-10	0.03	1-IE-FLI-AB_B50_JI,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPT
303	2.220E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-SSD-MA-1821U302,1-OEP-VCF-LP-CLOPT

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
304	2.179E-10	0.03	1-IE-FLI-AB_108_SP1,1-AFW-MOV-OO-FV5154__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
305	2.179E-10	0.03	1-IE-FLI-AB_108_SP2,1-AFW-MOV-OO-FV5154__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
306	2.175E-10	0.03	1-IE-FLI-AB_B08_LF,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
307	2.164E-10	0.03	1-IE-FLI-CB_122_SP,1-AFW-MOV-OO-FV5155__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
308	2.164E-10	0.03	1-IE-FLI-CB_123_SP,1-AFW-MOV-OO-FV5155__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
309	2.132E-10	0.03	1-IE-FLI-AB_C118_LF,1-ACP-CRB-CC-AA0205__,1-OEP-VCF-LP-CLOPT
310	2.076E-10	0.03	1-IE-FLI-DGB_101_LF,1-ACP-CRB-CC-AA0205__,1-OEP-VCF-LP-CLOPT
311	2.076E-10	0.03	1-IE-FLI-DGB_103_LF,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
312	2.066E-10	0.03	1-IE-FLI-AB_C113_LF1,1-AFW-MDP-MA-P4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPT
313	2.051E-10	0.03	1-IE-FLI-AB_C113_LF1,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MDP-MA-P4_00246-3
314	2.051E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BA03____,1-OEP-VCF-LP-CLOPT
315	2.051E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BB07____,1-OEP-VCF-LP-CLOPT
316	2.051E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BB16____,1-OEP-VCF-LP-CLOPT
317	2.051E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-MCCBBB__,1-OEP-VCF-LP-CLOPT
318	2.051E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-MCCBBF__,1-OEP-VCF-LP-CLOPT
319	2.049E-10	0.03	1-IE-FLI-AB_C120_LF,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
320	2.049E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-INV-FC-BD1I12__,1-OEP-VCF-LP-CLOPT
321	2.040E-10	0.03	1-IE-FLI-TB_500_LF,1-ACP-CRB-CC-AA0205__,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
322	2.040E-10	0.03	1-IE-FLI-TB_500_LF,1-ACP-CRB-CC-BA0301__,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPT
323	2.016E-10	0.03	1-IE-FLI-AB_C113_LF1,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-RLOOP
324	1.990E-10	0.03	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H
325	1.990E-10	0.03	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H
326	1.965E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-INV-MA-BD1I12__,1-OEP-VCF-LP-CLOPT
327	1.948E-10	0.03	1-IE-FLI-AB_C118_LF,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1668ACT_
328	1.944E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-CRB-CO-BA0309__,1-RCS-MDP-LK-BP2
329	1.944E-10	0.03	1-IE-FLI-AB_C120_LF,1-ACP-CRB-CO-BB1601__,1-RCS-MDP-LK-BP2
330	1.896E-10	0.03	1-IE-FLI-DGB_101_LF,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1668ACT_
331	1.893E-10	0.03	1-IE-FLI-AB_C120_LF,1-AFW-MDP-FR-P4002___,1-OEP-VCF-LP-CLOPT
332	1.889E-10	0.03	1-IE-FLI-CB_A60,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
333	1.886E-10	0.03	1-IE-FLI-CB_A48,1-AFW-MOV-OO-FV5154__,1-FLI-CB-A58A48-FP,1-OAB_TR-------H
334	1.881E-10	0.03	1-IE-FLI-CB_123_SP,1-CVC-MDP-FS-CCPB____,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPL
335	1.881E-10	0.03	1-IE-FLI-CB_122_SP,1-CVC-MDP-FS-CCPB____,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPL

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
336	1.869E-10	0.02	1-IE-FLI-AB_C113_LF1,1-ACP-DCP-FC-1B_PS4__,1-OEP-VCF-LP-CLOPT
337	1.869E-10	0.02	1-IE-FLI-AB_C113_LF1,1-ACP-DCP-FC-1B_PS1__,1-OEP-VCF-LP-CLOPT
338	1.854E-10	0.02	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-BYB1____,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT
339	1.793E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AA02____,1-LPI-MDP-MA-RHRB____
340	1.793E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AA02____,1-CVC-MDP-MA-CCPB____
341	1.793E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AA02____,1-LPI-MDP-MA-RHRB____
342	1.793E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AA02____,1-CVC-MDP-MA-CCPB____
343	1.785E-10	0.02	1-IE-FLI-CB_A60,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FS-ALL
344	1.784E-10	0.02	1-IE-FLI-AB_C120_LF,1-ACP-SSD-MA-1821U302,1-OEP-VCF-LP-CLOPT
345	1.743E-10	0.02	1-IE-FLI-TB_500_HI1,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
346	1.743E-10	0.02	1-IE-FLI-TB_500_HI2,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
347	1.666E-10	0.02	1-IE-FLI-TB_500_LF,1-ACP-CRB-CC-BA0301__,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPT
348	1.666E-10	0.02	1-IE-FLI-TB_500_LF,1-ACP-CRB-CC-AA0205__,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
349	1.650E-10	0.02	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-OAR_LTFB-TRA-H,1-OEP-VCF-LP-CLOPL
350	1.650E-10	0.02	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-OAR_LTFB-TRA-H,1-OEP-VCF-LP-CLOPL
351	1.648E-10	0.02	1-IE-FLI-AB_C120_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MDP-MA-P4_00246-3
352	1.643E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
353	1.643E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
354	1.633E-10	0.02	1-IE-FLI-AB_108_SP2,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL
355	1.633E-10	0.02	1-IE-FLI-AB_108_SP1,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL
356	1.631E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
357	1.631E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
358	1.625E-10	0.02	1-IE-FLI-CB_A48,1-EPS-SEQ-FO-1821U302,1-FLI-CB-A58A48-FP,1-OEP-VCF-LP-CLOPT
359	1.622E-10	0.02	1-IE-FLI-CB_123_SP,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL
360	1.622E-10	0.02	1-IE-FLI-CB_122_SP,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL
361	1.620E-10	0.02	1-IE-FLI-AB_C120_LF,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-RLOOP
362	1.544E-10	0.02	1-IE-FLI-CB_123_SP,1-NSCWCT-SPRAY,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1668A___
363	1.544E-10	0.02	1-IE-FLI-CB_122_SP,1-NSCWCT-SPRAY,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1668A___
364	1.543E-10	0.02	1-IE-FLI-CB_A60,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
365	1.543E-10	0.02	1-IE-FLI-CB_A60,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
366	1.540E-10	0.02	1-IE-FLI-CB_A60,1-EPS-DGN-FR-G4001___,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
367	1.540E-10	0.02	1-IE-FLI-CB_A60,1-CVC-MDP-MA-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
368	1.518E-10	0.02	1-IE-FLI-AB_B24_LF2,1-ACP-BAC-MA-BA03____,1-RCS-MDP-LK-BP2
369	1.518E-10	0.02	1-IE-FLI-AB_B24_LF2,1-ACP-BAC-MA-BB16____,1-RCS-MDP-LK-BP2
370	1.516E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BA03____,1-OEP-VCF-LP-CLOPT
371	1.516E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BB07____,1-OEP-VCF-LP-CLOPT
372	1.516E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BB16____,1-OEP-VCF-LP-CLOPT
373	1.516E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-MCCBBB__,1-OEP-VCF-LP-CLOPT
374	1.516E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-MCCBBF__,1-OEP-VCF-LP-CLOPT
375	1.514E-10	0.02	1-IE-FLI-AB_C115_LF,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
376	1.514E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-INV-FC-BD1I12__,1-OEP-VCF-LP-CLOPT
377	1.513E-10	0.02	1-IE-FLI-AB_D74_FP,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
378	1.511E-10	0.02	1-IE-FLI-CB_123_SP,1-CVC-MDP-FR-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
379	1.511E-10	0.02	1-IE-FLI-CB_122_SP,1-CVC-MDP-FR-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
380	1.502E-10	0.02	1-IE-FLI-AB_C120_LF,1-ACP-DCP-FC-1B_PS4__,1-OEP-VCF-LP-CLOPT
381	1.502E-10	0.02	1-IE-FLI-AB_C120_LF,1-ACP-DCP-FC-1B_PS1__,1-OEP-VCF-LP-CLOPT
382	1.497E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-CRB-CC-AA0205__,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
383	1.497E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-CRB-CC-AA0205__,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
384	1.497E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-CRB-CC-BA0301__,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
385	1.497E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-CRB-CC-BA0301__,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
386	1.486E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
387	1.486E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
388	1.486E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-BA0301__,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
389	1.486E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-BA0301__,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
390	1.476E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AA02____,1-CVC-MDP-TE-CCPB____
391	1.476E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AA02____,1-CVC-MDP-TE-CCPB____
392	1.452E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-INV-MA-BD1I12__,1-OEP-VCF-LP-CLOPT
393	1.441E-10	0.02	1-IE-FLI-AB_B50_JI,1-ACP-BAC-MA-AA02____,1-RCS-MDP-LK-BP2
394	1.441E-10	0.02	1-IE-FLI-AB_B50_JI,1-ACP-BAC-MA-AB15____,1-RCS-MDP-LK-BP2
395	1.438E-10	0.02	1-IE-FLI-CB_A60,1-ACP-BAC-FC-AA02____,1-OAB_TR-------H
396	1.436E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-CRB-CO-BA0309__,1-RCS-MDP-LK-BP2
397	1.436E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-CRB-CO-BB1601__,1-RCS-MDP-LK-BP2
398	1.435E-10	0.02	1-IE-FLI-CB_A48,1-EPS-DGN-FS-G4002___,1-FLI-CB-A58A48-FP,1-OEP-VCF-LP-CLOPT

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
399	1.410E-10	0.02	1-IE-FLI-TB_500_LF,1-NSCW-CT-NEED-SWAP,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-SWT-FC-TY16689B-CC
400	1.406E-10	0.02	1-IE-FLI-CB_A48,1-ACP-TFW-FC-BB16X___,1-FLI-CB-A58A48-FP
401	1.393E-10	0.02	1-IE-FLI-CB_A60,1-EPS-SEQ-CF-FOAB,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
402	1.386E-10	0.02	1-IE-FLI-TB_500_LF,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL,1-UET2-NOPORV-BLK
403	1.370E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-BAC-MA-BYB1____,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT
404	1.354E-10	0.02	1-IE-FLI-AB_B08_LF,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
405	1.344E-10	0.02	1-IE-FLI-AB_D74_FP,1-ACP-BAC-FC-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
406	1.344E-10	0.02	1-IE-FLI-AB_D74_FP,1-ACP-BAC-FC-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
407	1.339E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
408	1.339E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
409	1.339E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-CVC-MDP-MA-CCPB____,1-OEP-VCF-LP-CLOPL
410	1.339E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-CVC-MDP-MA-CCPB____,1-OEP-VCF-LP-CLOPL
411	1.337E-10	0.02	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP1
412	1.337E-10	0.02	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP1
413	1.335E-10	0.02	1-IE-FLI-AB_D74_FP,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-CLOPT
414	1.328E-10	0.02	1-IE-FLI-CB_A48,1-DCP-BAT-MA-BD1B____,1-FLI-CB-A58A48-FP,1-OEP-VCF-LP-CLOPT
415	1.327E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-BA03____,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
416	1.327E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-BA03____,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
417	1.327E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-BB07____,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
418	1.327E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-BB07____,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
419	1.327E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-MCCBBF__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
420	1.327E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-MCCBBF__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
421	1.327E-10	0.02	1-IE-FLI-AB_C118_LF,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPT
422	1.322E-10	0.02	1-IE-FLI-TB_500_LF,1-AFW-TDP-FR-P4001___,1-RPS-BME-CF-RTBAB
423	1.318E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-SSD-MA-1821U302,1-OEP-VCF-LP-CLOPT
424	1.318E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AB05____,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
425	1.318E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AB05____,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
426	1.318E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-MCCABF__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
427	1.318E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-MCCABF__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
428	1.292E-10	0.02	1-IE-FLI-DGB_101_LF,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPT
429	1.292E-10	0.02	1-IE-FLI-DGB_103_LF,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
430	1.271E-10	0.02	1-IE-FLI-TB_500_LF,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-RLOOP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
431	1.269E-10	0.02	1-IE-FLI-TB_500_LF,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
432	1.268E-10	0.02	1-IE-FLI-CB_A60,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
433	1.255E-10	0.02	1-IE-FLI-AB_C113_LF1,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-RLOOP
434	1.250E-10	0.02	1-IE-FLI-AB_C113_LF1,1-RCS-MDP-LK-BP2,1-SWS-MDP-MA-P4_00246-3
435	1.235E-10	0.02	1-IE-FLI-AB_D74_FP,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
436	1.233E-10	0.02	1-IE-FLI-CB_A48,1-FLI-CB-A58A48-FP,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_
437	1.228E-10	0.02	1-IE-FLI-TB_500_LF,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-CF-1668A69A
438	1.227E-10	0.02	1-IE-FLI-AB_C115_LF,1-AFW-MDP-MA-P4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPT
439	1.225E-10	0.02	1-IE-FLI-AB_108_SP1,1-AFW-MDP-FR-P4002___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
440	1.225E-10	0.02	1-IE-FLI-AB_108_SP2,1-AFW-MDP-FR-P4002___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
441	1.222E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-CRB-CC-BA0301__,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
442	1.222E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-CRB-CC-BA0301__,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
443	1.222E-10	0.02	1-IE-FLI-AB_108_SP2,1-ACP-CRB-CC-AA0205__,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPL
444	1.222E-10	0.02	1-IE-FLI-AB_108_SP1,1-ACP-CRB-CC-AA0205__,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPL
445	1.218E-10	0.02	1-IE-FLI-AB_C115_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MDP-MA-P4_00246-3
446	1.216E-10	0.02	1-IE-FLI-CB_122_SP,1-AFW-MDP-FR-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
447	1.216E-10	0.02	1-IE-FLI-CB_123_SP,1-AFW-MDP-FR-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
448	1.214E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-BA0301__,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
449	1.214E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-BA0301__,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
450	1.214E-10	0.02	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPL
451	1.214E-10	0.02	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPL
452	1.204E-10	0.02	1-IE-FLI-TB_500_LF,1-EPS-DGN-FR-G4002___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-CC-1668A___
453	1.204E-10	0.02	1-IE-FLI-TB_500_LF,1-EPS-DGN-FR-G4001___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-CC-1669A___
454	1.202E-10	0.02	1-IE-FLI-AB_B08_LF,1-ACP-BAC-FC-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
455	1.202E-10	0.02	1-IE-FLI-AB_B08_LF,1-ACP-BAC-FC-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
456	1.197E-10	0.02	1-IE-FLI-AB_C115_LF,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-RLOOP
457	1.195E-10	0.02	1-IE-FLI-AB_B08_LF,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-CLOPT
458	1.187E-10	0.02	1-IE-FLI-AB_C118_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1668ACT_
459	1.179E-10	0.02	1-IE-FLI-AB_C118_LF,1-ACP-BAC-FC-AA02____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
460	1.179E-10	0.02	1-IE-FLI-AB_C118_LF,1-ACP-BAC-FC-AB15____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
461	1.172E-10	0.02	1-IE-FLI-AB_C118_LF,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPT
462	1.155E-10	0.02	1-IE-FLI-DGB_101_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1668ACT_
463	1.151E-10	0.02	1-IE-FLI-CB_A60,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
464	1.148E-10	0.02	1-IE-FLI-CB_A48,1-ACP-BAC-MA-MCCBBF__,1-FLI-CB-A58A48-FP,1-OAB_TR-------H
465	1.148E-10	0.02	1-IE-FLI-CB_A48,1-ACP-BAC-MA-BB07____,1-FLI-CB-A58A48-FP,1-OAB_TR-------H
466	1.148E-10	0.02	1-IE-FLI-AB_D74_FP,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_
467	1.148E-10	0.02	1-IE-FLI-DGB_103_LF,1-ACP-BAC-FC-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
468	1.148E-10	0.02	1-IE-FLI-DGB_103_LF,1-ACP-BAC-FC-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
469	1.148E-10	0.02	1-IE-FLI-DGB_101_LF,1-ACP-BAC-FC-AB15____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
470	1.144E-10	0.02	1-IE-FLI-CB_A60,1-AFW-TDP-FR-P4001___,1-OA-MISPAF5095H,1-OAB_TR-------H
471	1.144E-10	0.02	1-IE-FLI-CB_A60,1-AFW-MDP-FS-P4003___,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
472	1.142E-10	0.02	1-IE-FLI-AB_C113_LF1,1-RCS-MDP-LK-BP1,1-SWS-CTF-MA-_B_1234_
473	1.141E-10	0.02	1-IE-FLI-DGB_101_LF,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPT
474	1.141E-10	0.02	1-IE-FLI-DGB_103_LF,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-CLOPT
475	1.119E-10	0.01	1-IE-FLI-TB_500_LF-CDS,1-RPS-BME-CF-RTBAB,1-UET2-NOPORV-BLK
476	1.110E-10	0.01	1-IE-FLI-AB_C115_LF,1-ACP-DCP-FC-1B_PS4__,1-OEP-VCF-LP-CLOPT
477	1.110E-10	0.01	1-IE-FLI-AB_C115_LF,1-ACP-DCP-FC-1B_PS1__,1-OEP-VCF-LP-CLOPT
478	1.110E-10	0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
479	1.110E-10	0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
480	1.110E-10	0.01	1-IE-FLI-CB_A48,1-FLI-CB-A58A48-FP,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
481	1.108E-10	0.01	1-IE-FLI-AB_C113_LF1,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-RLOOP
482	1.107E-10	0.01	1-IE-FLI-AB_108_SP1,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,/1-RPS-CCP-TM-CHA,1-RPS-CCX-CF-6OF8,1-RPS-XHE-XE-NSGNL
483	1.107E-10	0.01	1-IE-FLI-AB_108_SP2,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,/1-RPS-CCP-TM-CHA,1-RPS-CCX-CF-6OF8,1-RPS-XHE-XE-NSGNL
484	1.106E-10	0.01	1-IE-FLI-AB_B08_LF,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
485	1.102E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-CVC-MDP-TE-CCPB____,1-OEP-VCF-LP-CLOPL
486	1.102E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-CVC-MDP-TE-CCPB____,1-OEP-VCF-LP-CLOPL
487	1.102E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
488	1.102E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
489	1.099E-10	0.01	1-IE-FLI-CB_122_SP,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,/1-RPS-CCP-TM-CHA,1-RPS-CCX-CF-6OF8,1-RPS-XHE-XE-NSGNL
490	1.099E-10	0.01	1-IE-FLI-CB_123_SP,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,/1-RPS-CCP-TM-CHA,1-RPS-CCX-CF-6OF8,1-RPS-XHE-XE-NSGNL
491	1.088E-10	0.01	1-IE-FLI-CB_A60,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FS-ALL
492	1.084E-10	0.01	1-IE-FLI-AB_C118_LF,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPT
493	1.075E-10	0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP1

