From:	Miller, Ed
To:	Kuntz, Robert
Subject:	FW: NRC Staff Comments on Scenario Based IA Example Sections 1-6
Date:	Wednesday, October 30, 2013 10:41:00 AM
Attachments:	Draft WORKING EXAMPLE 06-12-2013_staff_feedback.pdf

Rob,
The attached file contains the NRC staff comments on NEI's scenario-based integrated assessment example, Sections 1-6 from the October 24, 2013, public meeting.

Ed Miller
415-2481

Working Example Template:

Scenario Based Integrated Assessment Evaluation of a "Sunny Day" Dam Failure with Advance Warning of an External Flood and Severe Site Flooding

June 12, 2013

Comment [NRC1]:
High-level staff feedback:
NRC staff believes this (partial) example has progressed well and is generally at the point where the level of detail provided support development of more detailed and specific site-specific evaluations.
A note about organization of staff comments in this document:
Comments provided in the margins are roughly grouped into the following "types" of comments:

- Editorial comments: These comments generally provide editorial suggestions for improving consistency and clarity of the text (e.g., typos, missing acronyms, suggestions for organizational changes to increase readability, consistency issues). Editorial comments and suggestions are provided in response to NEI's request (from the last public meeting) that staff include such comments as they are noted during the review. Several of the editorial comments are intended to improve clarity and reduce the potential need for RAIs if utilities utilize the format of the document. These edits should be made at NEI's discretion.
- Suggestions: These comments reflect areas where staff believes the example can be improved using the provided suggestions. The suggestions are intended to improve clarity and reduce the need for RAIs if utilities utilize the format of the document. These suggestions should be implemented at NEI's discretion (though staff will be interested in understanding which suggestions that are implemented or not).
- Clarification needed: This designation is used to indicate when clarification is needed in the document on a specific topic or to draw attention to questions staff had when reviewing the document.
- Request: This designation is used to indicate that the staff would like to see a change made.

Each "type" of comment is associated with a different color "comment bubble."
Additional notes:

- Staff would like to discuss these comments during the next public meeting with NEI to understand if NEI has any concerns and to offer clarification as needed. NRC staff does not generally expect that any of the comments provided in this example should result in a large amount of work to respond to. If NEI believes a comment would require an unnecessarily large amount of work to address, staff would like to discuss those comments at the next public meeting to ensure NEI understands the staff's intent before NEI "takes action" to address the comments.
- Some of the questions/suggestions provided in the staff comments may be most easily addressed through references to evaluations that the (fictional) licensee would have available or would have performed in response to other efforts and do not necessarily mean additional information/text would have to be added to the document.

Table of Contents

Acronyms and Abbreviations

Comment [Edits2]: Editorial: The following acronyms appear in the body of the text, but not the acronym list:
- KSF
- IA
- CST
- SDC
- TDAWF

AC	Alternating Current
ADV	Atmospheric Dump Valve
AFW	Auxiliary Feed Water
AMP	Ampere
AOP	Abnormal Operating Procedure
ASCE	American Society of Civil Engineers
AWG	American Wire ~~Guage~~Gauge
CFR	Code of Federal Regulation
CLB	Current Licensing Basis
DC	Direct Current
EPP	Emergency Preparedness Procedure
Fig.	Figure
ft.	feet
gpm	gallons per minute
HRA	Human Reliability Analysis
HRR	Hazard Reevaluation Report
Inst.	Instrument
ISG	Interim Staff Guidance
kva	kilovolt amperes
Mwt	Megawatts Thermal
MCC	Motor Control Center
MCR	Main Control Room
MSSV	Main Steam Safety Valve
NAVD	North American Vertical Datum

Comment [Edits3]: Editorial: Change to NAVD88 – North American Vertical Datum of 1988

NTTF	Near Term Task Force
P	Pump
PMF	Probable Maximum Flood
PRA	Probability Risk Assessment
PWR	Pressurized Water Reactor
QA	Quality Assurance
RCS	Reactor Coolant System
RRC	Regional Response Center
RWST	Refueling Water Storage Tank
SFMS	Severe Flooding Mitigation System
SFMSDG	Severe Flooding Mitigation System Diesel Generators
SFP	Spent Fuel Pool
SG	Steam Generator
SSC	System, Structures and Components
TDAFW	Turbine Driven Auxiliary Feed Water
USACE	United States Army Corp of Engineers
v	Volt
Vac	volts ac
Vdc	volts dc
WSE	Water Surface Elevation

Preface

~~JDL~~JLD-ISG-2012-~~0~~05, “Guidance for performing an Integrated assessment for External Flooding” [ML12311A214, November 30, 2012] provides a description of methods acceptable to the staff of the U.S. Nuclear Regulatory Commission (NRC) for performing the integrated assessment for external flooding as described in NRC’s March 12, 2012, request for information (Ref. 1) issued pursuant to Title 10 of the Code of Federal Regulations (10 CFR), Section 50.54, “Conditions of licenses,” regarding Recommendation 2.1 of the enclosure to SECY-11-0093, “Recommendations for Enhancing Reactor Safety in the 21st Century, the Near-Term Task Force (NTTF) Review of Insights from the Fukushima Dai-Ichi Accident” (Ref. 2). As discussed in the Interim Staff Guidance (ISG) the purpose of the integrated assessment is to: (1) evaluate the effectiveness of the current licensing basis under the reevaluated flood hazard, (2) identify plant-specific vulnerabilities due to external flood hazards, and (3) assess the effectiveness of existing or planned plant systems and procedures in protecting against flood conditions and mitigating consequences for the entire duration of a flooding event. ~~As discussed t~~The integrated assessment consists of (1) an assessment of the plant’s flood protection features and procedures (see section 6 of the ISG), and, if adequate margin is not available to demonstrate a highly reliable flood protection capability, (2) an assessment of flood mitigation capability (see Section 7 of the IA ISG). Should an assessment of mitigation capability be required, Section 7 of the ISG provides three options to the Utility. These options are: (a) perform a detailed qualitative evaluation of the plant /site mitigation capability through the use o~~r~~f more limiting scenarios, (b) establish conditional core damage probabilities for the spectrum of limiting hazards or (c) establish the overall external flood core damage and large early release frequencies through the use of a plant specific external flood PRA.

The purpose of this paper is to illustrate, by example, the key elements of evaluation of site/plant external flood mitigation capability as part of an Integrated Assessment using a scenario based approach. While the NRC offers three options for performing a mitigation capability assessment, the scenario based approach is expected to be applicable to most integrated assessment evaluations. Note, that as stated in ~~JDL~~JLD-ISG-2012-05 “the licensee is responsible for justifying that the scenario-based evaluation provides sufficient detail and supporting information (e.g., captures dependencies, interactions, and total flood effect) to demonstrate that there is high confidence that key safety functions can be maintained.”

The purpose of this example is to illustrate an application of the Integrated Assessment ~~Scenario~~ scenario-based approach (Reference 1) with a credible example. The Integrated Assessment notes that application of the scenario based approach is of sufficient detail and include the necessary supporting information to demonstrate that there is a high level of confidence that the key safety functions can be maintained in the event of the re-evaluated flood hazard(s) under consideration.

This example treats a single external flood scenario based on a “sunny day” failure of a hypothetical upstream dam located 200 miles from the fictitious site of a 3000 Mwt. 4-Loop PWR. The nuclear plant is a single unit site. As the treatment in this example is illustrative, it is necessarily incomplete. Where appropriate, the example includes preparer’s notes to provide guidance as to the type and detail of the information that may be expected in explaining the scenario. Note that the number, type and complexity of scenarios required to support a plant specific integrated assessment will vary.

In reviewing the example the following should be noted:

Comment [Suggest4]: Suggestion: Consider adding a brief paragraph in the Preface or Overview section introducing the scenario-based approach as discussed in ISG Section 7.2. Consider adding references to ISG Figure 4.

Comment [Request5]: Request: The scope of the integrated assessment includes “flood-induced loss of an ultimate heat sink (UHS) water source (e.g., due to failure of a downstream dam) that could be caused by the flood conditions.” Although this example does not include UHS loss, consider adding a preparer’s note, or paragraph in the Preface as a reminder to the user that flood-induced loss of UHS is within scope.

Comment [Edits6]: Editorial: Font doesn’t match the rest of the document.

Comment [Suggest7]: Suggestion: Consider incorporating concepts from figure 2 of the IA ISG into the text. For example, it may be helpful to the reader to reference the steps included in fig 2:
1. Define peer review scope…
2. ID flood scenario parameters
3. Evaluate flood protection systems
4. Evaluation mitigation capability
5. Document results

Note: Steps 1, 2, and 5 above are not currently included in this sentence.

Comment [Suggest8]: Suggestion: Change to “many”

Comment [Request9]: Request: This sentence is not accurate. The integrated assessment does not imply that the scenario-based approach *is* of sufficient detail but rather that the licensee is responsible for making that case. The previous paragraph makes this distinction.
Perhaps this sentence here is a “hold-over” from a previous draft? Please consider deleting it.

Comment [Suggest10]: Suggestion: Consider adding a statement, preparer’s note, or footnote describing if/how this example is or is not applicable to BWR plants.

Comment [Suggest11]: Suggestion: Consider adding a preparer’s note that describes anticipated examples of complexities for multi-unit site to help a user that would be using this example for a different situation.