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
494	1.075E-10	0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP1
495	1.070E-10	0.01	1-IE-FLI-TB_500_HI2,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
496	1.070E-10	0.01	1-IE-FLI-TB_500_HI1,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-CLOPT
497	1.070E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AA02____,1-CVC-MDP-FS-CCPB____
498	1.070E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AA02____,1-CVC-MDP-FS-CCPB____
499	1.060E-10	0.01	1-IE-FLI-CB_A48,1-AFW-MDP-FR-P4002___,1-FLI-CB-A58A48-FP,1-OAB_TR-------H
500	1.055E-10	0.01	1-IE-FLI-DGB_101_LF,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPT
501	1.055E-10	0.01	1-IE-FLI-DGB_103_LF,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
502	1.051E-10	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-LPI-MDP-FS-RHRB____,1-OEP-VCF-LP-CLOPL
503	1.051E-10	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-LPI-MDP-FS-RHRB____,1-OEP-VCF-LP-CLOPL
504	1.049E-10	0.01	1-IE-FLI-AB_108_SP1,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-CF-1668A69A
505	1.049E-10	0.01	1-IE-FLI-AB_108_SP2,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-CF-1668A69A
506	1.042E-10	0.01	1-IE-FLI-CB_122_SP,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-CF-1668A69A
507	1.042E-10	0.01	1-IE-FLI-CB_123_SP,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-CF-1668A69A
508	1.040E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-MCCABF__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
509	1.040E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-MCCABF__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
510	1.040E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-MCCABB__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
511	1.040E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-MCCABB__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
512	1.040E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AB05____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
513	1.040E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AB05____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
514	1.040E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AB15____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
515	1.040E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AB15____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
516	1.039E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-AD1I11__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
517	1.039E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-AD1I11__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
518	1.037E-10	0.01	1-IE-FLI-TB_500_LF,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
519	1.037E-10	0.01	1-IE-FLI-TB_500_LF,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPT
520	1.035E-10	0.01	1-IE-FLI-AB_108_SP1,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-SWT-FC-TY16689B-CC
521	1.035E-10	0.01	1-IE-FLI-AB_108_SP2,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-SWT-FC-TY16689B-CC
522	1.032E-10	0.01	1-IE-FLI-AB_D74_FP,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
523	1.029E-10	0.01	1-IE-FLI-AB_108_SP1,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FR-ALL
524	1.029E-10	0.01	1-IE-FLI-AB_108_SP2,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FR-ALL
525	1.028E-10	0.01	1-IE-FLI-AB_C113_LF1,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP1,1-SWS-MOV-MA-1669ACT_
526	1.027E-10	0.01	1-IE-FLI-AB_B08_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
527	1.027E-10	0.01	1-IE-FLI-CB_122_SP,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-SWT-FC-TY16689B-CC
528	1.027E-10	0.01	1-IE-FLI-CB_123_SP,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-SWT-FC-TY16689B-CC
529	1.025E-10	0.01	1-IE-FLI-AB_C113_LF1,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-RLOOP
530	1.022E-10	0.01	1-IE-FLI-CB_122_SP,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FR-ALL
531	1.022E-10	0.01	1-IE-FLI-CB_123_SP,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-CF-FR-ALL
532	1.008E-10	0.01	1-IE-FLI-AB_C120_LF,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-RLOOP
533	1.007E-10	0.01	1-IE-FLI-AB_C118_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_A_1234_
534	1.004E-10	0.01	1-IE-FLI-AB_C120_LF,1-RCS-MDP-LK-BP2,1-SWS-MDP-MA-P4_00246-3
535	1.001E-10	0.01	1-IE-FLI-CB_123_SP,1-ACP-SSD-MA-1821U301,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
536	1.001E-10	0.01	1-IE-FLI-CB_122_SP,1-ACP-SSD-MA-1821U301,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
537	1.001E-10	0.01	1-IE-FLI-AB_B24_LF2,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
538	9.936E-11	0.01	1-IE-FLI-TB_500_LF,1-AFW-TDP-FR-P4001___,1-RPS-ROD-CF-RCCAS
539	9.909E-11	0.01	1-IE-FLI-AB_108_SP1,1-ACP-CRB-CC-BA0301__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
540	9.909E-11	0.01	1-IE-FLI-AB_108_SP2,1-ACP-CRB-CC-BA0301__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
541	9.803E-11	0.01	1-IE-FLI-DGB_103_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_
542	9.803E-11	0.01	1-IE-FLI-DGB_101_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_A_1234_
543	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-LV0112C_,1-OEP-VCF-LP-CLOPL
544	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-LV0112E_,1-OEP-VCF-LP-CLOPL
545	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-HV8804B_,1-OEP-VCF-LP-CLOPL
546	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-HV8813__,1-OEP-VCF-LP-CLOPL
547	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-HV8807B_,1-OEP-VCF-LP-CLOPL
548	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-HV8508B_,1-OEP-VCF-LP-CLOPL
549	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-HV8801B_,1-OEP-VCF-LP-CLOPL
550	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-HV8105__,1-OEP-VCF-LP-CLOPL
551	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-LV0112C_,1-OEP-VCF-LP-CLOPL
552	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-LV0112E_,1-OEP-VCF-LP-CLOPL
553	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-HV8804B_,1-OEP-VCF-LP-CLOPL
554	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-HV8813__,1-OEP-VCF-LP-CLOPL
555	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-HV8807B_,1-OEP-VCF-LP-CLOPL
556	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-HV8508B_,1-OEP-VCF-LP-CLOPL
557	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-CC-HV8801B_,1-OEP-VCF-LP-CLOPL
558	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-MOV-OO-HV8105__,1-OEP-VCF-LP-CLOPL
559	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-LPI-MOV-OO-HV8812B_,1-OEP-VCF-LP-CLOPL

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
560	9.705E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-LPI-MOV-CC-HV8811B_,1-OEP-VCF-LP-CLOPL
561	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-LPI-MOV-OO-HV8812B_,1-OEP-VCF-LP-CLOPL
562	9.705E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-LPI-MOV-CC-HV8811B_,1-OEP-VCF-LP-CLOPL
563	9.698E-11	0.01	1-IE-FLI-CB_A48,1-AFW-MDP-MA-P4002___,1-FLI-CB-A58A48-FP,1-RCS-PRV-CC-RV0456A_
564	9.630E-11	0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FS-P4001___,1-OA-MISPAF5094H,1-OAB_TR-------H
565	9.630E-11	0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FS-P4001___,1-OA-MISPAF5094H,1-OAB_TR-------H
566	9.630E-11	0.01	1-IE-FLI-AB_108_SP1,1-AFW-MDP-FS-P4002___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
567	9.630E-11	0.01	1-IE-FLI-AB_108_SP2,1-AFW-MDP-FS-P4002___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
568	9.587E-11	0.01	1-IE-FLI-TB_500_LF-CDS,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
569	9.562E-11	0.01	1-IE-FLI-CB_122_SP,1-AFW-TDP-FS-P4001___,1-OA-MISPAF5095H,1-OAB_TR-------H
570	9.562E-11	0.01	1-IE-FLI-CB_123_SP,1-AFW-TDP-FS-P4001___,1-OA-MISPAF5095H,1-OAB_TR-------H
571	9.562E-11	0.01	1-IE-FLI-CB_122_SP,1-AFW-MDP-FS-P4003___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
572	9.562E-11	0.01	1-IE-FLI-CB_123_SP,1-AFW-MDP-FS-P4003___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
573	9.524E-11	0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FS-P4001___,1-EPS-DGN-FR-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
574	9.524E-11	0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FS-P4001___,1-EPS-DGN-FR-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
575	9.499E-11	0.01	1-IE-FLI-AB_B50_JI,1-ACP-CRB-CC-AA0205__,1-OEP-VCF-LP-CLOPT
576	9.402E-11	0.01	1-IE-FLI-CB_A60,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
577	9.402E-11	0.01	1-IE-FLI-CB_A60,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
578	9.402E-11	0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AYB1____,1-NSCWCT-SPRAY,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
579	9.402E-11	0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AYB1____,1-NSCWCT-SPRAY,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
580	9.394E-11	0.01	1-IE-FLI-TB_500_LF,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,/1-RPS-CCP-TM-CHA,1-RPS-CCX-CF-6OF8,1-RPS-XHE-XE-NSGNL,1-UET2-NOPORV-BLK
581	9.315E-11	0.01	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
582	9.315E-11	0.01	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
583	9.248E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
584	9.248E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
585	9.241E-11	0.01	1-IE-FLI-AB_B08_LF,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
586	9.201E-11	0.01	1-IE-FLI-CB_A48,1-AFW-MDP-MA-P4002___,1-EPS-SEQ-FO-1821U302,1-FLI-CB-A58A48-FP,1-OA-NSCWFAN---H
587	9.188E-11	0.01	1-IE-FLI-CB_A60,1-CVC-MDP-FS-CCPB____,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
588	9.180E-11	0.01	1-IE-FLI-AB_C120_LF,1-RCS-MDP-LK-BP1,1-SWS-CTF-MA-_B_1234_
589	9.084E-11	0.01	1-IE-FLI-AB_C120_LF,1-AFW-MDP-MA-P4002___,1-OEP-VCF-LP-RLOOP
590	9.012E-11	0.01	1-IE-FLI-AB_108_SP1,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CF-1668A69A
591	9.012E-11	0.01	1-IE-FLI-AB_108_SP2,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CF-1668A69A

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
592	8.948E-11	0.01	1-IE-FLI-CB_122_SP,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CF-1668A69A
593	8.948E-11	0.01	1-IE-FLI-CB_123_SP,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CF-1668A69A
594	8.903E-11	0.01	1-IE-FLI-AB_C120_LF,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-RLOOP
595	8.861E-11	0.01	1-IE-FLI-AB_C113_LF1,1-DCP-FUS-OP-BD104___,1-OEP-VCF-LP-CLOPT
596	8.837E-11	0.01	1-IE-FLI-AB_108_SP2,1-EPS-DGN-FR-G4002___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1668A___
597	8.837E-11	0.01	1-IE-FLI-AB_108_SP1,1-EPS-DGN-FR-G4002___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1668A___
598	8.837E-11	0.01	1-IE-FLI-AB_108_SP2,1-EPS-DGN-FR-G4001___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1669A___
599	8.837E-11	0.01	1-IE-FLI-AB_108_SP1,1-EPS-DGN-FR-G4001___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1669A___
600	8.819E-11	0.01	1-IE-FLI-DGB_103_LF,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
601	8.803E-11	0.01	1-IE-FLI-AB_108_SP1,1-OEP-VCF-LP-CLOPL,1-SWS-CTF-CF-FS-ALL
602	8.803E-11	0.01	1-IE-FLI-AB_108_SP2,1-OEP-VCF-LP-CLOPL,1-SWS-CTF-CF-FS-ALL
603	8.774E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4002___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1668A___
604	8.774E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4002___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1668A___
605	8.774E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1669A___
606	8.774E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-CC-1669A___
607	8.740E-11	0.01	1-IE-FLI-CB_122_SP,1-OEP-VCF-LP-CLOPL,1-SWS-CTF-CF-FS-ALL
608	8.740E-11	0.01	1-IE-FLI-CB_123_SP,1-OEP-VCF-LP-CLOPL,1-SWS-CTF-CF-FS-ALL
609	8.689E-11	0.01	1-IE-FLI-AB_C113_LF1,1-NSCW-CT-NEED-SWAP,1-NSCW-MOV-F-NON-RECBLE,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-CC-1669A___
610	8.678E-11	0.01	1-IE-FLI-AB_B50_JI,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1668ACT_
611	8.445E-11	0.01	1-IE-FLI-TB_500_HI1,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
612	8.445E-11	0.01	1-IE-FLI-TB_500_HI2,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
613	8.412E-11	0.01	1-IE-FLI-TB_500_LF-CDS,1-RPS-ROD-CF-RCCAS,1-UET2-NOPORV-BLK
614	8.368E-11	0.01	1-IE-FLI-AB_C118_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MDP-MA-P4_00135-3
615	8.356E-11	0.01	1-IE-FLI-CB_A60,1-RPS-BME-CF-RTBAB
616	8.332E-11	0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-MA-CCPB____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
617	8.332E-11	0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-MA-CCPB____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
618	8.332E-11	0.01	1-IE-FLI-CB_123_SP,1-EPS-SEQ-FO-1821U301,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
619	8.332E-11	0.01	1-IE-FLI-CB_122_SP,1-EPS-SEQ-FO-1821U301,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
620	8.289E-11	0.01	1-IE-FLI-CB_A48,1-AFW-MDP-MA-P4002___,1-CVC-MDP-MA-CCPB____,1-FLI-CB-A58A48-FP
621	8.258E-11	0.01	1-IE-FLI-AB_C120_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP1,1-SWS-MOV-MA-1669ACT_
622	8.236E-11	0.01	1-IE-FLI-AB_C120_LF,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-RLOOP
623	8.186E-11	0.01	1-IE-FLI-AB_D74_FP,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP2

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
624	8.186E-11	0.01	1-IE-FLI-AB_D74_FP,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP2
625	8.145E-11	0.01	1-IE-FLI-DGB_101_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MDP-MA-P4_00135-3
626	7.987E-11	0.01	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-CVC-MDP-FS-CCPB____,1-OEP-VCF-LP-CLOPL
627	7.987E-11	0.01	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-CVC-MDP-FS-CCPB____,1-OEP-VCF-LP-CLOPL
628	7.962E-11	0.01	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL,1-RCS-PRV-CC-RV0456A_
629	7.962E-11	0.01	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL,1-RCS-PRV-CC-RV0456A_
630	7.956E-11	0.01	1-IE-FLI-CB_A60,1-ACP-INV-MA-AD1I11__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
631	7.940E-11	0.01	1-IE-FLI-AB_C115_LF,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP1
632	7.940E-11	0.01	1-IE-FLI-AB_C115_LF,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP1
633	7.917E-11	0.01	1-IE-FLI-CB_A60,1-DCP-BCH-FC-AAABBABB-CC
634	7.805E-11	0.01	1-IE-FLI-TB_500_LF,1-EPS-SEQ-CF-FOAB,1-OEP-VCF-LP-RLOOP
635	7.615E-11	0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1A_PS1__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
636	7.615E-11	0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1A_PS1__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
637	7.615E-11	0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1A_PS4__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
638	7.615E-11	0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1A_PS4__,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
639	7.608E-11	0.01	1-IE-FLI-AB_108_SP2,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
640	7.608E-11	0.01	1-IE-FLI-AB_108_SP1,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
641	7.608E-11	0.01	1-IE-FLI-AB_108_SP2,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
642	7.608E-11	0.01	1-IE-FLI-AB_108_SP1,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
643	7.554E-11	0.01	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
644	7.554E-11	0.01	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-AD1B____,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPL
645	7.554E-11	0.01	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
646	7.554E-11	0.01	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-BD1B____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
647	7.515E-11	0.01	1-IE-FLI-CB_A48,1-AFW-MDP-MA-P4002___,1-DCP-BAT-MA-BD1B____,1-FLI-CB-A58A48-FP,1-OA-NSCWFAN---H
648	7.515E-11	0.01	1-IE-FLI-CB_A48,1-FLI-CB-A58A48-FP,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_B_1234_
649	7.451E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-RLOOP
650	7.421E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-RCS-MDP-LK-BP2,1-SWS-MDP-MA-P4_00246-3
651	7.356E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FS-G4001___,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
652	7.356E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FS-G4001___,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
653	7.356E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-MA-CCPB____,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPL
654	7.356E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-MA-CCPB____,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPL
655	7.326E-11	< 0.01	1-IE-FLI-AB_B08_LF,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP2
656	7.326E-11	< 0.01	1-IE-FLI-AB_B08_LF,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP2

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
657	7.183E-11	< 0.01	1-IE-FLI-AB_C118_LF,1-ACP-BAC-FC-AA02____,1-RCS-MDP-LK-BP2
658	7.183E-11	< 0.01	1-IE-FLI-AB_C118_LF,1-ACP-BAC-FC-AB15____,1-RCS-MDP-LK-BP2
659	7.120E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-DCP-FUS-OP-BD104___,1-OEP-VCF-LP-CLOPT
660	6.996E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-AFW-MDP-CF-START,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
661	6.993E-11	< 0.01	1-IE-FLI-AB_D74_FP,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_B_1234_
662	6.992E-11	< 0.01	1-IE-FLI-DGB_101_LF,1-ACP-BAC-FC-AB15____,1-RCS-MDP-LK-BP2
663	6.992E-11	< 0.01	1-IE-FLI-DGB_103_LF,1-ACP-BAC-FC-BA03____,1-RCS-MDP-LK-BP2
664	6.992E-11	< 0.01	1-IE-FLI-DGB_103_LF,1-ACP-BAC-FC-BB16____,1-RCS-MDP-LK-BP2
665	6.982E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-NSCW-CT-NEED-SWAP,1-NSCW-MOV-F-NON-RECBLE,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-CC-1669A___
666	6.886E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-AFW-MDP-FS-P4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPT
667	6.886E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-OA-MISPAF5094H,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPT
668	6.860E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-TE-CCPB____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
669	6.860E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-TE-CCPB____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
670	6.825E-11	< 0.01	1-IE-FLI-CB_A48,1-AFW-MDP-MA-P4002___,1-CVC-MDP-TE-CCPB____,1-FLI-CB-A58A48-FP
671	6.805E-11	< 0.01	1-IE-FLI-CB_123_SP,1-DCP-BAT-MA-AD1B____,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
672	6.805E-11	< 0.01	1-IE-FLI-CB_122_SP,1-DCP-BAT-MA-AD1B____,1-LPI-MDP-MA-RHRB____,1-OEP-VCF-LP-CLOPL
673	6.805E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-MA-CCPB____,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
674	6.805E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-MA-CCPB____,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
675	6.783E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-RCS-MDP-LK-BP1,1-SWS-CTF-MA-_B_1234_
676	6.772E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-NSCW-CT-NEED-SWAP,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-SWT-FC-TY16689B-CC
677	6.761E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
678	6.761E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
679	6.761E-11	< 0.01	1-IE-FLI-CB_A48,1-FLI-CB-A58A48-FP,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1669ACT_
680	6.713E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
681	6.713E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-AD11BD12-CC,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
682	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
683	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
684	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
685	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
686	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
687	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
688	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
689	6.580E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
690	6.578E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-RLOOP
691	6.573E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
692	6.573E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
693	6.573E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
694	6.573E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
695	6.567E-11	< 0.01	1-IE-FLI-TB_500_LF,1-AFW-MDP-MA-P4002___,1-EPS-DGN-FR-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPT
696	6.549E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-HPI-CKV-OO-189_____,1-OEP-VCF-LP-CLOPL
697	6.549E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-HPI-CKV-OO-189_____,1-OEP-VCF-LP-CLOPL
698	6.549E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CCP-DIVT-THRNCP,1-EPS-DGN-FR-G4001___,1-HPI-CKV-OO-129_____,1-OEP-VCF-LP-CLOPL
699	6.549E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CCP-DIVT-THRNCP,1-EPS-DGN-FR-G4001___,1-HPI-CKV-OO-129_____,1-OEP-VCF-LP-CLOPL
700	6.533E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
701	6.533E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
702	6.533E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
703	6.533E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
704	6.533E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
705	6.533E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
706	6.527E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
707	6.527E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
708	6.527E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
709	6.527E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
710	6.461E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-FR-G4001___,1-OAB_SI-------H,1-OEP-VCF-LP-CLOPL,1-PI-SGTR-SCREEN
711	6.461E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-FR-G4001___,1-OAB_SI-------H,1-OEP-VCF-LP-CLOPL,1-PI-SGTR-SCREEN
712	6.394E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-MOV-CF-1668A69A
713	6.394E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-MOV-CF-1668A69A
714	6.348E-11	< 0.01	1-IE-FLI-CB_122_SP,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-MOV-CF-1668A69A
715	6.348E-11	< 0.01	1-IE-FLI-CB_123_SP,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-MOV-CF-1668A69A
716	6.335E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
717	6.335E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
718	6.305E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-OAR_LTFB-TRA-H,1-OEP-VCF-LP-CLOPL
719	6.305E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-OAR_LTFB-TRA-H,1-OEP-VCF-LP-CLOPL
720	6.305E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
721	6.305E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
722	6.304E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-SWT-FC-TY16689B-CC
723	6.304E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-SWT-FC-TY16689B-CC
724	6.291E-11	< 0.01	1-IE-FLI-AB_D74_FP,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1669ACT_
725	6.290E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
726	6.290E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
727	6.280E-11	< 0.01	1-IE-FLI-CB_A60,1-RPS-ROD-CF-RCCAS
728	6.272E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FR-ALL

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
729	6.272E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FR-ALL
730	6.260E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
731	6.260E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
732	6.259E-11	< 0.01	1-IE-FLI-AB_B08_LF,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_B_1234_
733	6.259E-11	< 0.01	1-IE-FLI-CB_122_SP,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-SWT-FC-TY16689B-CC
734	6.259E-11	< 0.01	1-IE-FLI-CB_123_SP,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-SWT-FC-TY16689B-CC
735	6.230E-11	< 0.01	1-IE-FLI-AB_B24_LF2,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
736	6.227E-11	< 0.01	1-IE-FLI-CB_122_SP,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FR-ALL
737	6.227E-11	< 0.01	1-IE-FLI-CB_123_SP,1-RCS-MDP-LK-BP2,1-SWS-CTF-CF-FR-ALL
738	6.203E-11	< 0.01	1-IE-FLI-AB_D78_FP,1-EPS-DGN-FR-G4002___,1-OEP-VCF-LP-CLOPT
739	6.168E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FR-P4001___,1-EPS-SEQ-FO-1821U302,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
740	6.168E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FR-P4001___,1-EPS-SEQ-FO-1821U302,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
741	6.136E-11	< 0.01	1-IE-FLI-AB_C118_LF,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_A_1234_
742	6.102E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP1,1-SWS-MOV-MA-1669ACT_
743	6.100E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-MA-P4001___,1-OA-MISPAF5094H,1-OAB_TR-------H
744	6.100E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-MA-P4001___,1-OA-MISPAF5094H,1-OAB_TR-------H
745	6.100E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-MDP-FS-P4002___,1-AFW-TDP-MA-P4001___,1-OAB_TR-------H
746	6.100E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-MDP-FS-P4002___,1-AFW-TDP-MA-P4001___,1-OAB_TR-------H
747	6.086E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-RLOOP
748	6.056E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPL
749	6.056E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPL
750	6.056E-11	< 0.01	1-IE-FLI-CB_122_SP,1-AFW-TDP-MA-P4001___,1-OA-MISPAF5095H,1-OAB_TR-------H
751	6.056E-11	< 0.01	1-IE-FLI-CB_123_SP,1-AFW-TDP-MA-P4001___,1-OA-MISPAF5095H,1-OAB_TR-------H
752	6.056E-11	< 0.01	1-IE-FLI-CB_122_SP,1-AFW-MDP-FS-P4003___,1-AFW-TDP-MA-P4001___,1-OAB_TR-------H
753	6.056E-11	< 0.01	1-IE-FLI-CB_123_SP,1-AFW-MDP-FS-P4003___,1-AFW-TDP-MA-P4001___,1-OAB_TR-------H
754	6.033E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-MA-P4001___,1-EPS-DGN-FR-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
755	6.033E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-MA-P4001___,1-EPS-DGN-FR-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
756	5.983E-11	< 0.01	1-IE-FLI-DGB_103_LF,1-ACP-BAC-MA-BA03____,1-AFW-TDP-FR-P4001___
757	5.977E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AA02____,1-LPI-MDP-FS-RHRB____
758	5.977E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AA02____,1-LPI-MDP-FS-RHRB____
759	5.973E-11	< 0.01	1-IE-FLI-DGB_101_LF,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_A_1234_

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
760	5.973E-11	< 0.01	1-IE-FLI-DGB_103_LF,1-RCS-MDP-LK-BP2,1-SWS-CTF-MA-_B_1234_
761	5.967E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-ACP-CRB-CC-AA0205__,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
762	5.967E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-ACP-CRB-CC-BA0301__,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPT
763	5.929E-11	< 0.01	1-IE-FLI-TB_500_LF,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MDP-CF-FR-ABCDEF
764	5.912E-11	< 0.01	1-IE-FLI-AB_B50_JI,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPT
765	5.911E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-MCCBBD__,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
766	5.911E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-MCCBBD__,1-EPS-DGN-FR-G4001___,1-OEP-VCF-LP-CLOPL
767	5.774E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-FR-CCPB____,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPL
768	5.774E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-FR-CCPB____,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPL
769	5.723E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-SSD-MA-1821U302,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
770	5.723E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-SSD-MA-1821U302,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
771	5.682E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-SSD-MA-1821U302,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
772	5.682E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-SSD-MA-1821U302,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
773	5.670E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BA03____,1-OEP-VCF-LP-CLOPT
774	5.670E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BB07____,1-OEP-VCF-LP-CLOPT
775	5.670E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BB16____,1-OEP-VCF-LP-CLOPT
776	5.670E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-MCCBBB__,1-OEP-VCF-LP-CLOPT
777	5.670E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-MCCBBF__,1-OEP-VCF-LP-CLOPT
778	5.653E-11	< 0.01	1-IE-FLI-CB_A60,1-EPS-TNK-MA-DFOSTKA_,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
779	5.630E-11	< 0.01	1-IE-FLI-AB_B08_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1669ACT_
780	5.603E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-TE-CCPB____,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
781	5.603E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-TE-CCPB____,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
782	5.534E-11	< 0.01	1-IE-FLI-AB_B24_LF2,1-ACP-BAC-FC-BA03____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
783	5.534E-11	< 0.01	1-IE-FLI-AB_B24_LF2,1-ACP-BAC-FC-BB16____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
784	5.500E-11	< 0.01	1-IE-FLI-AB_B24_LF2,1-EPS-DGN-FS-G4002___,1-OEP-VCF-LP-CLOPT
785	5.483E-11	< 0.01	1-IE-FLI-TB_500_HI2,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL
786	5.445E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FR-P4001___,1-EPS-DGN-FS-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
787	5.445E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FR-P4001___,1-EPS-DGN-FS-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
788	5.430E-11	< 0.01	1-IE-FLI-TB_500_LF,1-AFW-TNK-RP-V4001___,1-OAB_TR-------H

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
789	5.373E-11	< 0.01	1-IE-FLI-DGB_103_LF,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1669ACT_
790	5.369E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-BD1I12__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
791	5.369E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-AD1I11__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
792	5.369E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-BD1I12__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
793	5.369E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-AD1I11__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
794	5.355E-11	< 0.01	1-IE-FLI-CB_A60,1-AFW-MDP-MA-P4003___,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
795	5.331E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-BD1I12__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
796	5.331E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-AD1I11__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
797	5.331E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-BD1I12__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
798	5.331E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-AD1I11__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
799	5.294E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-NSCW-CT-NEED-SWAP,1-NSCW-MOV-F-NON-RECBLE,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-MOV-CC-1669A___
800	5.292E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-MA-MCCBBB__,1-NSCW-CT-NEED-SWAP,1-NSCW-MOV-F-NON-RECBLE,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
801	5.288E-11	< 0.01	1-IE-FLI-AB_B50_JI,1-NSCWCT-SPRAY,1-RCS-MDP-LK-BP2,1-SWS-MOV-MA-1668ACT_
802	5.261E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-DCP-FUS-OP-BD104___,1-OEP-VCF-LP-CLOPT
803	5.252E-11	< 0.01	1-IE-FLI-AB_B50_JI,1-ACP-BAC-FC-AA02____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
804	5.252E-11	< 0.01	1-IE-FLI-AB_B50_JI,1-ACP-BAC-FC-AB15____,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
805	5.220E-11	< 0.01	1-IE-FLI-AB_B50_JI,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPT
806	5.194E-11	< 0.01	1-IE-FLI-CB_A48,1-DCP-DPL-FC-BD11____,1-FLI-CB-A58A48-FP
807	5.194E-11	< 0.01	1-IE-FLI-CB_A48,1-DCP-BDC-FC-BD1_____,1-FLI-CB-A58A48-FP
808	5.159E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-NSCW-CT-NEED-SWAP,1-NSCW-MOV-F-NON-RECBLE,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-CC-1669A___
809	5.133E-11	< 0.01	1-IE-FLI-CB_A60,1-EPS-DGN-FR-G4001___,1-LPI-MDP-FS-RHRB____,1-OEP-VCF-LP-CLOPL
810	5.126E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-BAC-FC-BYB1____,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT
811	5.099E-11	< 0.01	1-IE-FLI-AB_C118_LF,1-RCS-MDP-LK-BP2,1-SWS-MDP-MA-P4_00135-3
812	5.089E-11	< 0.01	1-IE-FLI-AB_B24_LF2,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
813	5.038E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FR-P4001___,1-DCP-BAT-MA-BD1B____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
814	5.038E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FR-P4001___,1-DCP-BAT-MA-BD1B____,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
815	5.027E-11	< 0.01	1-IE-FLI-TB_500_LF,1-AFW-MOV-CF-MINFL,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
816	4.998E-11	< 0.01	1-IE-FLI-CB_A60,1-ACP-INV-MA-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
817	4.973E-11	< 0.01	1-IE-FLI-CB_A48,1-DCP-CRB-CO-BD105___,1-FLI-CB-A58A48-FP
818	4.973E-11	< 0.01	1-IE-FLI-CB_A48,1-ACP-CRB-CO-BA0309__,1-FLI-CB-A58A48-FP
819	4.973E-11	< 0.01	1-IE-FLI-CB_A48,1-ACP-CRB-CO-BB1601__,1-FLI-CB-A58A48-FP
820	4.971E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-FS-CCPB____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
821	4.971E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-FS-CCPB____,1-EPS-SEQ-FO-1821U301,1-OEP-VCF-LP-CLOPL
822	4.963E-11	< 0.01	1-IE-FLI-DGB_101_LF,1-RCS-MDP-LK-BP2,1-SWS-MDP-MA-P4_00135-3
823	4.956E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-AFW-PMP-CF-RUN,1-OAB_TR-------H-HD,1-OAF_MFW------H
824	4.946E-11	< 0.01	1-IE-FLI-CB_A48,1-AFW-MDP-MA-P4002___,1-CVC-MDP-FS-CCPB____,1-FLI-CB-A58A48-FP
825	4.874E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-ACP-CRB-CC-BA0301__,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPT
826	4.874E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-ACP-CRB-CC-AA0205__,1-DCP-BAT-MA-BD1B____,1-OEP-VCF-LP-CLOPT
827	4.846E-11	< 0.01	1-IE-FLI-CB_A60,1-CVC-MDP-TE-CCPB____,1-EPS-DGN-MA-G4001___,1-OEP-VCF-LP-CLOPL
828	4.844E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-OEP-VCF-LP-CLOPT,1-SWS-CTF-MA-_B_1234_
829	4.829E-11	< 0.01	1-IE-FLI-AB_B50_JI,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPT
830	4.821E-11	< 0.01	1-IE-FLI-TB_500_LF,1-OEP-VCF-LP-CLOPT,1-SWS-MDP-CF-FS-ABCDEF
831	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-MDP-MA-P4002___,1-EPS-DGN-FR-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
832	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-MDP-MA-P4002___,1-EPS-DGN-FR-G4001___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
833	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1A_PS4__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
834	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1A_PS1__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
835	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1B_PS4__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
836	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1B_PS1__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
837	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1A_PS4__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
838	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1A_PS1__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
839	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1B_PS4__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
840	4.818E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1B_PS1__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
841	4.799E-11	< 0.01	1-IE-FLI-AB_A20,1-RPS-BME-CF-RTBAB,1-UET2-NOPORV-BLK
842	4.790E-11	< 0.01	1-IE-FLI-TB_500_LF,1-AFW-TDP-FR-P4001___,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL
843	4.789E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-AFW-MDP-CF-START,1-OEP-VCF-LP-CLOPT
844	4.784E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1A_PS4__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
845	4.784E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1A_PS1__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
846	4.784E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1B_PS4__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
847	4.784E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1B_PS1__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
848	4.784E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1A_PS4__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
849	4.784E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1A_PS1__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
850	4.784E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1B_PS4__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
851	4.784E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1B_PS1__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
852	4.728E-11	< 0.01	1-IE-FLI-AB_B24_LF2,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_B_1234_
853	4.663E-11	< 0.01	1-IE-FLI-CB_A60,1-AFW-PMP-CF-RUN,1-OAB_TR-------H
854	4.658E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-OC-1669A___
855	4.556E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BA03____,1-OEP-VCF-LP-CLOPT
856	4.556E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BB07____,1-OEP-VCF-LP-CLOPT
857	4.556E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BB16____,1-OEP-VCF-LP-CLOPT
858	4.556E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-MCCBBB__,1-OEP-VCF-LP-CLOPT
859	4.556E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-MCCBBF__,1-OEP-VCF-LP-CLOPT
860	4.510E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-CAD-XHE-SAFESTBLE,1-EPS-SEQ-CF-FOAB
861	4.510E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-CAD-XHE-SAFESTBLE,1-EPS-SEQ-CF-FOAB
862	4.487E-11	< 0.01	1-IE-FLI-AB_B50_JI,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-CTF-MA-_A_1234_