Comment [Edits12]: Editorial: Should this be “using” rather than “reviewing” because the reader will be using the example as guidance rather than reviewing it?

Comment [Edits13]: Editorial: It’s not clear where the “items that should be noted” end in the text that follows. Consider using different font or bulleted list to indicate the items that should be noted.

The example discussion illustrates an external flood mitigation capability evaluation using the scenario-based approach outlined in Reference 1. The identification of controlling flood mechanisms and the evaluation of external flood protection are only discussed to the extent necessary to define the scope and boundary conditions of the mitigation capability evaluation. A discussion ~~for~~ of the basis for selection of the flood mechanism to be evaluated will be required in the Integrated Assessment submittal. Additional discussion on the basis for the adequacy of the permanent and temporary external flood barriers and any associated procedures will also be required to complete the Integrated Assessment.

Comment [Edits14]: Editorial: This sentence is redundant to the next paragraph. Consider deleting this sentence.

The example focuses on an evaluation of external flood mitigation capabilities of the plant/site. Detailed discussion of the external flood protective barriers and procedures (not directly related to the mitigation activity) is not included in this illustration. Information regarding external flood protection would also need to be included to the extent appropriate to meet the intent of the integrated assessment.

As this example focuses on a single unit site, issues regarding equipment sharing, equipment and resource availability, and effectiveness of human actions that may be relevant for multi-unit sites are not directly addressed, although notes regarding the need for extended treatment are provided.

Comment [Clarify15]: Clarification needed: Are these notes provided?

Strategies included in this example do not necessarily represent endorsed mitigation strategies or actions for a particular event but rather focuses on the level of detail required to describe and justify the adequacy of a proposed external flood mitigation strategy.

Comment [Edits16]: Editorial: Consider specifying as "NRC-endorsed"

Normal plant procedures used in response to the flood event (e.g., plant shutdown) and that are routinely trained upon will be identified as being invoked but not discussed in detail. Flood specific procedures developed to prepare for, -mitigate or maintain, test or surveillance equipment in advance of a flood hazard will be discussed to the extent necessary to identify the procedure and the key attributes of that procedure. For additional details, the reader is referred to the specific procedure.

Comment [Suggest17]: Suggestion: Consider specifying that such procedures may require some discussion if the conditions under which they are performed as changed.

Comment [Edits18]: Editorial: This sentence was a bit hard to follow.

Comment [Edits19]: Editorial: Since this is a generic preface, consider making this text more generic. For example: "For additional details (in an actual analysis), the reader would normally be referred to the specific procedure. "

This flood scenario is presented only as a representative example of one flood scenario resulting from a "sunny day" failure of an upstream dam. Plant~~'~~s may have multiple flood mechanisms that may require an integrated assessment. The other mechanisms may be treated separately in other scenarios or enveloped by one or more evaluated scenarios.

The focus of the scenario example is on developing the justification for demonstrating confidence that the key plant safety functions are maintained throughout that external flood scenario. For illustration purposes, the example scenario presented does not include consideration of Spent Fuel Pool (SFP) cooling. A complete scenario description would be expected to also successfully disposition make-up to the SFP. Utilities are cautioned that events and mitigating conditions unique to their respective site may warrant consideration of additional plant safety functions and/or different responses.

Comment [Edits20]: Editorial: Change to "flood event duration" to match language in the IA ISG.

The structure of this document uses running text to provide illustrative examples of the example write-up and "~~preparer's~~ Preparer's Notes" in italics to highlight the intent of the key sections and provide guidance as to additional or alternate information that may be required to supplement scenario descriptions.

1. Overview

Recommendation 2.1 of the NTTF required that all nuclear power plants perform an external flood hazard re-evaluation using present day methods and assumptions typical of current regulatory practice. The hazard information contained in that re-evaluation noted that the site predicted maximum hazard flood elevation has increased 5 feet from 900 ft. (North American Vertical Datum of 1988, NAVD88) to 905 ft. (NAVD88). No other changes in the plant flood hazards were identified. For performing an integrated assessment of this flood elevation increase, the following specific characteristics of the external flood hazard were identified:

1. Flood height and associated effects
2. Warning time (time available from event notification to the time flood waters arrive on site)
3. Intermediate water surface elevations that trigger actions by plant personnel
4. Flood duration (Determined by hazard re-evaluation to be time between event notification and time flood waters recede from site. Note that this definition is separate from the IA definition of Flood event duration which includes the additional time for ensuring Reactor Coolant System (RCS) is in a safe stable state).
5. Other hazards associated with the scenario including debris and hydrostatic/hydrodynamic loading challenges and concurrent adverse weather conditions.
6. Plant mode(s) of operation during the flood duration

This overall integrated assessment scenario-based evaluation discussion is organized as follows:

Section 2, "Description of the Flood Scenario and Initial Conditions,", provides a detailed discussion of the full scenario including important features of the hazard under evaluation and site elevations. Section 3 includes an overview of the plant's flood mitigation features and detailed description of the Severe Flood Mitigation System (SFMS). Section 4 provides the justification for determining the SFMS equipment is reliable and documents the system's dependencies. Section 5 includes a timeline of the scenario and resources required to implement the mitigation strategy. Both a tabular and graphical presentation has been provided. Section 6 discusses the key safety functions (KSF) that are required to be maintained throughout the entire flood event duration. A success path has been included to illustrate the critical actions and equipment required to maintain the KSFs. Section 7 provides the assessment of the feasibility and reliability of critical flood mitigation manual actions. A discussion of available margin and uncertainty associated with the human action assessment is provided in Section 8. Section 9 concludes.

Note that the overall structure of the document is to provide high level information regarding the development of the hazard, event timelines, flood event duration and the general plant external flood mitigation strategies early in the document. Later sections (7 and 8) provide the details of the human reliability assessment supporting justification of the acceptability of the plant external flood mitigation strategies.

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Comment [Edits21]: Editorial: The 50.54(f) letter made the request that licensees reevaluate flood hazards. The NTTF report made the overall recommendation (i.e., the NTTF report did not "require" the hazard reevaluations).

Consider leveraging existing language from the 50.54(f) letter. Ex: "The 50.54(f) letter requests licensees and holders of construction permits under 10 CFR Part 50 to reevaluate the flooding hazards at their sites against present-day regulatory guidance and methodologies being used for early site permits and combined license reviews."

Comment [Clarify22]: Question: Is it realistic to assume that, if water levels increase by 5 ft, other key aspects (e.g. hydrostatic/hydrodynamic forces and areas of inundation) would not be expected to change? It is understood that such an assumption is made for ease of this example, but consider noting this simplification in a preparer's note or the preface.

Comment [Suggest23]: Suggestion: Here and throughout the document, consider using a different phrase from "flood duration" to describe this time period to avoid confusion with the IA ISG defined term "flood event duration." Perhaps something like "warning time plus period of inundation" can be used.
Also, for similar reasons, when simply referencing the time associated with performing an activity, consider using words like "timespan" rather than "duration."

Comment [Edits24]: Editorial: Add reference to the event tree as well.

Comment [Edits25]: Editorial: This sentence seems incomplete. Perhaps it means to say section 9 concludes the example of a scenario-based evaluation?

Comment [Edits26]: Editorial: What about sections 4-6?

~~7.~~2. Description of the Flood Scenario and Initial Conditions

--- Preparer's Note ---

The intent of this section is to provide a complete picture of the flood scenario being analyzed in order to put in context the details of the scenario-based mitigation assessment for the scenario in question. This section includes a description of the hazard(s), key features of the site and surrounding area that may impact the plant response to the hazard and expected plant initial conditions at the time of the onset of the hazard. The scenario description begins at the time at the time of dam breach and includes considerations of actions taken by the dam operator and state emergency preparedness operations from the point of incipient dam breach to the notification of the onset of the flood event through the point the plant is restored to a safe stable state.

This section provides a complete picture of the flood scenario being analyzed in order to put in context the details of the integrated assessment for the scenario in question. This section includes a description of the hazard(s), key features of the site and surrounding area that may impact the response of the plant to the hazard and expected plant initial conditions at the time of the onset of the hazard. The details of the hazard is as presented in the hazard re-evaluation report as required by NTTF 2.1 and submitted in Reference 3.

~~1.~~2.1 Scenario Selection

A review of the results of the hazard re-evaluation for all flooding mechanisms applicable to the hypothetical site indicates that the only flooding mechanism that either resulted in an increase in an adverse change in a flooding parameter (e.g., decreased warning time, or increased flood level) or required consideration of a previously unevaluated flood feature (e.g., debris considerations) involved the "sunny day" failure of a dam upstream of the site. The specific change that triggered the scenario selection was the predicted increase in the resulting Probable Maximum Flood (PMF) from 900 ft. (NAVD88)[1] to 905 ft (NAVD88). Table 2-1 provides a comparison of hydrologic parameters and key modeling assumptions between the Current Licensing Basis (CLB) and the re-evaluated hazard.

[1] All elevations are provided based on the North American Vertical Datum 1988

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Comment [Suggest27]: Suggestion: In this preparer's note, consider adding a reference to section 5.1 of the IA ISG to indicate that, while this example focuses on one particular scenario, consideration of other scenarios (or a bounding scenario) may be needed in an actual example.