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
863	4.478E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CAD-XHE-SAFESTBLE,1-EPS-SEQ-CF-FOAB
864	4.478E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CAD-XHE-SAFESTBLE,1-EPS-SEQ-CF-FOAB
865	4.478E-11	< 0.01	1-IE-FLI-CB_A48,1-EPS-SEQ-FO-1821U302,1-FLI-CB-A58A48-FP,1-RCS-PRV-DP-LODC,1-RCS-PRV-OO-RV0455A_
866	4.462E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-CRB-CC-AA0205__,1-LPI-MDP-FS-RHRB____,1-OEP-VCF-LP-CLOPL
867	4.462E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-CRB-CC-AA0205__,1-LPI-MDP-FS-RHRB____,1-OEP-VCF-LP-CLOPL
868	4.457E-11	< 0.01	1-IE-FLI-CB_A60,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPL
869	4.421E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-FC-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H
870	4.421E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-FC-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H
871	4.389E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-FS-CCPB____,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPL
872	4.389E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-FS-CCPB____,1-EPS-DGN-FS-G4001___,1-OEP-VCF-LP-CLOPL
873	4.357E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-MA-1669ACT_
874	4.294E-11	< 0.01	1-IE-FLI-AB_D74_FP,1-ACP-TFW-FC-BB16X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
875	4.274E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-TFW-FC-BB16X___,1-RCS-MDP-LK-BP1
876	4.254E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-NSCW-CT-NEED-SWAP,1-NSCW-MOV-F-NON-RECBLE,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-MOV-CC-1669A___
877	4.253E-11	< 0.01	1-IE-FLI-AB_B24_LF2,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-MA-1669ACT_
878	4.253E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-MCCBBB__,1-NSCW-CT-NEED-SWAP,1-NSCW-MOV-F-NON-RECBLE,1-NSCWCT-BYPASS,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
879	4.209E-11	< 0.01	1-IE-FLI-AB_A20_FP,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-CLOPT
880	4.126E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-NSCW-CT-NEED-SWAP,1-NSCWCT-BYPASS,1-RCS-MDP-LK-BP2,1-SWS-SWT-FC-TY16689B-CC
881	4.119E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-FC-BYB1____,1-NSCWCT-SPRAY,1-OEP-VCF-LP-CLOPT
882	4.111E-11	< 0.01	1-IE-FLI-AB_A20,1-ACP-CRB-CC-AA0205__,1-ACP-CRB-CC-BA0301__,1-OEP-VCF-LP-CLOPT
883	4.088E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-AFW-MDP-FS-P4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPT
884	4.088E-11	< 0.01	1-IE-FLI-AB_C115_LF,1-OA-MISPAF5094H,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPT
885	4.061E-11	< 0.01	1-IE-FLI-CB_123_SP,1-CVC-MDP-FS-CCPB____,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
886	4.061E-11	< 0.01	1-IE-FLI-CB_122_SP,1-CVC-MDP-FS-CCPB____,1-DCP-BAT-MA-AD1B____,1-OEP-VCF-LP-CLOPL
887	4.055E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,1-RPS-CBI-CF-6OF8,/1-RPS-CCP-TM-CHA,1-RPS-XHE-XE-NSGNL,1-UET2-NOPORV-BLK
888	4.040E-11	< 0.01	1-IE-FLI-CB_A60,1-AFW-MOV-OO-FV5155__,1-AFW-TDP-FR-P4001___,1-OAB_TR-------H
889	4.034E-11	< 0.01	1-IE-FLI-CB_A48,1-FLI-CB-A58A48-FP,1-LPI-MDP-MA-RHRB____,1-RCS-PRV-DP-LODC,1-RCS-PRV-OO-RV0455A_
890	4.032E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-NSCWCT-BYPASS,1-OEP-VCF-LP-CLOPT,1-SWS-MOV-CC-1669A___
891	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
892	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
893	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
894	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
895	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
896	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
897	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-BAC-MA-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
898	4.009E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-BAC-MA-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
899	4.005E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
900	4.005E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
901	4.005E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
902	4.005E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
903	3.983E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-FC-AA02____,1-LPI-MDP-MA-RHRB____
904	3.983E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-FC-AA02____,1-CVC-MDP-MA-CCPB____
905	3.983E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-FC-AA02____,1-LPI-MDP-MA-RHRB____
906	3.983E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-FC-AA02____,1-CVC-MDP-MA-CCPB____
907	3.982E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-AFW-PMP-CF-RUN,1-OAB_TR-------H-HD,1-OAF_MFW------H
908	3.981E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
909	3.981E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-BA03____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
910	3.981E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
911	3.981E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-BB16____,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
912	3.981E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
913	3.981E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-MA-AB15____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
914	3.977E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
915	3.977E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
916	3.977E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
917	3.977E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-FC-AD1I11__,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
918	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1B_PS4__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
919	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1B_PS1__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
920	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1A_PS4__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
921	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-DCP-FC-1A_PS1__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
922	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1B_PS4__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
923	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1B_PS1__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
924	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1A_PS4__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
925	3.936E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-DCP-FC-1A_PS1__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
926	3.908E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1B_PS4__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
927	3.908E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1B_PS1__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
928	3.908E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1A_PS4__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
929	3.908E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-DCP-FC-1A_PS1__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
930	3.908E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1B_PS4__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
931	3.908E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1B_PS1__,1-DCP-BAT-MA-AD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
932	3.908E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1A_PS4__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
933	3.908E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-DCP-FC-1A_PS1__,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
934	3.892E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-OEP-VCF-LP-CLOPT,1-SWS-CTF-MA-_B_1234_
935	3.881E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
936	3.881E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
937	3.870E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-AA02____,1-AFW-MDP-FS-P4002___
938	3.870E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-ACP-BAC-MA-AA02____,1-OA-MISPAF5094H
939	3.868E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-AFW-TDP-FR-P4001___,1-RPS-BME-CF-RTBAB
940	3.860E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
941	3.860E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
942	3.853E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
943	3.853E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP1
944	3.843E-11	< 0.01	1-IE-FLI-AB_B08_LF,1-ACP-TFW-FC-BB16X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
945	3.841E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
946	3.841E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
947	3.833E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
948	3.833E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-SSD-MA-1821U301,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
949	3.817E-11	< 0.01	1-IE-FLI-CB_123_SP,1-NSCWCT-SPRAY,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-MA-1668ACT_
950	3.817E-11	< 0.01	1-IE-FLI-CB_122_SP,1-NSCWCT-SPRAY,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL,1-SWS-MOV-MA-1668ACT_
951	3.814E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
952	3.814E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-INV-MA-BD1I12__,1-EPS-SEQ-FO-1821U301,1-OA-NSCWFAN---H,1-RCS-MDP-LK-BP2
953	3.768E-11	< 0.01	1-IE-FLI-AB_C118_LF,1-ACP-TFW-FC-AB15X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
954	3.743E-11	< 0.01	1-IE-FLI-AB_C120_LF,1-NSCWCT-SPRAY,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MOV-OC-1669A___
955	3.729E-11	< 0.01	1-IE-FLI-TB_500_LF,1-AFW-MDP-CF-START,1-AFW-TDP-FS-P4001___,1-OAB_TR-------H
956	3.728E-11	< 0.01	1-IE-FLI-AB_B50_JI,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP,1-SWS-MDP-MA-P4_00135-3
957	3.719E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-ACP-CRB-CF-A205301,1-OEP-VCF-LP-RLOOP
958	3.717E-11	< 0.01	1-IE-FLI-TB_500_HI2,/1-RPS-BME-TM-RTBA,/1-RPS-BME-TM-RTBB,/1-RPS-CCP-TM-CHA,1-RPS-CCX-CF-6OF8,1-RPS-XHE-XE-NSGNL
959	3.716E-11	< 0.01	1-IE-FLI-CB_A60,1-ACP-BAC-MA-AA02____,1-EPS-SEQ-FO-1821U302,1-OA-NSCWFAN---H
960	3.714E-11	< 0.01	1-IE-FLI-TB_500_LF-CDS,1-EPS-SEQ-FO-1821U301,1-EPS-SEQ-FO-1821U302,1-OEP-VCF-LP-CLOPT
961	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-LPI-MOV-OO-HV8812B_,1-OEP-VCF-LP-CLOPL
962	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-LPI-MOV-CC-HV8811B_,1-OEP-VCF-LP-CLOPL
963	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-LPI-MOV-OO-HV8812B_,1-OEP-VCF-LP-CLOPL
964	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-LPI-MOV-CC-HV8811B_,1-OEP-VCF-LP-CLOPL
965	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-LV0112C_,1-OEP-VCF-LP-CLOPL
966	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-LV0112E_,1-OEP-VCF-LP-CLOPL
967	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-HV8804B_,1-OEP-VCF-LP-CLOPL
968	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-HV8813__,1-OEP-VCF-LP-CLOPL
969	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-HV8807B_,1-OEP-VCF-LP-CLOPL
970	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-HV8508B_,1-OEP-VCF-LP-CLOPL
971	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-HV8801B_,1-OEP-VCF-LP-CLOPL
972	3.709E-11	< 0.01	1-IE-FLI-CB_123_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-HV8105__,1-OEP-VCF-LP-CLOPL
973	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-LV0112C_,1-OEP-VCF-LP-CLOPL
974	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-LV0112E_,1-OEP-VCF-LP-CLOPL
975	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-HV8804B_,1-OEP-VCF-LP-CLOPL
976	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-HV8813__,1-OEP-VCF-LP-CLOPL
977	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-HV8807B_,1-OEP-VCF-LP-CLOPL
978	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-HV8508B_,1-OEP-VCF-LP-CLOPL

Table B-1 Internal Flooding Significant Cut Sets

Cut Set	Prob/ Freq	Total %	Cut Set
979	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-CC-HV8801B_,1-OEP-VCF-LP-CLOPL
980	3.709E-11	< 0.01	1-IE-FLI-CB_122_SP,1-EPS-DGN-MA-G4001___,1-HPI-MOV-OO-HV8105__,1-OEP-VCF-LP-CLOPL
981	3.700E-11	< 0.01	1-IE-FLI-AB_C113_LF1,1-ACP-TFW-FC-NXRB____,1-EPS-DGN-FR-G4002___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
982	3.668E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-RCS-MDP-LK-BP1,1-SWS-CTF-CF-FS-ALL
983	3.668E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-RCS-MDP-LK-BP1,1-SWS-CTF-CF-FS-ALL
984	3.668E-11	< 0.01	1-IE-FLI-DGB_101_LF,1-ACP-TFW-FC-AB15X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
985	3.668E-11	< 0.01	1-IE-FLI-DGB_103_LF,1-ACP-TFW-FC-BB16X___,/1-OEP-VCF-LP-CLOPT,1-RCS-XHE-XM-TRIP
986	3.657E-11	< 0.01	1-IE-FLI-CB_A48,1-DCP-BAT-MA-BD1B____,1-FLI-CB-A58A48-FP,1-RCS-PRV-DP-LODC,1-RCS-PRV-OO-RV0455A_
987	3.642E-11	< 0.01	1-IE-FLI-CB_122_SP,1-RCS-MDP-LK-BP1,1-SWS-CTF-CF-FS-ALL
988	3.642E-11	< 0.01	1-IE-FLI-CB_123_SP,1-RCS-MDP-LK-BP1,1-SWS-CTF-CF-FS-ALL
989	3.640E-11	< 0.01	1-IE-FLI-AB_108_SP1,1-AFW-TDP-FS-P4001___,1-EPS-DGN-MA-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
990	3.640E-11	< 0.01	1-IE-FLI-AB_108_SP2,1-AFW-TDP-FS-P4001___,1-EPS-DGN-MA-G4002___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
991	3.613E-11	< 0.01	1-IE-FLI-TB_500_LF,1-RCS-MDP-LK-BP2,1-SWS-MDP-CF-FR-ABCDEF
992	3.611E-11	< 0.01	1-IE-FLI-CB_123_SP,1-ACP-BAC-FC-AA02____,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H
993	3.611E-11	< 0.01	1-IE-FLI-CB_122_SP,1-ACP-BAC-FC-AA02____,1-DCP-BAT-MA-BD1B____,1-OA-NSCWFAN---H
994	3.610E-11	< 0.01	1-IE-FLI-CB_123_SP,1-DCP-FUS-OP-AD104___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
995	3.610E-11	< 0.01	1-IE-FLI-CB_122_SP,1-DCP-FUS-OP-AD104___,1-OAB_TR-------H,1-OEP-VCF-LP-CLOPL
996	3.607E-11	< 0.01	1-IE-FLI-AB_A20,1-RPS-ROD-CF-RCCAS,1-UET2-NOPORV-BLK
Total	**7.512E-7**	**100**	Displaying 996 Cut Sets. (8728 Original)

B.2 Internal Flooding PRA Basic Event Importance Measures

The following importance measures were calculated:

- Fussell-Vesely (FV) – an indication of the percentage of the overall risk metric result (CDF) contributed by the cut sets containing the basic event.
- Risk Increase Ratio (RIR) – also referred to as risk-achievement worth; an indication of how much the overall risk metric (CDF) would go up if the specific event had probability equal to 1.0, corresponding to totally unreliable equipment or action.
- Risk Reduction Ratio (RRR) – also referred to as risk reduction worth; an indication of how much the overall risk metric (CDF) would be reduced if the specific event probability equaled zero, corresponding to a totally reliable piece of equipment or action.
- Birnbaum - an indication of the sensitivity of the overall risk metric (CDF) with respect to the basic event of concern.