Comment [Suggest28]: Suggestion: In the preparer's notes for each section in the example, consider adding a reference to the items from the IA ISG that the section is intended to address.

For example, this section of the example is intended to address the following items from the bulleted list under the second paragraph in section 7.2 of the IA ISG:

- Flood scenario parameters
- The credible flood protection failure modes
- All direct consequences of flood protection failure
- The plant conditions and all equipment affected by the consequences of flood protection failure

Comment [Suggest29]: Suggestion: This part of the preparer's note is very specific to this example (e.g., it gives commentary on the specific scenario and doesn't give any generic guidance), which differs from most of the preparer's notes in the document. Consider making this more general.

Comment [Edits30]: Editorial: Note the earlier comment regarding the differences between the NTTF recommendations and what's required/requested by the 50.54(f) letter.

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Comment [Edits31]: Editorial: A word appears to be missing here.

Comment [Clarify32]: Clarification needed: It is not clear what is meant here. Is this sentence intending to say that the DBF was a PMF and now a sunny day dam failure exceeds that elevation? Or is this intended to say that that the estimated water level resulting from a sunny day failure increased from 900 ft to 905 ft?

~~2.~~2.3 Flood Characterization

The plant has an external flood protection system that is based on a design basis flood of 900 ft (NAVD88). Plant grade is 895 ft. The results of the re-evaluated hazard height indicate that a "sunny day" failure of an upstream dam would create a flood that could reach 905 ft. A flood elevation in excess of 900 ft. will result in all CLB flood protection barriers at the site being overtopped; resulting in a loss of core cooling and inventory control safety functions. The anticipated time for the flood to reach plant grade is 24 hours (including consideration of wave run up). The 900 ft. level (including margin for wave run up) may be reached as early as 30 hours after the initial dam breach. A peak flood height of 905 ft can potentially be reached 6 hours later. This flood height is expected to remain near the peak elevation for a period of approximately two weeks. After that time the flood is predicted to gradually subside at a rate of 1 ft per day. The scenario is terminated when the plant is placed in a long term stable condition such that there is high confidence that the all key plant and safety functions can be met indefinitely (See Section 2.4).

Figure 2-1 illustrates the expected transient behavior of the flood from the time of dam failure to the time the river level subsides to below site grade. While this time defines the duration of the flood, the flood event duration scenario discussion continues until a stable state is achieved. In accordance with Reference 1, the flood event duration to be used for the integrated assessment evaluation is the time interval from when conditions are met for entry into flood procedures or notification of impending flood and lasts until flood waters recede and the plant from site and the plant is in a safe and stable state that can be maintained in that state indefinitely. As the hazard re-evaluation does not consider mitigation strategies the flood duration captured in Figure 2-1 for the "sunny day" dam failure is a subset of that interval that initiates at the time the site receives notification of an impending flood and lasts until flood waters recede and the plant from site. Table 2-2 provides a mapping of the instantaneous water level and the relevant elevations of site physical features, protective site and equipment barriers and equipment locations. Note that in judging plant actions, the site is entirely "dry" for first 24 hours of the event and all SSCs are functional up until the flood reaches 900 ft. (NAVD88) (thirty hours into the event). As discussed in Section 3, associated resupply routes are available to ensure an indefinite period of plant operation.

Comment [Request33]: Request: Please make sure the temporal description of the flood scenario is unambiguous about the flood event duration. Specifically, this text is not clear with respect to whether the scenario ends when (i) river level subsides to below site grade, (ii) flood waters recede from the site, or (iii) the plant is in a safe and stable state.
Consider starting the section with the definition of the flood event duration from the IA ISG, and then explaining how Figure 2-1 departs from this definition. However the section should be clear that the integrated assessment is conducted over the entire flood event duration as defined in the IA ISG.

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Comment [NRCedit34]: Editorial: Consider structuring these sentences more systematically.
Ex: "The anticipated time for the flood (including consideration of wave run up) to reach plant grade (895ft) is 24 hours after initial dam breach. The top of flood barriers (900 ft) may be reached as early as 30 hours after the initial dam breach. The peak flood height (905 ft) can potentially be reached 36 hours after initial dam breach."

Comment [NRCedit35]: Editorial: Plant grade and site grade are used throughout the example. Unless there is an intentional desire to refer to different grades, consider only using one of the terms.

Comment [Clarify36]: Clarification needed: Two weeks is equivalent to 336 hrs. However, this is not consistent with the figures throughout the document, for example:

- Fig. 2-1 shows the peak lasts for approximately 75hrs (from 36hrs to ~110hrs).
- Fig. 5-1 shows the peak lasting for 252hrs (from 26hrs to 288hrs)

It is not clear why these values are different throughout the document.

Comment [Edits37]: Editorial: Consider linking this statement directly to the definition to flood event duration and including a reference to the ISG

Comment [Edits38]: Editorial: Note other comments regarding the use of the word "duration" in two contexts throughout the example. Here, consider the following edit: "While this time defines the time from the initiating event until flood waters recede, the flood event duration scenario discussion continues until a safe and stable state is achieved that can be maintained indefinitely."

Comment [Edits39]: Editorial: For completeness, clarify whether the "site" includes the intake structure. Also, consider adding a reference to the flood protection evaluation.
Ex: "the site (including intake structure) is entirely "dry" for first 24 hours of the event and all SSCs are ~~functional~~ protected up until the flood reaches 9(...

Table 2-1 Re-Evaluated Hazard Definitions (Section 5 of IA) "Sunny day" failure of Upstream Dam			
Parameter/Feature	**Re-Evaluated hazard Condition**	**Current Licensing ~~B~~basis**	**Comment**
Scenario Type	Sunny Day Dam Failure	Sunny Day Dam Failure	Selected for Integrated assessment as re-evaluated hazard exceeds a design basis flood parameter or did not consider a relevant flood parameter in the design basis
Plant Initial Condition at time of Flood	Shutdown	Shutdown	All equipment considered operable prior to onset of flood
Plant grade	895 ft.	895 ft.	~~FASR~~ FSAR Section XXX
Initial River Level at site	890 ft.	890 ft~~-~~.	See Reference 3
Probable maximum Flood	905 ft.	900 ft.	Re-evaluated hazard PMF exceeds CLB by 5 feet
Warning Time*	24 hours prior to flood reaching site grade 30 hours for flood to overtop flood barriers	24 hours prior to flood reaching site grade. Flood barriers not overtopped	Flood barriers designed to CLB PMF. Warning time includes time for dam operators to notify site management. This time interval is considered in evaluating site actions.
Flood Elevation Profile	See Figure 2-1	Flood barriers evaluated at PMF (900 ft.)	
Flood Duration[2]	13.5 days	Unspecified	See Footnote
Wind waves and run-up effects [3]	Included in flood elevations estimates	Included in flood elevations estimates	Wave run-up based on maximum two year wind speed

[2] Flood duration from re-evaluated hazard based on time from when Conditions are met for entry into flood procedures or notification of impending flood and lasts until flood waters recede from site. The Flood event duration for mitigation capability evaluation extends to the time the plant is in a safe and stable state that can be maintained [in that state] indefinitely. estimated from time water reaches

[3] For purposes of human performance assessments nominal weather conditions assumed a worst two year site wind speed. As the "sunny day " dam failure and wind conditions are uncorrelated the likelihood of occurrence of this wind speed in combination with a sunny day dam failure is 0.0015.

Comment [Edits40]: Editorial: Consider adding a placeholder for a reference to supporting data (e.g., specific section(s) of the flood hazard reevaluation report).

Comment [Edits41]: Editorial: Consider adding a placeholder for a reference to supporting data (e.g., specific section(s) of the FSAR).

Comment [Edits42]: Editorial: Note earlier comment about consistent use of either "site grade" or "plant grade"

Comment [Clarify43]: Clarification needed: Does this intend to mean the peak flood height from the sunny dam failure (rather than a PMF)?

Comment [Edits44]: Editorial: What does the star (*) link to?

Comment [Clarify45]: Clarification needed: Is this intended to reference the PMF or more generically reference the design basis flood?

Comment [Suggest46]: Suggestion: For clarity, use distinct terms to distinguish between the IA ISG "flood event duration" and other definitions that are used to identify, for example, the period of inundation of the site.

Comment [NRCedit47]: Clarification needed: What is the basis for the numerical values used in the footnote? Consider adding a reference (e.g., to an evaluation performed as part of the flood hazard reevaluation report).

Table 2-1
Re-Evaluated Hazard Definitions (Section 5 of IA)
"Sunny day" failure of Upstream Dam

Parameter/Feature	Re-Evaluated hazard Condition	Current Licensing Bbasis	Comment
Debris Effects	No significant debris loading predicted on credited mitigation SSCs	Considered in CLB consistent with CLB PMF	See Section 2.3
Hydrodynamic/hydrostatic loading	No significant hydrodynamic/hydrostatic loading predicted on credited mitigation SSCs	Considered in CLB consistent with CLB PMF	See Section 2.3
Sedimentation	Considered	Considered in CLB consistent with CLB PMF	See Section 2.3
Erosion	Considered	Considered in CLB consistent with CLB PMF	See Section 2.3

Comment [Edits40]: Editorial: Consider adding a placeholder for a reference to supporting data (e.g., specific section(s) of the flood hazard reevaluation report).