The importance measures for all significant basic events are included in Table B-2 (ranked by FV importance). Significant basic events are defined as those basic events that have a FV importance greater than 0.005 or a risk-achievement worth greater than 2. In addition to the importance measures listed above, Table B-2 also includes the basic event name, the number of cut sets in which that basic event appears (listed under column heading *Count*), the calculated probability or frequency associated with the basic event, and the basic event description.

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-RCS-XHE-XM-TRIP	1456	3.300E-01	2.93E-01	1.595E+00	1.415E+00	7.028E-07	Operator fails to trip RCPs
1-OEP-VCF-LP-CLOPT	2773	5.300E-03	2.81E-01	5.351E+01	1.389E+00	4.176E-05	Consequential loss of offsite power - transient
1-OA-NSCWFAN---H	1742	1.000E+00	2.15E-01	1.000E+00	1.274E+00	1.701E-07	Operator fails to start NSCW fan manually (place holder)
1-IE-FLI-AB_C113_LF1	348	2.240E-04	1.96E-01	8.775E+02	1.244E+00	6.935E-04	Internal flooding in AB C113
1-EPS-SEQ-CF-FOAB	120	2.148E-04	1.87E-01	8.726E+02	1.230E+00	6.896E-04	Sequencers fail from common cause to operate
1-RCS-MDP-LK-BP2	1088	2.000E-01	1.78E-01	1.713E+00	1.217E+00	7.051E-07	Rcp seal stage 2 integrity (binding/popping open) fails
1-IE-FLI-AB_C120_LF	347	1.800E-04	1.65E-01	9.158E+02	1.197E+00	7.237E-04	Internal flooding in AB C120 due to NSCW pipe failure
1-OEP-VCF-LP-CLOPL	2623	3.000E-02	1.53E-01	5.947E+00	1.181E+00	4.034E-06	Consequential loss of offsite power - loca
1-OAB_TR-------H	922	5.800E-02	1.39E-01	3.262E+00	1.162E+00	1.900E-06	Operator fails to feed and bleed - transient
1-EPS-DGN-FR-G4002___	346	3.297E-02	1.31E-01	4.843E+00	1.151E+00	3.143E-06	DG1B fails to run by random cause (24 hr mission)
1-IE-FLI-CB_122_SP	1389	2.780E-04	1.29E-01	4.652E+02	1.148E+00	3.673E-04	Internal flooding in CB 122
1-IE-FLI-CB_123_SP	1393	2.780E-04	1.29E-01	4.653E+02	1.148E+00	3.674E-04	Internal flooding in CB 123
1-IE-FLI-AB_C115_LF	300	1.330E-04	1.17E-01	8.772E+02	1.132E+00	6.932E-04	Internal flooding in AB C115 due to NSCW pipe failure
1-ACP-BAC-MA-BA03____	222	2.150E-04	8.82E-02	4.109E+02	1.097E+00	3.243E-04	4.16KV bus 1BA03 in maintenance
1-ACP-BAC-MA-BB16____	165	2.150E-04	8.75E-02	4.080E+02	1.096E+00	3.220E-04	480V switchgear 1BB16 in maintenance

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-IE-FLI-AB_108_SP1	1135	2.800E-04	7.50E-02	2.689E+02	1.081E+00	2.120E-04	Internal flooding in AB 108
1-IE-FLI-AB_108_SP2	1127	2.800E-04	7.50E-02	2.687E+02	1.081E+00	2.118E-04	Internal flooding in AB 108
1-EPS-DGN-FR-G4001___	420	3.297E-02	6.33E-02	2.856E+00	1.068E+00	1.518E-06	DG1A fails to run by random cause (24 hr mission)
1-EPS-DGN-MA-G4002___	192	1.260E-02	5.13E-02	5.020E+00	1.054E+00	3.221E-06	DG1B in maintenance
1-EPS-SEQ-FO-1821U302	590	3.330E-03	4.02E-02	1.303E+01	1.042E+00	9.546E-06	Sequencer B fails to operate
1-EPS-SEQ-FO-1821U301	620	3.330E-03	3.03E-02	1.005E+01	1.031E+00	7.185E-06	Sequencer A fails to operate
1-AFW-TDP-FR-P4001___	482	3.802E-02	2.63E-02	1.666E+00	1.027E+00	5.479E-07	TDAFWP fails to run
1-ACP-CRB-CC-BA0301__	178	5.350E-03	2.60E-02	5.841E+00	1.027E+00	3.850E-06	RAT B supply CRB randomly fails to open
1-ACP-CRB-CF-A205301	36	3.498E-04	2.49E-02	7.222E+01	1.026E+00	5.636E-05	CCF of switchyard AC breakers AA205 & BA301 to open
1-NSCWCT-SPRAY	634	9.040E-01	2.38E-02	1.003E+00	1.024E+00	2.081E-08	NSCW CTS in spray mode (fraction of time)
1-IE-FLI-CB_A60	493	5.190E-05	2.36E-02	4.558E+02	1.024E+00	3.598E-04	internal flooding in CB A60
1-DCP-BAT-MA-BD1B____	390	2.720E-03	2.26E-02	9.270E+00	1.023E+00	6.559E-06	Battery 1BD1B in maintenance
1-EPS-DGN-MA-G4001___	258	1.260E-02	2.25E-02	2.760E+00	1.023E+00	1.410E-06	DG1A in maintenance
1-IE-FLI-TB_500_LF	701	2.160E-03	2.06E-02	1.053E+01	1.021E+00	7.552E-06	Internal flooding in TB Fire Zone 500
1-ACP-BAC-FC-BA03____	145	4.776E-05	1.98E-02	4.156E+02	1.020E+00	3.280E-04	4.16KV bus 1BA03 fails
1-ACP-BAC-FC-BB16____	121	4.776E-05	1.97E-02	4.125E+02	1.020E+00	3.255E-04	480V switchgear 1BB16 randomly fails
1-ACP-BAC-MA-AA02____	247	2.150E-04	1.78E-02	8.365E+01	1.018E+00	6.539E-05	Bus 1AA02 in maintenance
1-FLI-CB-A58A48-FP	332	1.000E-01	1.78E-02	1.160E+00	1.018E+00	1.405E-07	Propagation factor for internal flooding from corridor A58 to 4160 VAC switchgear room A48
1-IE-FLI-CB_A48	332	9.210E-05	1.78E-02	1.938E+02	1.018E+00	1.525E-04	internal flooding in CB A48
1-DCP-BAT-MA-AD1B____	409	2.720E-03	1.63E-02	6.986E+00	1.017E+00	4.748E-06	Battery 1AD1B in maintenance
1-SWS-CTF-MA-_B_1234_	62	4.080E-05	1.63E-02	4.003E+02	1.017E+00	3.159E-04	All four NSCW train B tower fans unavailable due to maintenance
1-SWS-MOV-MA-1669ACT_	98	4.060E-05	1.48E-02	3.662E+02	1.015E+00	2.889E-04	NSCW TR B spray valve HV1669A closed for CT maintenance
1-ACP-CRB-CC-AA0205__	231	5.350E-03	1.44E-02	3.684E+00	1.015E+00	2.135E-06	RAT A supply CRB randomly fails to open
1-AFW-MDP-MA-P4002___	183	3.000E-03	1.35E-02	5.481E+00	1.014E+00	3.555E-06	MDAFWP B unavailable due to T&M
1-EPS-DGN-FS-G4002___	151	2.940E-03	1.23E-02	5.182E+00	1.012E+00	3.318E-06	DG1B fails to start by random cause
1-RCS-MDP-LK-BP1	233	1.250E-02	1.09E-02	1.861E+00	1.011E+00	6.896E-07	RCP seal stage 1 integrity (binding/popping open) fails
1-SWS-CTF-CF-FS-ALL	24	1.048E-05	8.84E-03	8.445E+02	1.009E+00	6.672E-04	4 or more (all combinations) NSCW fans fail from common cause to start
1-IE-FLI-DGB_101_LF	70	7.320E-06	7.89E-03	1.079E+03	1.008E+00	8.525E-04	Internal flooding in DG1B room 101 due to NSCW pipe failure
1-IE-FLI-AB_D74_FP	89	8.570E-06	7.50E-03	8.758E+02	1.008E+00	6.920E-04	Internal flooding in AB D74 propagates to 480 VAC switchgear room D105

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-IE-FLI-AB_C118_LF	75	7.520E-06	6.95E-03	9.255E+02	1.007E+00	7.313E-04	Internal flooding in AB C118 due to NSCW pipe failure
1-IE-FLI-AB_B08_LF	72	7.670E-06	6.67E-03	8.697E+02	1.007E+00	6.872E-04	Internal flooding in AB B08 due to NSCW pipe failure
1-IE-FLI-DGB_103_LF	79	7.320E-06	6.49E-03	8.868E+02	1.007E+00	7.007E-04	Internal flooding in DG1A room 103 due to NSCW pipe failure
1-ACP-TFW-FC-BB16X___	62	1.526E-05	6.26E-03	4.112E+02	1.006E+00	3.245E-04	Transformer 1BB16X fails
1-AFW-MDP-MA-P4003___	61	3.000E-03	6.20E-03	3.062E+00	1.006E+00	1.636E-06	MDAFWP A unavailable due to T&M
1-EPS-DGN-FS-G4001___	204	2.940E-03	5.99E-03	3.030E+00	1.006E+00	1.610E-06	DG1A fails to start by random cause
1-IE-FLI-TB_500_LF-CDS	303	6.320E-04	5.75E-03	1.009E+01	1.006E+00	7.192E-06	Internal flooding in TB impacting condensate system
1-NSCWCT-BYPASS	453	9.620E-02	5.40E-03	1.051E+00	1.005E+00	4.442E-08	NSCW CTS in bypass mode (fraction of time)
1-AFW-PMP-CF-RUN	37	1.549E-05	5.31E-03	3.436E+02	1.005E+00	2.710E-04	CCF of AFW pumps to run (excluding driver)
1-ACP-INV-MA-AD1I11__	287	8.810E-04	5.15E-03	6.839E+00	1.005E+00	4.623E-06	Inverter 1AD1I11 in maintenance
1-OEP-VCF-LP-RLOOP	206	1.682E-04	4.91E-03	3.02E+01	1.005E+00	2.310E-05	Random loss of offsite power during post-trip mission time (24 hours)
1-AFW-MDP-FS-P4002___	129	1.000E-03	4.79E-03	5.78E+00	1.005E+00	3.785E-06	MDAFWP B (P4-002) randomly fails to start
1-OA-MISPAF5094H	129	1.000E-03	4.79E-03	5.78E+00	1.005E+00	3.785E-06	Post-test mispositioning of MDAFWP B suction manual valve HV5094
1-CVC-MDP-MA-CCPB____	109	3.000E-03	4.46E-03	2.48E+00	1.004E+00	1.175E-06	CCP-B unavailable due to maintenance
1-LPI-MDP-MA-RHRB____	110	3.000E-03	4.45E-03	2.48E+00	1.004E+00	1.174E-06	RHR pump B in maintenance
1-CVC-MDP-TE-CCPB____	98	2.470E-03	4.38E-03	2.77E+00	1.004E+00	1.401E-06	CCP-B unavailable due to test
1-ACP-BAC-FC-AA02____	168	4.776E-05	4.27E-03	9.04E+01	1.004E+00	7.075E-05	4.16KV bus 1AA02 fails
1-ACP-BAC-MA-AB15____	134	2.150E-04	4.05E-03	1.99E+01	1.004E+00	1.492E-05	480V switchgear 1AB15 in maintenance
1-RPS-BME-CF-RTBAB	67	1.610E-06	3.70E-03	2.30E+03	1.004E+00	1.815E-03	CCF RTB-A and RTB-B (mechanical)
1-IE-FLI-AB_B24_LF2	74	3.530E-06	3.16E-03	8.96E+02	1.003E+00	7.077E-04	Internal flooding in AB B24 due to NSCW pipe failure
1-CVC-MDP-FS-CCPB____	86	1.790E-03	3.16E-03	2.76E+00	1.003E+00	1.395E-06	CCP-B fails to start due to random faults
1-SWS-MOV-CC-1669A___	139	3.530E-04	3.10E-03	9.78E+00	1.003E+00	6.947E-06	NSCW CT B spray valve fails to open on demand
1-IE-FLI-AB_B50_JI	56	3.350E-06	3.08E-03	9.21E+02	1.003E+00	7.273E-04	Internal flooding in AB B50 jet impingement on cable tray
1-RPS-ROD-CF-RCCAS	55	1.210E-06	2.72E-03	2.24E+03	1.003E+00	1.774E-03	CCF 10 or more RCCAS fail to drop
1-ACP-INV-FC-BD1I12__	144	2.148E-04	2.43E-03	1.23E+01	1.002E+00	8.950E-06	Inverter 1BD1I12 randomly fails
1-DCP-BCH-FC-AAABBABB-CC	35	1.525E-06	2.41E-03	1.58E+03	1.002E+00	1.249E-03	CCF of BCHs 1AD1CA, 1AD1CB, 1BD1CA, & 1BD1CB
1-IE-FLI-AB_A20	153	2.710E-04	2.33E-03	9.59E+00	1.002E+00	6.796E-06	Internal flooding in AB A06
1-AFW-MDP-FS-P4003___	43	1.000E-03	2.25E-03	3.24E+00	1.002E+00	1.777E-06	MDAFWP A randomly fails to start
1-OA-MISPAF5095H	43	1.000E-03	2.25E-03	3.24E+00	1.002E+00	1.777E-06	Post-test mispositioning of MDAFWP A suction manual HV5095