Comment [Edits41]: Editorial: Consider adding a placeholder for a reference to supporting data (e.g., specific section(s) of the FSAR).

Comment [Edits48]: Editorial: Add a reference to the section of the (fictional) flood hazard reevaluation report where this is described.

Comment [Edits49]: Editorial: The mitigation SSCs have not yet been discussed in the document before being mentioned in this table.

Comment [Edits50]: Editorial: Add a reference to the section of the (fictional) flood hazard reevaluation report where this is described.

Comment [Edits51]: Editorial: It would help the user if consistent terminology is used throughout the document. For example, the document also refers to the SFMS equipment and other terms.

Comment [Clarify52]: Clarification needed: It is not clear what this means.

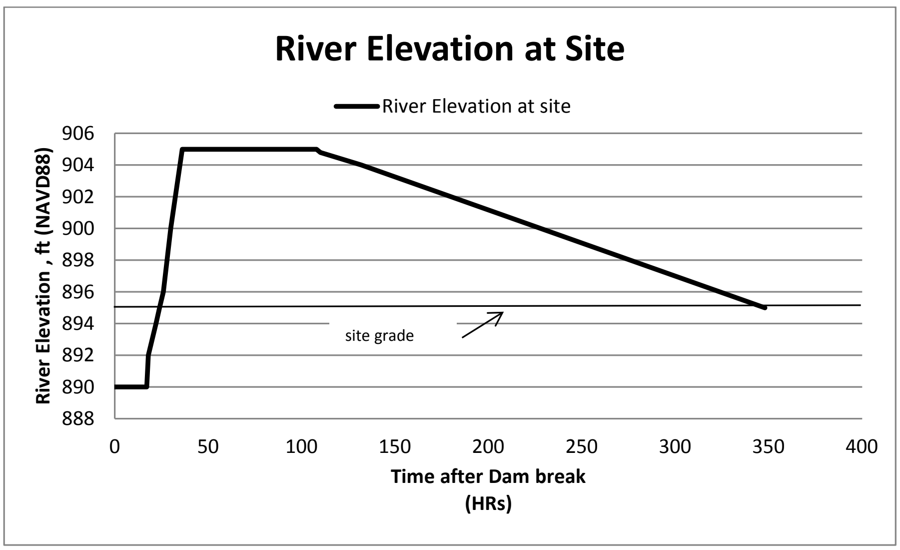

Figure 2-1: Scenario Site Flood Profile

Comment [Suggest53]: Suggestion: Note earlier comment about consistency regarding the length of the "flood peak."

Comment [Suggest54]: Suggestion: Consider whether the following is an applicable consideration:

The hydrograph onsite may differ from the river elevation due to barriers. Barriers may impeded inundation, but when overtopped, initial water level rise onsite may be more rapid than river. Conversely barriers may slow water recession from site

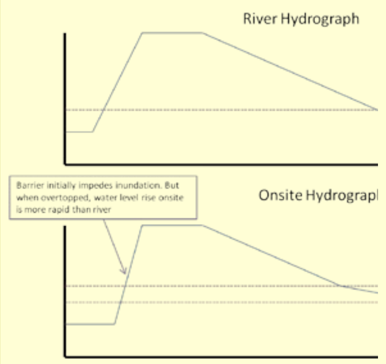

Table 2-2
Significant Elevations/Action Points

Elevation (NAVD88)	Significant Elevations and Plant Conditions	Comments
915	Lower elevation of Severe Flood Mitigation System (SFMS) facility	Facility houses key flood mitigation equipment above peak flood elevation
905	Re-Evaluated Peak Flood Height	EDGs not functional
904		TDAFW inoperable
903		
902	TD AFW Protection Overtopped – Rooms of Permanently Installed EDGs Flooded Offsite power lost as Switchyard is de-energized (switchyard protected to 902 ft by a berm however action is taken early to avoid potential for electrical shock hazards.	Equipment protected by barriers with top elevation of 900 ft. are available for the CLB event but will be lost during the re-evaluated hazard.
901		
900	Plant Design Basis Flood Barriers Topped - Lose Intake Structure and Auxiliary Building begins to flood	
899		
898	Elevation of connection Point to Well Water System and storage location for back-up air supplies and special equipment (for ADV)	Actions to move, implement/install equipment to be performed in advance of flood reaching site grade.
897	Elevation of Storage of Spool piece Connector	Actions to move and align spool piece to be performed in advance of flood reaching site grade.
896		Ability to move about site begins to degrade.
895	Plant Grade Operators begin process to Disconnect Switchyard from Offsite Power	No onsite impact of flood as water level is below site grade. Site access normal. Off-site power expected to be available. Emergency power available.
894		
: 891		
890	Initial Water Level At Start of Event All notifications and preparatory actions begin at this river level (for details see Table 3) Note well water pumps located at the 885 ft elevation	
889		

Comment [Suggest55]: Suggestion: Add elevation at which the plant will be shut down to this table.

Comment [MB56]: Editorial: change to "overtopped"

Comment [Edits57]: Editorial: Remove reference to spool piece because it has been removed from the rest of the document.

Comment [Request58]: Request: One foot of water on site will affect/degrade ability to move around site. Consider changing this text to "ability to move around site is degraded."

Comment [Clarify59]: Clarification needed: Other tables in the document show the switchyard is disconnected at this elevation rather than the "beginning of the process" to disconnect.

Comment [Edits60]: Editorial: Consider including a separate line item for the well pumps.

Comment [Edits61]: Editorial: Consider describing as "*submersible* well water pumps"

The intake structure is designed for operation to the PMF and includes debris protection up to the CLB licensing level of 900 ft. Thus, until plant barriers are overtopped the intake structure does not clog and the service water systems can be maintained operable. Turbine driven AFW pumps can be operated and are protected to a site elevation of 902.5 ft. The EDG rooms begin flooding at 902 ft and EDGs will not be operable by the time the flood height is expected to reach 905 ft.

It has been determined that it is not physically possible to provide protection for the existing CLB flood mitigation equipment at the new higher flood elevation. However, a mitigation strategy has been developed using a recently developed dedicated Severe Flood Mitigation System (SFMS) which provides highly reliable mitigation for flood events beyond the current 900 ft. design PMF elevation and up to an elevation of 915 ft. This system provides an alternate source of power, instrumentation and water to maintain the plant in a safe shutdown mode. Details on the Severe Flood Mitigation System are presented in Section 3. Equipment reliability considerations for this system are included in sections 4.

The flood event duration for mitigation system capability initiates at the time of notification of dam breach and lasts until flood waters recede ~~and~~from the plant from site and the plant is in a safe and stable state that can be maintained indefinitely. The following paragraphs provide an introductory overview of the event sequence.

Comment [Edits62]: Editorial: Consider adding a reference to the fictional flood protection evaluation. Ex: "As demonstrated in the flood protection evaluation of the integrated assessment (which used existing engineering evaluations), it has been demonstrated that the intake structure is designed for operation to [**] and includes debris protection up to the CLB licensing level of 900 ft."

Comment [Edits63]: Editorial: To make this section easier to follow, consider introducing Fig. 3-1 as this point and including an overview of the site flood protection features/system.

Comment [Clarify64]: Clarification needed: Is the relevance of this statement related to the fact that the (fictional) hazard reevaluation found that the debris loads did not change from the DBF? If so, please state as such.

Comment [Suggest65]: Suggestion: Operating experience has shown that clogging on intakes can be an issue. Consider describing why the intake would not clog before the barriers overtop, or why this is not otherwise an issue. For the purposes of the example, consider referencing some (fictional) evaluation that has been performed.

Comment [Suggest66]: Suggestion/observation: It is understood that this is an assumption for this example. However, it is noted that this may not be realistic and in an actual submittal additional justification would likely be required to explain why the EDGs can operate with three feet of water in the room.

Comment [Clarify67]: Clarification needed: Is it not clear what is meant by "not physically possible." This is a strong statement.

Comment [Clarify68]: Clarification needed: Is this a different set of "mitigation" equipment than what s evaluated in the example?

Comment [Edits69]: Editorial: Consider including references to the remaining sections of the example?

The plant is notified of a dam failure ~~1~~ one hour after onset and this is confirmed by gauge readings downstream of the dam. Agreements are in place between the dam operator, state and utility to assure notification of impending and existing dam failures or significant changes in dam operation that may affect the plant (see also Table 5-1). Gauge readings at upstream locations and predicted river levels at the site are provided directly to the site from the USACE with a 30 minute delay. This information is also available from the USACE website. A memorandum of understanding regarding information transfer between the USACE and the utility is provided in an attachment. While not credited in this assessment, dam distress can be seen prior to failure (several hours) as the dam owner periodically inspects the dam condition, and that the dam owner will notify the state of impending failure. The state will notify the plant of a potential failure and the plant management will be primed for an event.

Comment [Suggest70]: Suggestion: These types of assumptions are reasonable for the purposes of a simple example, but it is noted that upstream gauges may be damaged by the flood wave from a dam failure. It may be helpful to communicate (e.g., via a preparer's note) that certain assumptions are made to support an example, but a real IA would require justification that conditions hold (e.g., demonstrate that the gauge readings will be available during the event).

Comment [Edits71]: Editorial: Clarify where this attachment is located (or if it will not be included with the example and if it is a fictional reference).

The current assessment assumes that the initial action starts at the time the dam breach is reported to the utility administration. Dam owner surveillance activities are likely to extend this time interval by identifying and reporting pre-failure conditions to the state. While not credited reasonable dam operator and state actions taken prior to dam failure are discussed in Section 5. The Flooding Hazard Re-evaluation shows the flood will not reach the site for a period of 24 hours and will not exceed the current plant design basis flood physical protection features of the plant for at least 30 hours after the dam break. As the flood will not reach the site grade for 24 hours, normal land access to the plant's protected area is available for 24 hours after the dam break. For additional information on site ~~topology~~ topography see Section 3 (Figure 3-1).

Comment [Edits72]: Editorial: This paragraph and the latter portion of the above paragraph seem redundant.

Comment [Edits73]: Editorial: Clarify or delete.

Comment [Suggest74]: Observation: While this is a reasonable assumption for an example, depending on the actual situation, questions may arise about the effect of concurrent events (e.g., ongoing evacuations that require roads to run "one-way") that may challenge this assumption (at least initially).

The plant is initially operated at full power and all plant systems are available until the flood level reaches site grade. All safety related systems will be available until the flood level reaches 900 ft. As flood conditions in excess of 900 ft. are expected, the plant is shutdown according to plant standard operating procedures for an emergency shutdown (AOP-XXX). Once initiated, an emergency shutdown is typically accomplished within 6 hours. As onsite and/or emergency power is available during the shutdown, any RCS leakage prior to reaching cold shutdown conditions is made up by the normal plant charging system. Once on shutdown cooling, the RCS pressure and temperature are reduced so as to remove temperature/pressure challenges to the RCP seals. Under these conditions RCS seal integrity can be maintained indefinitely. It is estimated that in this mode of operation RCS seal leakage will have a low leak rate, such that, the core will remain covered for period well in excess of the expected event duration.[4]

Comment [Suggest75]: Suggestion: Consider adding a reference to the basis for this number (i.e., don't need additional discussion, but perhaps just a reference to where additional information can be found).

Comment [Suggest76]: Suggestion: Here and throughout the document, consider adding references to other documents or evaluations that support these statements. Note: It is not necessary to provide the details here, but a reference would be helpful.

Comment [Suggest77]: Suggestion: Consider removing references to numerical values and instead include placeholders (e.g., [x]) to indicate to the user that such information should be provided but without explicitly providing the information in the example (unless necessary for the example).

Once a dam breach scenario is identified, plant staff will be directed to ready the SFMS. The overall process takes approximately 12 hours and involves (1) alignment of well water pumps to the SG via the AFW injection piping and RWST, (2) depressurization of the SGs to create a stable, reliable steam relief path, and (3) implementation of the SFMS [See Timeline in Section 5]. Once the flood reaches the 900 ft. elevation a "cliff edge" effect begins whereby equipment previously protected by the barriers begins to flood. Equipment stored below the 900 ft. elevation will be quickly submerged defeating any

[4] For a plant with an RCS inventory of about 75,000 gallons and using a rule of thumb that 70% of the inventory resides above a typical core, RCS leakrate of 0.1 gpm (bounding RCP seal combined leakrate) would take approximately 1 year to reach a core uncovery condition.

additional actions involving this equipment (see table 2-2). The emergency diesel generator room begins to flood at 900 ft. elevation and EDGs are flooded at 905 ft. elevation. Offsite and emergency onsite power is expected to be available until the flood height reaches 902 ft. A permanent berm protects offsite power to 902 ft., however procedure [AOP XX] de-energizes switchyard for purposes of personnel protection. This action is taken after the SFMS has been implemented and verified functional. In addition, once the SFMS facility is validated operable then command and control is transferred from main control room (MCR) to the SFMS building.

Adverse site weather conditions are not anticipated following a "sunny day" dam breach. However, the mitigation capability evaluation will consider potential implications of performing the associated mitigation actions consistent with the high wind speeds used in the re-evaluation of the PMF.

Table 2-2 provides a list of actions and significant elevations associated with the flood event duration.

Comment [Clarify78]: Clarification needed: the previous page says EDGs rooms begin flooding at 902ft, whereas this statement says 900ft.

Comment [Clarify79]: Clarification needed: Table 2-2 indicates that operators begin disconnecting the switchyard at 895ft. Table 5-5 indicates switchyard is disconnected from the grid at 895ft. Therefore, it is not clear how offsite power is "expected" to be available to the site until elevation 902ft. Perhaps this statement is intended to indicate that the grid is expected to still be "up" and, therefore, available to plant staff if they wanted to use it until 902ft?

Comment [Clarify80]: Clarification needed: Doesn't the SFMS need to be "running" (not just verified functional) before the switchyard is deenergized?

Comment [Clarify81]: Clarification needed: Is this intended to say that the scenario-based evaluation is using more intense wind-speeds (e.g., wind speeds that were used in the evaluation of the PMF rather than the 2-year wind speeds used in conjunction with the sunny-day dam failure event)?

~~3.~~2.4 Consideration of Associated Effects

--- *Preparer's Note* ---

The intent of this section is to consider the associated effects that are addressed in the 2.1 flooding hazard reevaluation report within the context of the scenario being evaluated in the IA.

Flood hazards include ancillary affects that occur as a result of the flood. These effects include: wind loads, treatment of debris, water-borne missiles and hydrostatic and hydrodynamic loads, sedimentation, soil erosion, groundwater ingress and other pertinent effects. This section includes aspects of the treatment of associated effects that impacts the ability of the plant systems to mitigate the event. Detailed assessments of the protective features of these effects on the associated structures are provided in the flood hazard protection portion of the evaluation.

Where applicable, treatment of debris includes transport of flotsam that can clog safety systems as well as water-borne missiles (as appropriate for the site) which may damage exposed equipment or result in failure of mitigation system protective components. In instances where the hazard re-evaluation notes debris impact on external flood mitigation is not credible, provide appropriate references to that report.

In cases where the initiating event can degrade plant features as well as cause a flood hazard (e.g., seismic failure of dams), the simultaneous impact of these factors should be addressed in the integrated assessment.

2.3.1 Wind, Waves and Wave Run-up

The wind, wave and wave run-up has been included in the maximum Water Surface Elevation (WSE). The wind effects are considered in the Human Reliability Analysis (HRA). See Reference 3 for additional details.

2.3.2 Water-borne missiles and debris

Flood hazards also include the impact of debris. For the scenario described herein key components of the external flood mitigation system are either located above the elevation of the maximum flood height, or are located underground (e.g., wells) such that they are not expected to be affected by any of these factors. As access to well pumps are protected by manhole covers, debris collection within the well such that pump suction could be challenged was not considered credible.

The only components of ~~that~~ the system exposed to a credible waterborne missile threat are the auxiliary feedwater injection piping and associated tees. As large barges or other large waterborne debris are not common to the area and the flood depth is not conducive to transport of larger debris above site grade, waterborne missile transport of debris capable of damaging the AFW pipelines were judged to not be credible. Additional discussion of the debris and waterborne missile impact on external flood mitigation is provided in Reference 3.

2.3.3 Hydrodynamic and hydrostatic effects

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> **Comment [Edits82]:** Editorial: Consider adding "… and were considered in the flood protection evaluation of the integrated assessment."

> **Comment [Edits83]:** Editorial: Consider adding: "…height *by site topography*" to make it clear the grade is actually higher that the max WSE (versus having a building that is located at a lower elevation but with equipment staged higher, which would bring up more questions).

> **Comment [NRCedit84]:** Editorial: Consider adding a reference to a (fictional) evaluation that describes how the design basis of pump protection is established and evaluated (note: the details of the evaluation aren't necessarily needed, but a reference would be helpful).

> **Comment [Clarify85]:** Clarification needed: What about the RWST? Does the last sentence of the paragraph cover the RWST?

> **Comment [Suggest86]:** Suggestion: Consider adding a reference to the (fictional) flood hazard reevaluation report so that this statement does not look "unsubstantiated" as part of the integrated assessment. Ex: "As demonstrated in the flood hazard reevaluation report (ref #, section #) large barges or other large waterborne debris are not common to the area and the flood depth is not conducive to transport of larger debris above site grade."
>
> Consider adding similar references to the flood hazard reevaluation report throughout the document when "claims" such as this are made.

> **Comment [Clarify87]:** Clarification needed: What is the elevation/location of the AFW pipes?

> **Comment [Edits88]:** Editorial: Is this intended to be a reference to the flood hazard reevaluation report or something else?

The only components affected by hydrodynamic affects involve piping runs from the well discharge to the steam generator feedwater piping connection. The ability of these piping runs to withstand loading associated with the floodwaters is provided in the Flood Protection Evaluation for these structures. Foundations of the SFMS facility have also been evaluated and found not to be compromised by predicted hydrostatic /hydrodynamic loading. As the SFMS Facility is located above the peak flood elevation, these structures and their associated components are not subject to hydrodynamic and hydrostatic loads.

2.3.4 Sedimentation

As the river flood will transport tons of sediment to the site, the impact of sedimentation on early plant mitigation and long term recovery was considered. While sedimentation will occur throughout the site, the wells will be covered and therefore not subject to significant sedimentation. Other key equipment is generally located above the peak flood elevation and therefore not subject to the impact of sedimentation.