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-ACP-CRB-CO-BA0309__	38	5.400E-06	2.20E-03	4.08E+02	1.002E+00	3.217E-04	Feeder CRB 1BA03 spuriously opens - 1BA03 to 1BB16X
1-ACP-CRB-CO-BB1601__	38	5.400E-06	2.20E-03	4.08E+02	1.002E+00	3.217E-04	Supply CRB 1BB16 spuriously opens - 1BB16X to 1BB16
1-SWS-MOV-CF-1668A69A	57	1.187E-05	1.85E-03	1.57E+02	1.002E+00	1.232E-04	NSCW CT spray valves HV1668A, 1669A fail from common cause to open
1-SWS-SWT-FC-TY16689B-CC	45	1.170E-05	1.82E-03	1.57E+02	1.002E+00	1.231E-04	NSCW return wtr temp switches TY1668B &1669B fail - CCF
1-LPI-MDP-FS-RHRB____	67	1.000E-03	1.79E-03	2.79E+00	1.002E+00	1.413E-06	RHR pump B fails to start due to random fault
1-ACP-DCP-FC-1B_PS1__	137	1.574E-04	1.77E-03	1.23E+01	1.002E+00	8.914E-06	Failure of 48V sequencer power supply PS-1
1-ACP-DCP-FC-1B_PS4__	137	1.574E-04	1.77E-03	1.23E+01	1.002E+00	8.914E-06	Failure of 28V sequencer power supply PS-4
1-SWS-MOV-CC-1668A___	111	3.530E-04	1.76E-03	5.99E+00	1.002E+00	3.951E-06	NSCW CT A spray valve HV1668A fails to open on demand
1-ACP-INV-FC-AD1I11__	128	2.148E-04	1.75E-03	9.15E+00	1.002E+00	6.447E-06	Inverter 1AD1I11 randomly fails
1-SWS-MOV-MA-1668ACT_	122	8.730E-05	1.72E-03	2.07E+01	1.002E+00	1.556E-05	NSCW train A return isolation valve HV1668A closed for CT maintenance
1-ACP-INV-MA-BD1I12__	108	2.060E-04	1.70E-03	9.23E+00	1.002E+00	6.515E-06	inverter 1BD1I12 in maintenance
1-EPS-TNK-MA-DFOSTKB_	31	4.000E-04	1.65E-03	5.12E+00	1.002E+00	3.257E-06	Train A diesel fuel oil storage tank in maintenance
1-ACP-BAC-MA-MCCBBB__	126	2.150E-04	1.64E-03	8.65E+00	1.002E+00	6.049E-06	480V MCC 1BBB in maintenance
1-ACP-SSD-MA-1821U302	110	1.870E-04	1.64E-03	9.78E+00	1.002E+00	6.950E-06	Sequencer B unavailable due to maintenance
1-AFW-MOV-OO-FV5154__	60	3.530E-04	1.64E-03	5.63E+00	1.002E+00	3.664E-06	MDAFWP B mini flow MOV randomly fails to close
1-ACP-BAC-MA-BB07____	54	2.150E-04	1.55E-03	8.21E+00	1.002E+00	5.705E-06	480V switchgear 1BB07 in maintenance
1-ACP-BAC-MA-MCCBBF__	53	2.150E-04	1.55E-03	8.19E+00	1.002E+00	5.687E-06	480V MCC 1BBF in maintenance
1-RPS-CBI-CF-6OF8	41	2.700E-06	1.38E-03	5.11E+02	1.001E+00	4.034E-04	CCF 6 bistables in 3 of 4 channels
1-OAR_LTFB-TRA-H	102	6.000E-04	1.33E-03	3.22E+00	1.001E+00	1.754E-06	Operator fails to establish HPR for long-term F&B - transients
1-ACP-DCP-FC-1A_PS1__	122	1.574E-04	1.28E-03	9.11E+00	1.001E+00	6.418E-06	Failure of 48V sequencer power supply PS-1
1-ACP-DCP-FC-1A_PS4__	122	1.574E-04	1.28E-03	9.11E+00	1.001E+00	6.418E-06	Failure of 28V sequencer power supply PS-4
1-EPS-TNK-MA-DFOSTKA_	108	6.260E-04	1.25E-03	2.99E+00	1.001E+00	1.573E-06	Train A diesel fuel oil storage tank in maintenance
1-ACP-SSD-MA-1821U301	97	2.070E-04	1.17E-03	6.66E+00	1.001E+00	4.475E-06	Sequencer A unavailable due to maintenance
1-ACP-BAC-FC-AB15____	88	4.776E-05	1.11E-03	2.41E+01	1.001E+00	1.830E-05	480V switchgear 1AB15 randomly fails
1-SWS-MDP-MA-P4_00246-3	23	2.790E-06	1.10E-03	3.96E+02	1.001E+00	3.127E-04	All 3 NSCW train B pumps unavailable due to maintenance
1-ACP-BAC-MA-BYB1____	73	2.150E-04	1.08E-03	6.04E+00	1.001E+00	3.988E-06	120/240V panel 1BYB1 in maintenance
1-ACP-INV-FC-AD11BD12-CC	14	1.207E-06	9.63E-04	7.98E+02	1.001E+00	6.307E-04	CCF of inverters 1AD1I11/1BD1I12

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-CTF-CF-FR-ALL	19	1.120E-06	9.43E-04	8.43E+02	1.001E+00	6.657E-04	4 or more (all combinations) NSCW fans fail from common cause to run
1-CVC-MDP-FR-CCPB____	39	5.494E-04	9.33E-04	2.70E+00	1.001E+00	1.343E-06	CCP-B fails to run due to random faults
1-RPS-CCX-CF-6OF8	28	1.830E-06	9.20E-04	5.04E+02	1.001E+00	3.976E-04	CCF 6 analog process logic modules in 3 of 4 channels
1-AFW-MDP-CF-START	45	5.020E-05	9.03E-04	1.90E+01	1.001E+00	1.422E-05	CCF of AFW MDPs to start
1-AFW-MDP-FR-P4002___	38	1.984E-04	9.00E-04	5.54E+00	1.001E+00	3.588E-06	MDAFWP B randomly fails to run
1-ACP-BAC-MA-AB05____	44	2.150E-04	8.94E-04	5.16E+00	1.001E+00	3.289E-06	480V switchgear 1AB05 in maintenance
1-ACP-BAC-MA-MCCABF__	42	2.150E-04	8.79E-04	5.09E+00	1.001E+00	3.233E-06	480V MCC 1ABF in maintenance
1-IE-FLI-TB_500_HI2	59	9.400E-05	8.51E-04	1.01E+01	1.001E+00	7.164E-06	Internal flooding in tb due to TPCCW maintenance
1-DCP-FUS-OP-BD104___	89	7.464E-05	8.16E-04	1.19E+01	1.001E+00	8.644E-06	Supply current fuse between CRB 1BD104 & inverter fails
1-AFW-MOV-OO-FV5155__	18	3.530E-04	7.75E-04	3.20E+00	1.001E+00	1.737E-06	MDAFWP A mini flow MOV randomly fails to close
1-ACP-BAC-MA-MCCABB__	74	2.150E-04	7.63E-04	4.55E+00	1.001E+00	2.808E-06	480V MCC 1ABB in maintenance
1-IE-FLI-TB_500_HI1	58	9.400E-05	7.27E-04	8.73E+00	1.001E+00	6.116E-06	Internal flooding in TB Fire Zone 500
1-SWS-CTF-MA-_A_1234_	41	4.080E-05	7.02E-04	1.82E+01	1.001E+00	1.362E-05	All four NSCW train A tower fans unavailable due to maintenance (PSA value)
1-SWS-MDP-MA-P4_00135-3	43	3.390E-05	6.47E-04	2.01E+01	1.001E+00	1.509E-05	All 3 NSCW train A pumps unavailable due to maintenance
1-HPI-MOV-CC-HV8801B_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	Charging pump BIT injection MOV fails to open -random fault
1-HPI-MOV-CC-HV8804B_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	HV8804B in hp rec. Suction line from RHR HX A fail to open - random fault
1-HPI-MOV-CC-HV8807B_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	MOV HV8807B in CCP and SIP suction X-connection fail to open-random fault
1-HPI-MOV-CC-LV0112E_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	CCP RWST suction isolation MOV fails to open - random fault
1-HPI-MOV-OO-HV8105__	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	Normal Charging Isolation MOV HV8105 fails to close random fault
1-HPI-MOV-OO-HV8508B_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	CCP B mini flow valve fail to close - random
1-HPI-MOV-OO-HV8813__	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	SI pumps mini flow isolation MOV fails to close - random fault
1-HPI-MOV-OO-LV0112C_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	VCT isolation LV0112C fails to close - random fault
1-LPI-MOV-CC-HV8811B_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	RHRP B containment sump suction MOV HV8811B fails to open by random cause
1-LPI-MOV-OO-HV8812B_	32	3.530E-04	5.93E-04	2.68E+00	1.001E+00	1.328E-06	RHRP B RWST suction MOV HV8812B fails to close due to random fault

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-DCP-FUS-OP-AD104___	83	7.464E-05	5.87E-04	8.86E+00	1.001E+00	6.215E-06	Supply current fuse between CRB 1AD104 & inverter fails
1-ACP-BAC-MA-AYB1____	49	2.150E-04	5.30E-04	3.47E+00	1.001E+00	1.951E-06	120/240V panel 1AYB1 in maintenance
1-AFW-MDP-FR-P4003___	14	1.984E-04	4.32E-04	3.17E+00	1.000E+00	1.720E-06	MDAFWP A (P4-003) randomly fails to run
1-HPI-CKV-OO-129_____	34	2.382E-04	4.10E-04	2.72E+00	1.000E+00	1.362E-06	NCP discharge check valve 129 fails to close
1-HPI-CKV-OO-189_____	32	2.382E-04	4.04E-04	2.70E+00	1.000E+00	1.342E-06	CCP RWST suction CV 189 fails to close
1-ACP-BAC-FC-BB07____	51	4.776E-05	4.03E-04	9.44E+00	1.000E+00	6.678E-06	480V switchgear 1BB07 randomly fails
1-ACP-BAC-FC-MCCBBF__	51	4.776E-05	4.03E-04	9.44E+00	1.000E+00	6.678E-06	480V MCC 1BBF fails
1-ACP-BAC-FC-MCCBBB__	69	4.776E-05	3.91E-04	9.19E+00	1.000E+00	6.478E-06	480V MCC 1BBB randomly fails
1-HPI-XHE-XR-XVM207	56	1.000E-04	3.63E-04	4.63E+00	1.000E+00	2.869E-06	Operator fails to restore RWST XVM 207 after test and maintenance
1-ACP-BAC-MA-MCCBBD__	28	2.150E-04	3.57E-04	2.66E+00	1.000E+00	1.312E-06	480V MCC 1BBD in maintenance
1-ACP-TFW-FC-AB15X___	43	1.526E-05	3.44E-04	2.36E+01	1.000E+00	1.785E-05	Transformer 1AB15X fails
1-ACP-TFW-FC-NXRB____	43	1.526E-05	3.44E-04	2.36E+01	1.000E+00	1.783E-05	RAT 1NXRB fails
1-IE-FLI-AB_D78_FP	24	3.550E-07	3.02E-04	8.53E+02	1.000E+00	6.736E-04	Internal flooding in AB D78 propagates to 480 VAC switchgear room D105
1-SWS-MDP-CF-FS-ABCDEF	14	4.211E-06	2.95E-04	7.11E+01	1.000E+00	5.548E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FR-ABCDEF	26	8.363E-08	2.79E-04	3.33E+03	1.000E+00	2.632E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-ACP-BAC-FC-BYB1____	48	4.776E-05	2.71E-04	6.68E+00	1.000E+00	4.494E-06	120/240V panel 1BYB1 fails
1-ACP-BAC-FC-AB05____	44	4.776E-05	2.54E-04	6.32E+00	1.000E+00	4.206E-06	480V switchgear 1AB05 randomly fails
1-ACP-BAC-FC-MCCABF__	42	4.776E-05	2.50E-04	6.24E+00	1.000E+00	4.142E-06	480V MCC 1ABF fails
1-RPS-CBI-CF-4OF6	16	8.210E-06	2.44E-04	3.08E+01	1.000E+00	2.354E-05	CCF 4 bistables in 2 of 3 channels
1-SWS-MOV-OC-1669A___	15	7.008E-07	2.44E-04	3.49E+02	1.000E+00	2.754E-04	NSCW train B spray valve HV1669A spuriously closes
1-IE-FLI-AB_A20_FP	51	2.270E-05	2.44E-04	1.17E+01	1.000E+00	8.489E-06	Internal flooding in AB A20 propagates to rooms A11 and A12
1-SWS-RLY-FC-AX36869_-CC	25	1.538E-06	2.18E-04	1.43E+02	1.000E+00	1.120E-04	CCF of AX3 relays for open/close NSCW MOVS 1HV1668A/B & 1669A/B after LOSP
1-ACP-DPL-FC-BY2B____	38	1.802E-05	2.08E-04	1.25E+01	1.000E+00	9.131E-06	Panel 1BY2B fails
1-ACP-BAC-FC-MCCABB__	55	4.776E-05	2.07E-04	5.33E+00	1.000E+00	3.422E-06	480V MCC 1ABB randomly fails
1-RCS-PRV-CF-RV5A6A__	36	1.044E-04	2.02E-04	2.94E+00	1.000E+00	1.532E-06	PORVS PV0455A (5A) & PV0456A (6A) fail from common cause to open
1-RPS-CCX-CF-4OF6	13	6.330E-06	1.85E-04	3.03E+01	1.000E+00	2.314E-05	CCF 4 analog process logic modules in 2 of 3 channels
1-AFW-MOV-CF-MINFL	20	1.055E-05	1.76E-04	1.77E+01	1.000E+00	1.318E-05	CCF of AFW MDP mini flow valves 5155 & 5154

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-ACP-CNT-OO-_BK346__	39	2.480E-05	1.73E-04	7.96E+00	1.000E+00	5.502E-06	SFSS relay K346B contacts fails to close
1-ACP-TFW-FC-_1BSEQT1	34	1.526E-05	1.72E-04	1.22E+01	1.000E+00	8.893E-06	Sequencer transformer T1 fails
1-ACP-TFW-FC-_1BSEQT2	34	1.526E-05	1.72E-04	1.22E+01	1.000E+00	8.893E-06	Sequencer transformer T3 fails
1-ACP-BAC-FC-AYB1____	46	4.776E-05	1.58E-04	4.31E+00	1.000E+00	2.617E-06	120/240V panel 1AYB1 fails
1-DCP-BAT-FC-BD1B____	34	1.404E-05	1.58E-04	1.22E+01	1.000E+00	8.893E-06	Battery 1BD1B randomly fails (125V)
1-ACP-DPL-FC-AY2A____	32	1.802E-05	1.57E-04	9.72E+00	1.000E+00	6.900E-06	Panel 1AY2A fails
1-DCP-DPL-FC-BD11____	26	5.640E-06	1.43E-04	2.64E+01	1.000E+00	2.006E-05	Distribution panel 1BD11 fails
1-AFW-TNK-RP-V4001___	10	4.334E-07	1.40E-04	3.25E+02	1.000E+00	2.563E-04	CST 1 failure
1-SWS-MDP-CF-FS-ABCD	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABCF	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABDE	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABEF	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ACDF	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ADEF	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BCDE	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BCEF	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-CDEF	11	2.000E-06	1.37E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-LPI-MDP-CF-START	31	4.878E-05	1.36E-04	3.80E+00	1.000E+00	2.212E-06	RHR pumps A, B fail from common cause to start
1-DCP-CRB-CO-BD105___	24	5.400E-06	1.34E-04	2.59E+01	1.000E+00	1.969E-05	Supply CRB 1BD105 from bus 1BD1 to 1BD11 spuriously opens
1-ACP-TFW-FC-BB07X___	19	1.526E-05	1.34E-04	9.81E+00	1.000E+00	6.965E-06	Transformer 1BB07X fails
1-ACP-CNT-OO-_AK346__	26	2.480E-05	1.33E-04	6.38E+00	1.000E+00	4.253E-06	SFSS relay K346A contacts fails to close
1-DCP-BDC-FC-BD1_____	25	5.640E-06	1.32E-04	2.44E+01	1.000E+00	1.847E-05	125V bus 1BD1 fails
1-ACP-TFW-FC-_1ASEQT1	30	1.526E-05	1.31E-04	9.57E+00	1.000E+00	6.782E-06	Sequencer transformer T1 fails
1-ACP-TFW-FC-_1ASEQT2	30	1.526E-05	1.31E-04	9.57E+00	1.000E+00	6.782E-06	Sequencer transformer T3 fails
1-SWS-MDP-CF-FR-ABCD	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MDP-CF-FR-ABCF	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ABDE	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ABEF	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ACDF	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ADEF	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BCDE	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BCEF	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-CDEF	23	3.967E-08	1.29E-04	3.26E+03	1.000E+00	2.577E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FS-ABCDE	11	1.870E-06	1.28E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABCDF	11	1.870E-06	1.28E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABCEF	11	1.870E-06	1.28E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABDEF	11	1.870E-06	1.28E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ACDEF	11	1.870E-06	1.28E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BCDEF	11	1.870E-06	1.28E-04	6.94E+01	1.000E+00	5.412E-05	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-RLY-FC-AX46869_-CC	15	1.538E-06	1.24E-04	8.15E+01	1.000E+00	6.367E-05	Relays AX4 for opening NSCW 1HV1668A/B & 1669A/B after LOSP fails - CCF
1-DCP-BAT-FC-AD1B____	30	1.404E-05	1.20E-04	9.57E+00	1.000E+00	6.782E-06	Battery 1AD1B randomly fails (125V)
1-SWS-MDP-CF-FR-ABCDE	22	3.724E-08	1.20E-04	3.23E+03	1.000E+00	2.550E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ABCDF	22	3.724E-08	1.20E-04	3.23E+03	1.000E+00	2.550E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ABCEF	22	3.724E-08	1.20E-04	3.23E+03	1.000E+00	2.550E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MDP-CF-FR-ABDEF	22	3.724E-08	1.20E-04	3.23E+03	1.000E+00	2.550E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ACDEF	22	3.724E-08	1.20E-04	3.23E+03	1.000E+00	2.550E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BCDEF	22	3.724E-08	1.20E-04	3.23E+03	1.000E+00	2.550E-03	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-CVC-MDP-FS-CCPACCPB-CC	24	4.224E-05	1.17E-04	3.77E+00	1.000E+00	2.189E-06	CCF of CCP-A & CCP-B to start
1-SWS-RLY-FC-AX3_69AB	18	2.480E-05	1.15E-04	5.63E+00	1.000E+00	3.661E-06	NSCW relay AX3 for opening/closing 1HV1669A/B fails
1-ACP-CRB-CO-AA0210__	25	5.400E-06	1.06E-04	2.07E+01	1.000E+00	1.558E-05	Feeder CRB 1AA02 spuriously opens - 1AA02 to 1AB15X
1-ACP-CRB-CO-AB1501__	25	5.400E-06	1.06E-04	2.07E+01	1.000E+00	1.558E-05	Supply CRB 1AB15 spuriously opens - 1AB15X to 1AB15
1-SWS-RLY-FC-162_1X69	15	2.480E-05	1.06E-04	5.28E+00	1.000E+00	3.387E-06	relay 162-1X for opening HV1669A/B fails random
1-ACP-CRB-CO-BA0301__	22	5.400E-06	1.06E-04	2.06E+01	1.000E+00	1.546E-05	RAT B Supply CRB BA0301 to 4160V bus BA03 spuriously opens
1-DCP-BAT-CF-ALL	15	1.235E-07	1.03E-04	8.38E+02	1.000E+00	6.617E-04	CCF of 125V batteries
1-SWS-SWT-FC-TY1669B_	7	9.864E-06	1.00E-04	1.12E+01	1.000E+00	8.028E-06	NSCW train B return water temperature switch TY1669B fails - random fault
1-AFW-MDP-CF-RUN	14	6.072E-06	9.63E-05	1.69E+01	1.000E+00	1.255E-05	CCF of AFW MDPs to run
1-SWS-RLY-FC-162_1X89-CC	10	1.538E-06	9.39E-05	6.20E+01	1.000E+00	4.828E-05	Relays 162-1X for opening HV1668A /BAND 1669A /B after LOSP fails -CCF
1-ACP-TFW-FC-BBB03X__	17	1.526E-05	9.26E-05	7.06E+00	1.000E+00	4.797E-06	480V MCC Transformer 1BBB03X fails
1-ACP-TFW-FC-AB05X___	19	1.526E-05	9.16E-05	7.00E+00	1.000E+00	4.747E-06	Transformer 1AB05X fails
1-LPI-MDP-FR-RHRB____	17	5.842E-05	8.99E-05	2.54E+00	1.000E+00	1.217E-06	RHR pump B failsto run due to random fault (24hr mission)
1-HPI-MOV-OO-HV8105&6-CC	19	3.174E-05	8.25E-05	3.60E+00	1.000E+00	2.057E-06	Normal Charging Isolation MOVs HV8106 & HV8105 fails to close due to CCF
1-HPI-MOV-OO-LV0112BC-CC	19	3.174E-05	8.25E-05	3.60E+00	1.000E+00	2.057E-06	VCT isolation MOVs LV0112B & C fails to close - CCF
1-ACP-BAC-FC-MCCBBD__	16	4.776E-05	7.23E-05	2.51E+00	1.000E+00	1.198E-06	480V MCC 1BBD randomly fails
1-SWS-MDP-FR-P4_002__	12	3.816E-05	6.23E-05	2.63E+00	1.000E+00	1.291E-06	NSCW pump 2 fail to run
1-SWS-MDP-FR-P4_004__	12	3.816E-05	6.23E-05	2.63E+00	1.000E+00	1.291E-06	NSCW pump 4 fail to run
1-ACP-TFW-FC-NXRA____	13	1.526E-05	5.90E-05	4.86E+00	1.000E+00	3.056E-06	RAT 1NXRA fails
1-SWS-MOV-CF-116-ABCDEF	9	8.698E-07	5.77E-05	6.73E+01	1.000E+00	5.246E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-ACP-TFW-FC-ABB03X__	14	1.526E-05	5.61E-05	4.68E+00	1.000E+00	2.907E-06	480V MCC Transformer 1ABB03X fails