2.3.5 Erosion

Hydrological and geo-technic evaluations of the design of the SFMS Facility indicate that the structure will remain stable for the entire event duration. Soil erosion may an issue in the long term as it may wash away soil above buried cables credited for powering the well water pumps. To minimize this impact cable runs are protected within seal piping runs. Erosion over an extended period of time may wash away soil underneath the SFMS Building. However, this impact is not expected to be significant in the time frame of interest.

2.3.6 Groundwater Ingress

The effects of groundwater ingress have been evaluated to not be applicable to this scenario.

2.3.7 Other Pertinent Effects

There are no additional effects that are applicable to this scenario as defined in the Hazard Reevaluation Report (HRR).

2.4 Site Description and Topography

-- Preparer's Note --

The objective of this section is to establish a basis for ensuring that off-site fuel supplies will be available to the site in advance and in the days immediately following the event. Regional resource centers may provide longer term assistance using air support[5]. If relevant provide a topographical map of the site. Additionally, pathways required to implement mitigation strategies and ingress to the site should be fully described herein.

[5] Short term supply of equipment via airlift is not expected to be required. If air-lifted equipment is credited, address any concurrent issues that may exist due to the flood hazard.

Comment [Edits89]: Editorial: Change to "hydraulic and geotechnical." Also, consider using the terminology "scour" where appropriate in this paragraph.

Comment [Clarify90]: Clarification needed: Specify the time frame (e.g., flood event duration).

Comment [Suggest91]: Suggestion: Consider adding a reference to the (fictional) flood hazard reevaluation report so that this statement does not look "unsubstantiated" as part of the integrated assessment.

Comment [Edits92]: Editorial: Based on the title of this question, it seems like it would include more than what is described in the preparer's note.

Comment [NRCedit93]: Clarification needed: Is this footnote intended to apply to the example or to indicate that, generically, it is not expected that any site will require short-term supply of equipment via airlift?

Note that the discussion should include capability of air support to access site or off-site staging areas (which may be challenged by concurrent weather conditions under some flood scenarios) as well as capability to move resources from the staging area to the site.

The ability of the plant to respond to and mitigate the event is strongly dependent on the topography of the site and its environs. As the maximum re-evaluated hazard has been calculated to be 905 ft. , flood mitigation electrical AC supplies have been housed in the SFMS building) outside the protected site area, under the direct control of the utility, with a floor elevation of 915 ft. Section 3 of the IA provides the details of the SFMS building and details. Access to the SFMS facility and mitigation equipment is available from a highway and local roads which will be above the flood elevation. All major bridges between the surrounding community and the town are expected to remain passable for the event duration.

Comment [Suggest94]: Suggestion: Consider discussing (or adding a reference to a document that discusses) whether this affects security.

Comment [Clarify95]: Clarification needed: Would a topo map (or similar figure) be provided in an actual submittal to illustrate or help explain this?

2.5 Long Term Mitigation and Safe Stable State

Comment [Edits96]: Editorial: Would this section be better suited as part of the latter sections of the document (e.g., section 6)? Also, consider using language from the IA ISG (e.g., "sustaining functions indefinitely" could be replaced by "safe and stable plant state that can be maintained indefinitely").

Sustaining functions indefinitely implies the availability of reliable means of satisfying all key safety functions and that no physical/access impediment exists with regard to availability of trained personnel, a continuous means for injection into the RCS and/or steam generator as appropriate, boration capability (as needed) and a source of AC power. In this scenario, mitigation systems to be employed for long term operation may include mobile generators, transformers and associated busses capable of driving redundant injection pumps into the RCS or SG, as appropriate. Indefinite operation also implies that resources exist for the maintenance, repair and operation of the long term mitigation equipment. These features will be supplemented with support from the Regional Resource Centers.

~~8.~~3. Overview of Flood Mitigation Features

-- Preparer's Note --

The intent of this section is meant to describe the flood mitigation features/systems that are relevant to understanding the strategy and ability of the utility to protect the plant from the external flood hazard being evaluated and associated plant capabilities to mitigate the event. The primary focus should be on the systems and components that will be available and utilized to ensure that key reactor safety functions are maintained without the normal and emergency systems that may have become unavailable as a result of the hazard. These safety functions include reactivity control, reactor inventory control, decay heat removal, containment Integrity, and reactor pressure control which are described in detail in Section 6.

It is expected that components and systems have been identified specifically for this scenario and the description provided herein will demonstrate the design attributes and capabilities of the component and systems.~~.~~ It is important to provide functional drawings such as P&ID's, one lines, plan and elevations to aid in fully describing the mitigation features in the scenario evaluation. It is also important that details for equipment ratings, installation details such as mountings, elevations etc., be provided that will aid in demonstrating assurance that the equipment can perform the required function. Section 4.0 of this example will expand upon the component description to discuss reliability aspects of the flood mitigation equipment. This section does not invoke or imply any specific equipment operational requirements but is illustrative for the purpose of the example and provides the user with an indication of the level of detail to be presented.

~~1.~~3.1 Overview

As stated in Section 2, it has been determined that it is not physically possible to provide protection for the existing CLB flood mitigation equipment at the new flood hazard elevation. As part of the flood mitigation strategy, a Severe Flood Mitigation System (SFMS) has been designed to provide mitigation for a flood greater than the current 900 ft. design basis PMF and greater than the recalculated beyond design basis flood hazard of 905 ft. A seismic, tornado proof concrete building designed in accordance with American Society of Civil Engineers (ASCE) Code 7-10 has been built at an elevation of 915ft. and is located above the recalculated flood level and external to any flood plain as shown on Fig.3-1 and Fig. 3.2. This building is designed to house power, control and monitoring equipment components and systems required to maintain the reactor in a safe and stable state. This facility is manned as part of the initial preparations for the event and prior to the onset of flood waters to the site, and is used independently from the main control room should the main control room require evacuation during the event. Access from the plant to the SFMS is provided by pathways at elevation 915 ft., above the recalculated flood hazard level of 905 ft. as shown on Fig.3-1 and Fig. 3.2 and the SFMS has sufficient stores (food, drinking water) to support the required operating staff for a period of 15 days. External access to the SFMS building is from multiple roads that are not within the flood plain and are not

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Comment [Suggest97]: Suggestion: In the preparer's notes for each section in the example, consider adding a reference to the items from the IA ISG that the section is intended to address.

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Comment [Request98]: Request: "seismic, tornado-proof" is not a technically defensible statement. Consider something like "A concrete building designed in accordance with… (which considers …[specify what it means for the seismic and tornado robustness of the building].) has been built…"
Note: It is recognized that this text was added in response to a previous comment that asked what "it meant" to meet the ASCE Code for the building. Perhaps it is better to simply reference the code as originally done.

Comment [Clarify99]: Clarification needed: What conditions cause the control room to be evacuated? At what elevation is the control room located?

Comment [Suggest100]: Suggestion: Consider adding a reference to the (fictional) flood protection evaluation, which likely would have shown these walkways are not susceptible to failure from hydrostatic/dynamic loads, etc.

Comment [Suggest101]: Suggestion: Somewhere in this paragraph, specify whether the SFMS facility is the location from which field personnel will be dispatched… and that the facility is capable of housing personnel, including operators and field personnel (or specifically state if the examples assumes housing personnel it is not necessary). Table 3-1 seems to suggest the building is designed to house personnel when it says "House and protect SFMSDGs, and staff for event duration." However, it is probably worth explicitly mentioning that here.

expected to be flooded, as confirmed by topographical survey. These roads effectively connect the SFMS building with surrounding communities and provide road access for resupply of the SFMS facility (fuel, stores, equipment). A helipad area is also adjacent to the SFMS building to allow ready access for airborne supplies. The facility has connection stations for fuel and electrical power. Building lighting, pathway egress/ingress and ventilation are powered by the SFMS Motor Control Center (MCC). Although not normally manned, the building is monitored by normal operator rounds.

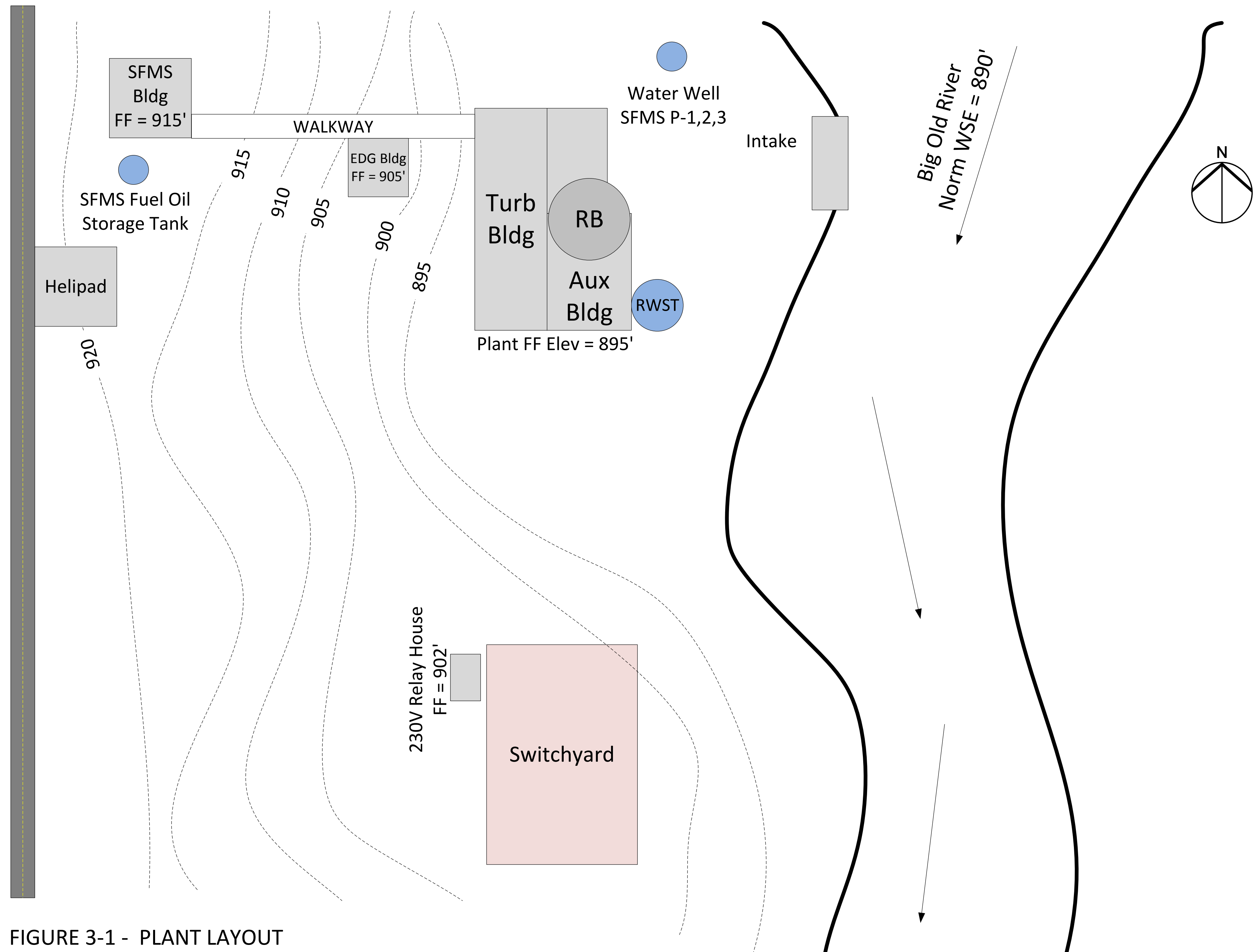

FIGURE 3-1 - PLANT LAYOUT

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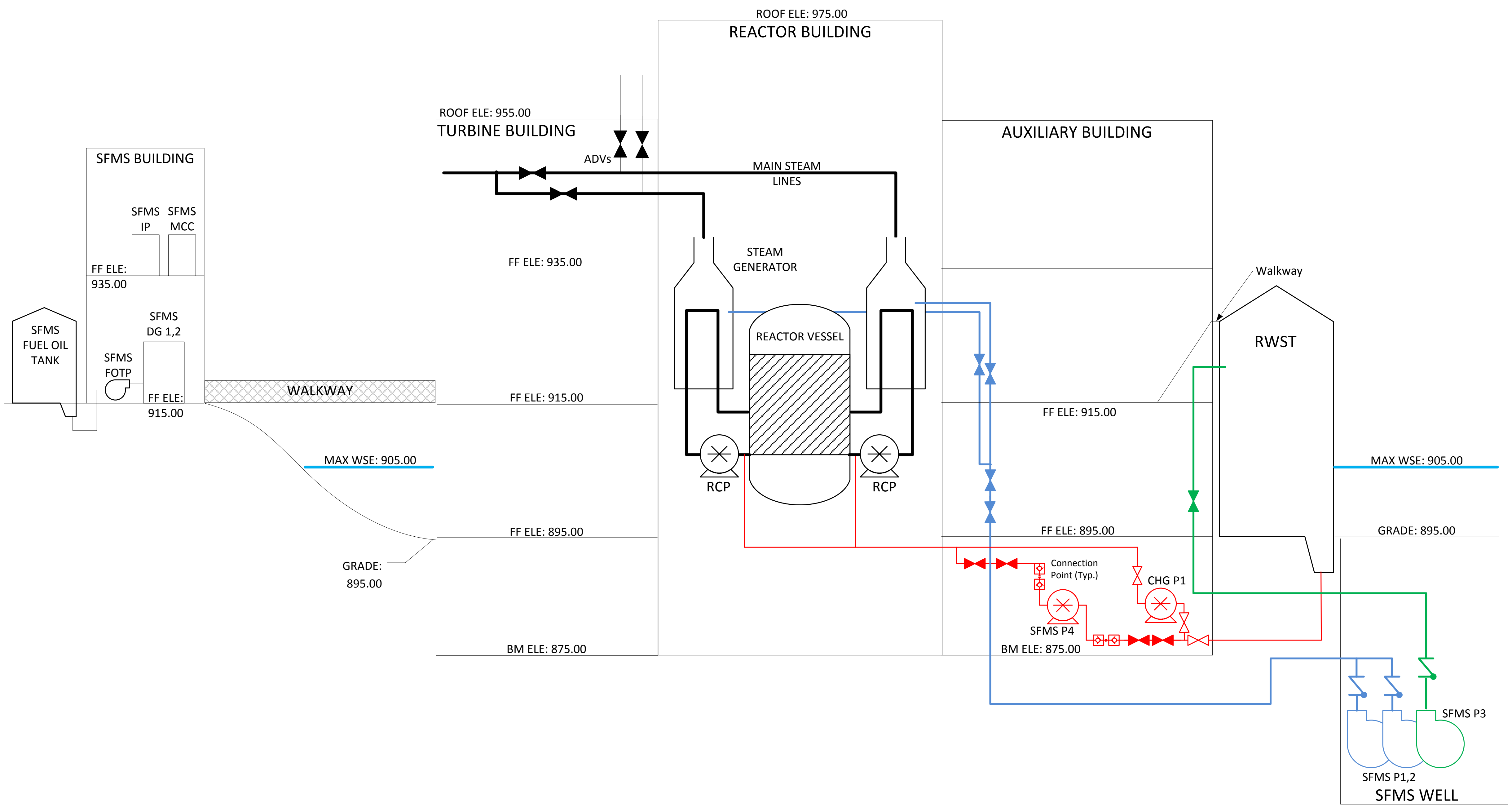
FIGURE 3-2
SIMPLIFIED PLANT ELEVATION DRAWING
Not To Scale



~~2.~~3.2 Severe Flood Mitigation System

The SFMS is presented in Figure 3-3.

Electrical Power

The SFMS consists of the power, controls, pumps, valves, connections and monitoring equipment to maintain the reactor in a safe and stable state. Two (2) air cooled skid mounted self-contained diesel engines powering 500kva 480volt air cooled generators are provided to provide power to all required SFMS components. Each SFMS diesel generator set is designed to provide sufficient capacity, starting kva and voltage to operate all SFMS equipment as well as the lighting, ventilation, and other house loads of the SFMS building. Each SFMS diesel generator set is connected to one (1) 480v, 600amp, SFMS MCC that contains the operating controls for the SFMS components. Only one SFMS diesel generator set is needed and is connectable to the SFMS MCC via a kirk-key, manually operated transfer switch located within the SFMS MCC. Cabling from each SFMS diesel generator set to the SFMS MCC is routed via embedded conduit and raceway completely within the building. The SFMS MCC is normally connected to station power via an underground cable but is disconnected when the SFMS facility is activated and station power is presumed lost via manually opening a circuit breaker at the SFMS MCC. The SFMS MCC services the loads identified in Table3-1.

A 125v, 500 ampere hour SFMS DC battery is provided and is connected to a 125vdc power panel. This panel provides 125vdc power to all required SFMS DC loads. The SFMS 125vdc power panel normally receives power from a 480v/125vdc 250 amp battery charger that is connected to the SFMS MCC. The battery charger is sized to carry the SFMS DC loads and recharge the battery in 12 hours. Should the SFMS MCC fail to provide power to the charger, the battery is designed to meet the required loads for 16 hours. This time is sufficient to allow the alternate SFMS diesel generator set to be connected to the SFMS MCC. All cable connections are routed in embedded conduit or raceway completely within the SFMS building.

A 120vac 5kva SFMS inverter is also provided. The SFMS inverter is connected to the 125vdc SFMS power panel and provides power directly to a 120vac power panel that in turn provides power to the SFMS instrumentation loads. All cable connections are routed in embedded conduit or raceway within the SFMS building.

A simplified one line diagram illustrating the SFMS electrical system is shown in Fig.3-3.

All equipment housed within the SFMS facility has been procured commercial grade and are part of the plants normal operational, maintenance and engineering programs (see Section 4). Additionally, spare equipment (multiple spare connectors and cables) are available and accessible during the flood.