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MDP-CF-FR-BD	6	1.563E-07	5.61E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BF	6	1.563E-07	5.61E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-DF	6	1.563E-07	5.61E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-RLY-FC-AX3_68AB	15	2.480E-05	5.58E-05	3.25E+00	1.000E+00	1.778E-06	relay AX3 for opening/closing NSCW 1HV1668A/B fails - random fault
1-SWS-RLY-FC-162_1X68	13	2.480E-05	5.28E-05	3.13E+00	1.000E+00	1.685E-06	relay 162-1X for opening HV1668A/B fails random
1-DCP-BDC-FC-AD1_____	22	5.640E-06	4.93E-05	9.74E+00	1.000E+00	6.912E-06	125V bus 1AD1 fails
1-SWS-RLY-FC-162_1ALL-CC	8	7.440E-07	4.82E-05	6.58E+01	1.000E+00	5.127E-05	Relays 162-1 associated with opening of HV-11600
1-DCP-DPL-FC-AD11____	21	5.640E-06	4.73E-05	9.39E+00	1.000E+00	6.634E-06	Distribution panel 1AD11 fails
1-ACP-CRB-CO-BY2B02__	18	5.400E-06	4.72E-05	9.74E+00	1.000E+00	6.916E-06	CRB 1BY2B02 between inverter 1BD1I12 & 1BY2B spuriously opens
1-DCP-CRB-CO-BD101___	18	5.400E-06	4.72E-05	9.74E+00	1.000E+00	6.916E-06	CRB from battery 1BD1B to bus 1BD1 spuriously opens
1-DCP-CRB-CO-BD104___	18	5.400E-06	4.72E-05	9.74E+00	1.000E+00	6.916E-06	CRB 1BD104 between inverter 1BD1I12 & 1BD1 spuriously opens
1-DCP-CRB-CO-BD1104__	18	5.400E-06	4.72E-05	9.74E+00	1.000E+00	6.916E-06	CRB BD1104 spuriously opens on load shed logic circuits
1-DCP-CRB-CO-BY2B08__	18	5.400E-06	4.72E-05	9.74E+00	1.000E+00	6.916E-06	CRB spuriously opens (BY2B08 to sequencer B)
1-SWS-MDP-CF-FS-BD	9	8.309E-06	4.70E-05	6.65E+00	1.000E+00	4.471E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BF	9	8.309E-06	4.70E-05	6.65E+00	1.000E+00	4.471E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-DF	9	8.309E-06	4.70E-05	6.65E+00	1.000E+00	4.471E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-DCP-CRB-CO-AD105___	19	5.400E-06	4.28E-05	8.92E+00	1.000E+00	6.264E-06	Supply CRB 1AD105 from bus 1AD1 to 1AD11 spuriously opens
1-ACP-CRB-CO-BA0304__	11	5.400E-06	4.16E-05	8.71E+00	1.000E+00	6.096E-06	Feeder CRB 1BA03 spuriously opens - 1BA03 to 1BB07X
1-ACP-CRB-CO-BB0701__	11	5.400E-06	4.16E-05	8.71E+00	1.000E+00	6.096E-06	Supply CRB 1BB07 spuriously opens - 1BB07X to 1BB07
1-ACP-CRB-CO-BB0714__	11	5.400E-06	4.16E-05	8.71E+00	1.000E+00	6.096E-06	CRB from 480V switchgear 1BB07 to 480V MCC 1BBF spuriously opens
1-RPS-UVL-CF-UVDAB	9	1.040E-05	4.11E-05	4.96E+00	1.000E+00	3.128E-06	CCF UV drivers trains A and B (2 OF 2)

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-HPI-MOV-CC-HV8807AB-CC	9	3.174E-05	4.09E-05	2.29E+00	1.000E+00	1.020E-06	MOVs HV8807A & B IN CCP and SIP suctioncross connection fail to open-CCF
1-AFW-CKV-CC-002_____	6	1.070E-05	3.94E-05	4.69E+00	1.000E+00	2.916E-06	MDAFWP discharge CKV 002 randomly fails to open
1-AFW-CKV-CC-058_____	6	1.070E-05	3.94E-05	4.69E+00	1.000E+00	2.916E-06	MDAFWP B suction CKV 058 randomly fails to open
1-AFW-CKV-CC-010214__-CC	7	1.166E-07	3.57E-05	3.07E+02	1.000E+00	2.424E-04	CCF of AFW pumps discharge line CKVs 001, 002, & 014 to open
1-AFW-CKV-CC-331358__-CC	7	1.166E-07	3.57E-05	3.07E+02	1.000E+00	2.424E-04	CCF of AFW pumps suction CKVs 033, 013, 058 to open
1-ACP-CRB-CO-AY2A02__	17	5.400E-06	3.44E-05	7.37E+00	1.000E+00	5.038E-06	CRB 1AY2A02 between inverter 1AD1I11 & 1AY2A spuriously opens
1-DCP-CRB-CO-AD101___	17	5.400E-06	3.44E-05	7.37E+00	1.000E+00	5.038E-06	CRB from battery 1AD1B to bus 1AD1 spuriously opens
1-DCP-CRB-CO-AD104___	17	5.400E-06	3.44E-05	7.37E+00	1.000E+00	5.038E-06	CRB 1AD104 from inverter 1AD1I11 to 1AD1 spuriously opens
1-DCP-CRB-CO-AD1104__	17	5.400E-06	3.44E-05	7.37E+00	1.000E+00	5.038E-06	CRB AD1104 spuriously opens on load shed logic circuits
1-DCP-CRB-CO-AY2A08__	17	5.400E-06	3.44E-05	7.37E+00	1.000E+00	5.038E-06	CRB spuriously opens (AY2A08 to sequencer A)
1-HPI-MOV-CC-HV8801AB-CC	8	1.626E-05	3.28E-05	3.02E+00	1.000E+00	1.597E-06	Charging pump BIT injection MOVs HV8801A & B fail to open due to CCF
1-ACP-CRB-CO-BB1609__	10	5.400E-06	3.26E-05	7.03E+00	1.000E+00	4.771E-06	Feeder CRB 1BB16 spuriously opens - 1BB16 to 1BBB
1-DCP-CRB-CO-BD1101__	8	5.400E-06	2.95E-05	6.47E+00	1.000E+00	4.327E-06	CRB BD1101 spuriously opens on load shed logic circuits
1-DCP-CRB-CO-BD111024	8	5.400E-06	2.95E-05	6.47E+00	1.000E+00	4.327E-06	CRB BD1110 to fan control logic spuriously opens
1-SWS-MOV-CF-116-ABCDE	6	4.696E-07	2.87E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ABCDF	6	4.696E-07	2.87E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ABCEF	6	4.696E-07	2.87E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ABDEF	6	4.696E-07	2.87E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ACDEF	6	4.696E-07	2.87E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-BCDEF	6	4.696E-07	2.87E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MDP-CF-FS-AC	8	8.309E-06	2.72E-05	4.28E+00	1.000E+00	2.593E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MDP-CF-FS-AE	8	8.309E-06	2.72E-05	4.28E+00	1.000E+00	2.593E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-CE	8	8.309E-06	2.72E-05	4.28E+00	1.000E+00	2.593E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-AFW-CKV-CF-PDCV	7	8.753E-08	2.68E-05	3.07E+02	1.000E+00	2.424E-04	CCF of pump discharge CKVs 001, 002, & 014
1-AFW-CKV-CF-PSCV	7	8.753E-08	2.68E-05	3.07E+02	1.000E+00	2.424E-04	CCF of pump suction CKVs 033, 058, & 013
1-ACP-CRB-CO-BBB45___	8	5.400E-06	2.67E-05	5.95E+00	1.000E+00	3.912E-06	480V MCC CRB 1BBB45 spuriously opens
1-ACP-CRB-CO-BYB116__	8	5.400E-06	2.67E-05	5.95E+00	1.000E+00	3.912E-06	120/240V CRB 1BYB116 spuriously opens
1-ACP-CRB-CO-AA0221__	9	5.400E-06	2.51E-05	5.65E+00	1.000E+00	3.675E-06	Feeder CRB 1AA02 spuriously opens - 1AA02 to 1AB05X
1-ACP-CRB-CO-AB0501__	9	5.400E-06	2.51E-05	5.65E+00	1.000E+00	3.675E-06	Supply CRB 1AB05 spuriously opens - 1AB05X to 1AB05
1-ACP-CRB-CO-AB0514__	9	5.400E-06	2.51E-05	5.65E+00	1.000E+00	3.675E-06	CRB from 480V switchgear 1AB05 to 480V MCC 1ABF spuriously opens
1-HPI-MOV-CF-0112DE	8	1.187E-05	2.40E-05	3.02E+00	1.000E+00	1.597E-06	CCP RWST suction isolation MOVS LV0112 D& E fail from common cause to open
1-HPI-MOV-CF-8801AB	8	1.187E-05	2.40E-05	3.02E+00	1.000E+00	1.597E-06	CHARGING pump BIT injection MOVs HV8801A & B fail from common cause to open
1-AFW-SCV-CC-037_____	2	1.260E-05	2.37E-05	2.88E+00	1.000E+00	1.488E-06	MDAFWP B flow distribution line to SG 2 STOP CKV 037 randomly fails to open
1-AFW-SCV-CC-040_____	2	1.260E-05	2.37E-05	2.88E+00	1.000E+00	1.488E-06	MDAFWP B flow distribution line to SG 3 STOP CKV 040 randomly fails to open
1-AFW-SCV-CC-114_____	2	1.260E-05	2.37E-05	2.88E+00	1.000E+00	1.488E-06	SG 2 AFW feed line stop CKV 114 randomly fails to open
1-AFW-SCV-CC-115_____	2	1.260E-05	2.37E-05	2.88E+00	1.000E+00	1.488E-06	SG 3 AFW feed line stop CKV 115 randomly fails to open
1-SWS-MOV-CF-116-ABDE	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ABDF	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ABEF	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ACDE	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ACDF	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-ACEF	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MOV-CF-116-BCDE	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-BCDF	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-BCEF	6	3.852E-07	2.35E-05	6.20E+01	1.000E+00	4.828E-05	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-HPI-CKV-CC-013_____	8	1.070E-05	2.16E-05	3.02E+00	1.000E+00	1.597E-06	CCP BIT injection CV 013 (downstream of BIT before cold legs) fail to open - random fault
1-HPI-CKV-CC-189_____	8	1.070E-05	2.16E-05	3.02E+00	1.000E+00	1.597E-06	CCP RWST suction CV 189 fails to open
1-AFW-CKV-CC-001_____	5	1.070E-05	2.07E-05	2.94E+00	1.000E+00	1.532E-06	MDAFWP A discharge line CKV 001 randomly fails
1-AFW-CKV-CC-033_____	5	1.070E-05	2.07E-05	2.94E+00	1.000E+00	1.532E-06	MDAFWP A suction CKV 033 randomly fails to open
1-SWS-MDP-CF-FR-ABD	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ABF	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-ADF	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BCD	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BCF	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BDE	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BDF	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BEF	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-CDF	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-DEF	6	5.730E-08	2.06E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-AFW-CKV-CC-126_____	2	1.070E-05	2.01E-05	2.88E+00	1.000E+00	1.488E-06	SG 2 AFW feed line CKV 126 randomly fails to open
1-AFW-CKV-CC-128_____	2	1.070E-05	2.01E-05	2.88E+00	1.000E+00	1.488E-06	SG 3 AFW feed line CKV 128 randomly fails to open
1-AFW-CKV-CC-001014__-CC	3	4.506E-07	2.01E-05	4.56E+01	1.000E+00	3.526E-05	CCF of AFW pumps discharge line CKVs 001 & 014 to open
1-AFW-CKV-CC-033013__-CC	3	4.506E-07	2.01E-05	4.56E+01	1.000E+00	3.526E-05	CCF of AFW pumps suction CKVs 033 & 013 to open

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-AFW-CKV-CC-002014__-CC	2	4.506E-07	1.85E-05	4.21E+01	1.000E+00	3.248E-05	CCF of AFW pumps discharge CKVs 002 & 014
1-AFW-CKV-CC-058013__-CC	2	4.506E-07	1.85E-05	4.21E+01	1.000E+00	3.248E-05	CCF of AFW pumps suction CKVs 058 & 013 to open
1-ACP-CRB-CO-AB1509__	7	5.400E-06	1.67E-05	4.10E+00	1.000E+00	2.449E-06	Feeder CRB 1AB15 spuriously opens - 1AB15 to 1ABB
1-DCP-CRB-CO-AD1101__	7	5.400E-06	1.67E-05	4.10E+00	1.000E+00	2.449E-06	CRB AD1101 spuriously opens on load shed logic circuits
1-DCP-CRB-CO-AD111024	7	5.400E-06	1.67E-05	4.10E+00	1.000E+00	2.449E-06	CRB AD1110 to fan control logic spuriously opens
1-ACP-CRB-CO-AA0205__	6	5.400E-06	1.54E-05	3.85E+00	1.000E+00	2.251E-06	RAT A Supply CRB AA0205 to 4.16KV bus AA02 spuriously opens
1-ACP-CRB-CO-ABB02___	7	5.400E-06	1.51E-05	3.80E+00	1.000E+00	2.213E-06	480V MCC AC CRB 1ABB02 spuriously opens
1-ACP-CRB-CO-AYB116__	7	5.400E-06	1.51E-05	3.80E+00	1.000E+00	2.213E-06	120/240V CRB 1AYB116 spuriously opens
1-SWS-MDP-CF-FR-ABDF	6	3.967E-08	1.42E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BCDF	6	3.967E-08	1.42E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FR-BDEF	6	3.967E-08	1.42E-05	3.60E+02	1.000E+00	2.836E-04	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FR
1-SWS-MDP-CF-FS-ABD	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABF	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ADF	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BCD	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BCF	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BDE	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BDF	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BEF	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-CDF	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MDP-CF-FS-DEF	4	2.907E-06	1.19E-05	5.08E+00	1.000E+00	3.223E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-AFW-CKV-CF-SGCV	2	4.762E-08	9.75E-06	2.06E+02	1.000E+00	1.619E-04	CCF of SG CKVs 125, 126, 127, & 128
1-AFW-SCV-CC-1131415_-CC	2	4.234E-08	8.67E-06	2.06E+02	1.000E+00	1.619E-04	CCF of SG AFW feed line stop CKVs 113
1-AFW-SCV-CC-1161314_-CC	2	4.234E-08	8.67E-06	2.06E+02	1.000E+00	1.619E-04	CCF of SG AFW feed line stop CKVs 116, 113, & 114 to open
1-AFW-SCV-CC-1161315_-CC	2	4.234E-08	8.67E-06	2.06E+02	1.000E+00	1.619E-04	CCF of SG AFW feed line stop CKVs 116, 113, & 115 to open
1-AFW-SCV-CC-1161415_-CC	2	4.234E-08	8.67E-06	2.06E+02	1.000E+00	1.619E-04	CCF of SG AFW feed line stop CKVs 116, 114, & 115 to open
1-CVC-MDP-FR-CCPACCPB-CC	6	4.877E-06	8.55E-06	2.75E+00	1.000E+00	1.387E-06	CCF of CCP-A & CCP-B to run
1-AFW-TFF-FC-FT5154__	4	2.323E-06	8.00E-06	4.44E+00	1.000E+00	2.723E-06	MDAFWP B mini flow line flow transmitter FT-5154 randomly fails
1-SWS-MDP-CF-FS-ABDF	3	2.000E-06	7.20E-06	4.60E+00	1.000E+00	2.846E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BCDF	3	2.000E-06	7.20E-06	4.60E+00	1.000E+00	2.846E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BDEF	3	2.000E-06	7.20E-06	4.60E+00	1.000E+00	2.846E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-AFW-SCV-CC-16131415-CC	2	2.772E-08	5.68E-06	2.06E+02	1.000E+00	1.619E-04	CCF of SG AFW feed line stop CKVs 116, 113, 114, & 115 to open
1-RPS-TLC-CF-SSLAB	4	2.100E-06	5.61E-06	3.67E+00	1.000E+00	2.114E-06	CCF solid state logic in trains A and B (4 of 4)
1-SWS-MDP-CF-FS-ABC	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ABE	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ACD	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ACE	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ACF	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-ADE	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MDP-CF-FS-AEF	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-BCE	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-CDE	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-SWS-MDP-CF-FS-CEF	3	2.907E-06	4.94E-06	2.70E+00	1.000E+00	1.345E-06	System Generated Event based upon RASP CCF event : 1-SWS-MDP-CF-FS
1-AFW-SCV-CC-114115__-CC	2	1.116E-07	4.58E-06	4.21E+01	1.000E+00	3.248E-05	CCF of SG AFW feed line stop CKVs 114 & 115 to open
1-AFW-SCV-CC-113114__-CC	2	1.116E-07	4.57E-06	4.19E+01	1.000E+00	3.236E-05	CCF of SG AFW feed line stop CKVs 113 & 114 to open
1-AFW-SCV-CC-113115__-CC	2	1.116E-07	4.57E-06	4.19E+01	1.000E+00	3.236E-05	CCF of SG AFW feed line stop CKVs 113 & 115 to open
1-AFW-SCV-CC-116114__-CC	2	1.116E-07	4.57E-06	4.19E+01	1.000E+00	3.236E-05	CCF of SG AFW feed line stop CKVs 116 & 114 to open
1-AFW-SCV-CC-116115__-CC	2	1.116E-07	4.57E-06	4.19E+01	1.000E+00	3.236E-05	CCF of SG AFW feed line stop CKVs 116 & 115 to open
1-AFW-SCV-CC-116113__-CC	2	1.116E-07	4.55E-06	4.18E+01	1.000E+00	3.225E-05	CCF of SG AFW feed line stop CKVs 116 & 113 to open
1-AFW-SCV-CC-HICCF___-CC	1	2.570E-08	4.07E-06	1.59E+02	1.000E+00	1.253E-04	High order CCF comb. caused AFWS fail-stop CV FTO-AF flow distribution lines
1-SWS-MOV-OC-1668A___	2	7.008E-07	3.90E-06	6.57E+00	1.000E+00	4.404E-06	NSCW train A return isolation valve HV1668A spuriously closes
1-AFW-TFF-FC-FT5155__	2	2.323E-06	3.60E-06	2.55E+00	1.000E+00	1.226E-06	AFW MDP A mini flow line flow transmitter FT-5155 randomly fails
1-AFW-CKV-CC-001002__-CC	1	4.506E-07	2.71E-06	7.02E+00	1.000E+00	4.763E-06	CCF of AFW pumps discharge line CKVs 001 & 002 to open
1-AFW-CKV-CC-033058__-CC	1	4.506E-07	2.71E-06	7.02E+00	1.000E+00	4.763E-06	CCF of AFW pumps suction CKVS 033 & 058 to open
1-SWS-CTF-CF-S-ABCDEFGH	1	1.067E-07	1.54E-06	1.55E+01	1.000E+00	1.145E-05	System Generated Event based upon RASP CCF event : 1-SWS-FAN-CF-S
1-SWS-MOV-CF-116-DE	1	9.760E-07	1.47E-06	2.50E+00	1.000E+00	1.187E-06	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116
1-SWS-MOV-CF-116-DF	1	9.760E-07	1.47E-06	2.50E+00	1.000E+00	1.187E-06	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116

Table B-2 Internal Flooding Basic Event Importance Measures

Name	Count	Prob	FV	RIR	RRR	Birnbaum	Description
1-SWS-MOV-CF-116-EF	1	9.760E-07	1.47E-06	2.50E+00	1.000E+00	1.187E-06	System Generated Event based upon RASP CCF event : 1-SWS-MOV-CF-116

APPENDIX C: INTERNAL FLOODING TOPICS FOR FUTURE WORK

In developing the NRC's Level 1 internal flooding PRA (IFPRA), a number of topics were identified where additional study may be warranted. These topics were identified by the team developing the model, internal reviews, and the September 2017 review by the Level 3 PRA Technical Advisory Group.[13] While further study of these topics were not completed as part of NRC's Level 1 IFPRA, the issues are documented here if future work on the topic is considered. Each identified issue was assigned to the following categories for future consideration.

- **Potential Model Enhancement** – The PRA could be enhanced with further analysis of the issue. However, the level of effort and resources required were not commensurate with improvement in study quality.
- **Consideration for Future Work** – The issue would require more analysis and/or new method development. Further work in the area could represent an improvement to the current state of practice.
- **Candidate for Sensitivity Study** – The issue could be adequately addressed by performing a sensitivity study on the baseline PRA model.
- **Out of Scope** – An issue that may be related to the internal flooding analysis, but was considered out of scope for the current study.

Table C-1 Internal Flooding Topics for Future Work

Topic Area	Description	Disposition
Hydraulic analysis of postulated floods	Documentation was not always available for the detailed hydraulic analysis of postulated floods including evaluation of flow rates, leakage through barriers and doors, effectiveness of drains, propagation pathways, and flood height with time. The PRA could be improved by a more thorough hydraulic evaluation, particularly for risk significant flood areas. For example, scenario 1-FLI-CB_A48_FP could benefit from additional evaluation of potential flood propagation from corridor A58 to room A48.	Potential Model Enhancement
Flood impacts on essential switchgear rooms	Given the importance of the essential switchgear rooms, additional evaluation of flood propagation that could impact essential switchgears for both safety-related trains may be warranted. If the assumptions and modeling approaches used in the hydraulic analyses were to be re-evaluated, then careful consideration should be given to any potential flood scenarios that could impact both essential switchgear rooms.	Potential Model Enhancement

[13] The Level 3 PRA project Technical Advisory Group (TAG) consists of senior NRC technical staff in the area of PRA and in supporting technical areas (e.g., thermal hydraulics or seismic hazard), as well as one experienced PRA representative from the Electric Power Research Institute and one from Westinghouse. The TAG is tasked with providing insight, advice, and guidance to the Level 3 PRA project team on an ongoing basis, and reviewing all major project reports.

Table C-1 Internal Flooding Topics for Future Work

Topic Area	Description	Disposition
Floods impacting both Units	In addressing the site level risk, additional consideration should be given to floods that could potentially impact both reactor units. The reference plant had very limited shared structures. One potential area that could be of concern was an area that includes the Unit 1 and Unit 2 control rooms. If a significant flood were to impact one control room, then the other control room would be impacted as well. While all flooding scenarios that could propagate to the control room were screened from further analysis, additional review and confirmation of the screening could be performed with consideration for impacts on both units.	Consideration for Future Work
Large turbine building floods propagating to connected areas	There were no direct connections from the turbine building to other buildings, such as the control building. So, there is limited potential for floods to propagate to other buildings. However, the modeled turbine building floods include very large capacity flood sources (e.g., circulating water), and these assume that all equipment on the lower level of the turbine building was failed due to the flood. Additional impacts outside the building could be considered, such as propagation to the transformer yard or switchyard.	Consideration for Future Work
Steam line breaks	The flooding analysis minimizes the contribution from steam line breaks. The internal events PRA does account for main steam (MS) and main feedwater (MFW) line breaks in the analysis. For the internal events analysis, the accident sequence modeling was focused on the plant response to the reactor transient, but does not account for possible local impacts on equipment near the break. It would be appropriate and consistent with EPRI flooding PRA guidance to consider multiple locations for MS/MFW breaks and incorporate the local impacts into the plant response model. This would be an improvement to the study. Another issue was that there were many steam lines identified as potential flooding sources, but they were not included in the estimation of flooding frequency. These were not necessarily the same lines that would be considered as high-energy line breaks in the internal events analysis. It was not until a detailed update of the flooding frequencies was performed that it was noticed that all steam lines were systematically ignored in the frequency estimation. These contributions to flooding frequency should be included.	Potential Model Enhancement
Flooding impacts on turbine building non-safety batteries	Insights from the internal events PRA identify the importance of non-safety related batteries located in the turbine building for restoring offsite power. None of the modeled turbine building floods included any impacts on these batteries. However, additional consideration should be given to the impacts of a large steam release in the turbine building (see description of “Steam line breaks” topic, above.) This could be a candidate for sensitivity study. It should be noted that the potential importance of these batteries depends on a consequential LOOP occurring. For a non-LOOP flood scenario, the loss of the batteries would have little impact on the accident response.	Candidate for Sensitivity Study
Fire suppression system actuation	The analysis does not address scenarios where a “flood” (a steam release) results in fire suppression system actuation in other parts of the plant. Water submergence and spray, other effects such as water/steam jet impingement, pipe whip, humidity, condensation and temperature were considered for equipment failure due to flood	Potential Model Enhancement

Table C-1 Internal Flooding Topics for Future Work

Topic Area	Description	Disposition
	events. However, this particular failure mode, where steam/humidity results in fire suppression actuation, was not considered in NRC's model development.	
Flood impacts on SSCs	The analysis assumes that flood waters reaching a zone will cause the loss of all equipment in that zone (regardless of flood height). Per operating experience, the number of flooding events failing large numbers of PRA-relevant components is much smaller than the number of flooding events. The assumption that flood water reaching a zone will cause loss of all equipment is potentially conservative and was identified as a modeling uncertainty in Table 4.5. Given the uncertainty in flood initiating event frequency, maximum flood height, susceptibility to other failure mechanisms (e.g., humidity), it was unclear if more optimistic assumptions would be appropriate. A more realistic modeling approach could be considered as a future enhancement.	Consideration for Future Work
Impact of NSCW pipe failures	As discussed in 3.2.4, for the most important zone (AB_C113), the postulated failure of NSCW piping would not result in an immediate plant trip, but such a trip was assumed. The scenario could lead to a subsequent plant trip if required action and associated completion time are not met under LCO conditions. Other options could be to model repair/recovery action to prevent plant shutdown, or to model the impact of a controlled plant shutdown to meet the requirements of the LCO. Both of these alternative approaches were considered beyond the state of practice. The assumption of a plant trip was acknowledged as being potentially conservative. Other modeling alternatives could be considered in the future.	Consideration for Future Work
Statistical model for initiating event frequencies	Several modeling choices were made in the approach to estimating flooding initiating event frequencies. The choice of prior distribution can have a significant impact on the estimates. This project used constrained non-informative prior (CNIP) gamma distributions with mean values reported by EPRI. For this study, it was desired to use a gamma distribution for two reasons: (1) consistency with the other initiating event frequency distributions in the study, and (2) the choice of a conjugate prior for Poisson distributed data makes it easier for performing the updates. The use of the CNIP was selected because it provides a straightforward way to translate the EPRI data to a gamma prior distribution. Also, using the CNIP does not overwhelm the plant-specific data, as some other Bayesian update approaches are prone to do. The CNIP has been noted to introduce increased variance in the estimates, which may be appropriate given the uncertainty in the frequency estimate process. The CNIP may not always be the best choice, but it is often used in frequency estimates. The choice of total system feet of piping and the arbitrary pipe size category definitions can have a large impact on frequency estimate uncertainty, too. Other modeling choices could have been made, and could be considered as a model enhancement. Uncertainty in the frequency estimates can also be addressed through sensitivity studies.	Potential Model Enhancement and Candidate for Sensitivity Study

Table C-1 Internal Flooding Topics for Future Work

Topic Area	Description	Disposition
Heavy load drops resulting in floods	The analysis does not explicitly discuss the possibility of heavy load drop accidents (especially in the turbine building), as exemplified by the 2013 event at Arkansas Nuclear One and discussed in NRC Information Notice 2016-11. Although such accidents may be less important to a single-unit, at-power analysis, they appear to be worth investigation in the multi-source analysis. A full PRA evaluation of heavy load drops could be an improvement to the study, but was considered to be out of the scope of the internal flooding PRA. Additional information would have to be gathered to assess the types of heavy load lifts, probability of drop, impacts on the plant, etc.	Out of scope
Post-flood human failure events	The internal flooding analysis identified post-flood human failure events (HFEs) that were unrelated to flood mitigation. These HFEs can be influenced by stress and other factors related to the flooding scenarios. A set of human error probability (HEP) multiplier values could be developed to scale HEPs for flood scenarios. The HEP multipliers were not implemented in the NRC IFPRA model due to insignificant contribution from the post-flood HFEs that would be affected. A potential model enhancement could be considered to include the HEP multipliers and quantify the impact on internal flooding CDF results.	Potential Model Enhancement
Impact of conditional pipe failures in response to a random initiating event	The probability of a pipe failure in response to an initiating event is expected to be lower than the other component failures (e.g., pumps, valves) that can impact mitigating system reliability. The flooding operating experience considered by Reference IF-9 supports that such pipe failures would be rare. However, there appears to be a lack of systematic evaluations of conditional pipe failure probabilities that could contribute to mitigating system failures in response to the event. The demand of a piping system in response to an initiating event can involve stresses (e.g., water hammer, rapid pressurization) that can increase the failure probability. These types of conditions are not well captured in the operating experience data because demands in response to an initiating event are rare. Under some conditions the conditional failure probabilities may not be insignificant. For example, a piping system that is susceptible to aging related degradation effects and then is stressed due to a system demand in response to an initiating event could have a significantly increased conditional failure probability, and there could be multiple pipe segments susceptible to failure. Additional study is needed to fully characterize the issues and determine types of conditional pipe failures that could have risk significant impacts.	Consideration for Future Work