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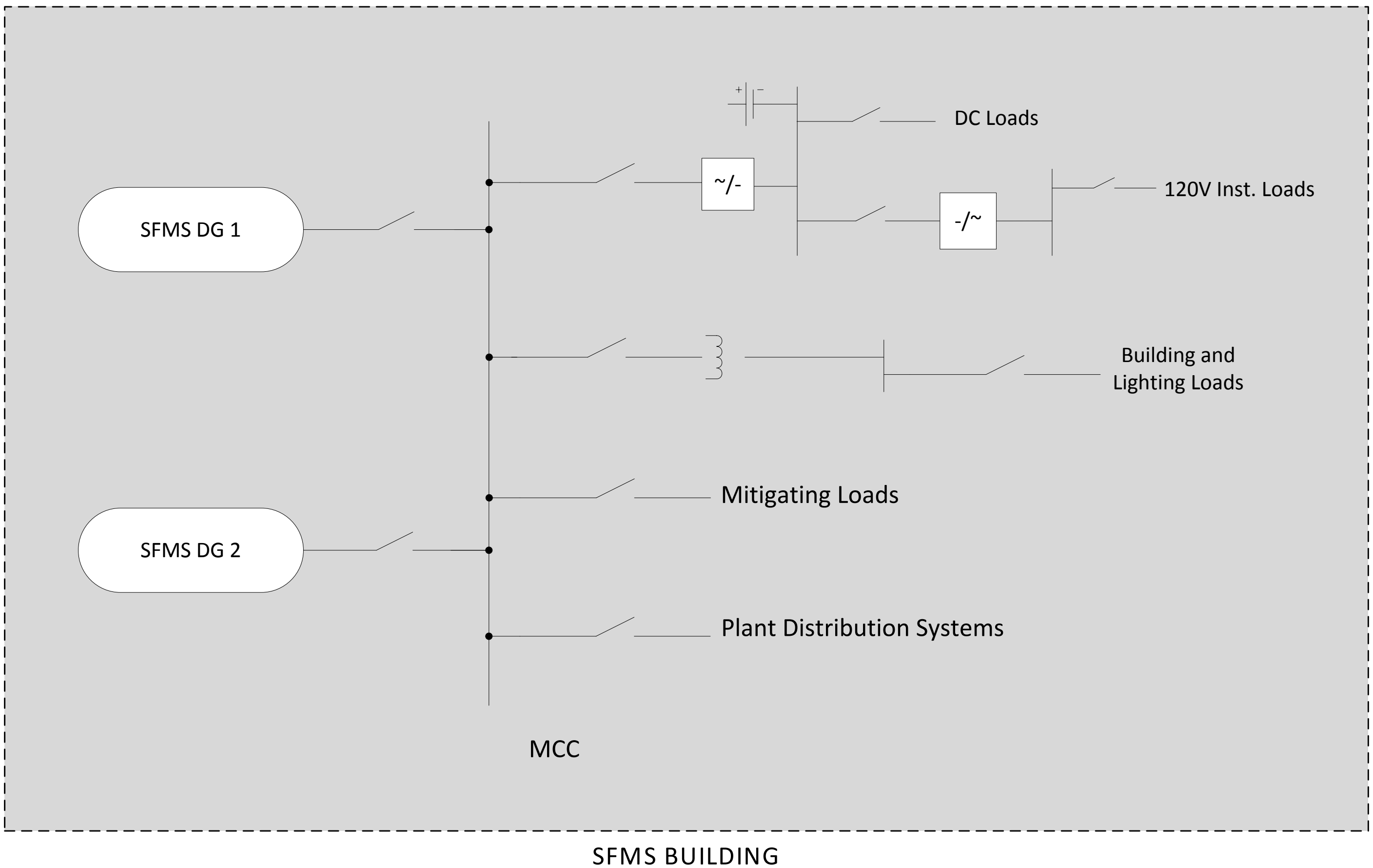
Comment [Edits102]: Editorial: This may not be a well-known term.

Comment [Clarify103]: Clarification needed: Is this sentence referencing the connection to supply normal house loads to the SFMS building?

Comment [Clarify104]: Clarification needed: Is this step intended to be a deliberate disconnect during the startup sequencing for the flood event? Is it intended that the SFMS be available to provide power when there is no flooding? Figure 3-3 indicates the possibility of powering other load sets. 3-1

Comment [Suggest105]: Suggestion: Clarify what is meant by "accessible."

FIGURE 3-3 – Simplified Diagram of SFMS Electrical Distribution



Decay Heat Removal and RCS Inventory Control

In order to provide decay heat removal during this event, two (2) submersible 250gpm centrifugal SFMS pumps 1 and 2 have been provided to take suction from two (2) wells located on the flood plain evaluated to have sufficient capacity to meet the inventory requirements of the event. Each SFMS pump has sufficient capacity to provide up to three (3) times that necessary to remove decay heat in excess of 12 hours after shutdown. Piping is installed between the SFMS pumps and steam generator feed lines such that each well pump feeds one steam generator. Delivery to the steam generators is effected by injection through a tee connection to the AFW Lines. Two manually operated valves are provided to isolate the piping connection inlet flange from the AFW lines.

The SFMS pumps are powered from the SFMS MCC located in the SFMS building and are electrically connected via approximately 2000ft. of 4/0 AWG cable installed in underground duct bank. The conduits within the underground duct bank are sealed at the last manhole and at the building entrance to preclude any water path into the building.

To provide makeup to the RCS, an installed 25 gpm positive displacement SFMS pump 4 is provided. The pump is connected to the RCS by a pipe and manual valve scheme that allows the SFMS pump 4 to take suction from the suction side of the existing charging pump (Refueling Water Storage Tank (RWST)) and pump into the discharge of the existing charging pump (RCS). The SFMS pump 4 is powered by a 7.5hp 460v motor and is connected to the 480v SFMS MCC via 2- 1/c # 8 AWG in sealed underground duct. Alignment of SFMS pump 4 to the RCS is as per procedure AOP XXX. Prior to the flood reaching the site, the RWST is filled with borated water per plant technical specifications. To provide water to the RWST, a 50 gpm centrifugal SFMS pump 3 has been provided to take suction from a well located on the flood plain. The SFMS pump 3 is powered by a 15hp 460v motor connected to the 480v SFMS MCC via 2-1/c #6 AWG in sealed underground duct and is controlled from the SFMS MCC. Alignment of SFMS pump 4 is also covered by procedure AOP XXX. Boric Acid crystals can be added to the RWST via an upper man way to the tank in accordance with plant procedure AOP XXX. A simplified diagram of the SFMS feedwater and RCS make up systems is provided in Fig. 3-4.

Instrumentation and Control

Instrumentation required to monitor the RCS, and decay heat removal parameters is provided on the SFMS Instrument panel located in the SFMS facility. Two channels each of Steam Generator Level, Steam Generator Pressure, RCS Pressure, RCS Temperature and Containment Pressure are provided on the panel. The panel receives power from the 125vdc SFMS panel and the 120v SFMS inverter system. The system is completely contained within the SFMS building with exception of the incoming channel cables which enter the building in underground sealed duct. Control of the SFMS components is from the SFMS MCC via start/stop switches on the SFMS MCC doors.

Diesel Fuel Oil Supply System

Each SFMS DG is provided with a 75 gallon tank mounted on the SFMS DG skid. Each fuel tank can be resupplied via connections to a 10,000 gallon Fuel Oil Storage Tank located outside the SFMS building.

Comment [Clarify106]: Clarification needed: The figures seem to show that there is one well with three pumps, whereas this text references two pumps.
Also, consider including the yield of the well-pumps or providing a reference to a different evaluation that has already addressed this issue.

Comment [Request107]: Request: Add reference to the flood protection evaluation (or other existing evaluation) where the seals would have been demonstrated capable of withstanding the reevaluated flood hazard. Ex: "The conduits within the underground duct bank are sealed at the last manhole and at the building entrance to preclude any water path into the building. The seals have been demonstrated to be able to withstand the reevaluated flood hazard as part of the flood protection evaluation in the integrated assessment."

Comment [Suggest108]: Suggestion: Describe where the pump is located (e.g., elevation) and why the pump will be available if inundated. Section 4.4 refers to the pump being submersible, but it would be helpful to state as such here.

Comment [Edits109]: Editorial: Clarify which upper manway is being referred to (e.g., through reference to figure 3-2).

Comment [Suggest110]: Suggestion: For consistency, ensure all instrumentation in Table 3-1 is mentioned here (e.g., Add PZR level instrumentation).

Comment [Clarify111]: Clarification needed: Is transfer to refill the daytank automatic?

Comment [Suggest112]: Suggestion: Consider adding the amount of time "run-time" this provides. Ex: "Each SFMS DG is provided with a [x] gallon tank mounted on the SFMS DG skid, which is sufficient to run the DGs for [x] hours." Or include references to other (fictional) documents that provide that information.

Fuel supplies to the SFMS DGs can be cross tied. Power to the fuel oil transfer pumps is from the SFMS MCC and is controlled from the SFMS MCC or thru an external, local control station adjacent to the 10,000 gallons SFMS tank. Several contracts with local fuel oil dealers are in effect that would allow transport of a fuel oil truck with [X] gallons of fuel to be provided to the site on [x] hours notice. The tanker truck is to be parked in a lot outside of the SFMS building and serves as the long term fuel oil makeup for the external fuel oil tank or may be directly connected to the SFMS oil fill line. The fuel oil level is read from a sight gauge within the SFMS facility on the day tank and fuel oil storage tank.

Table 3-1

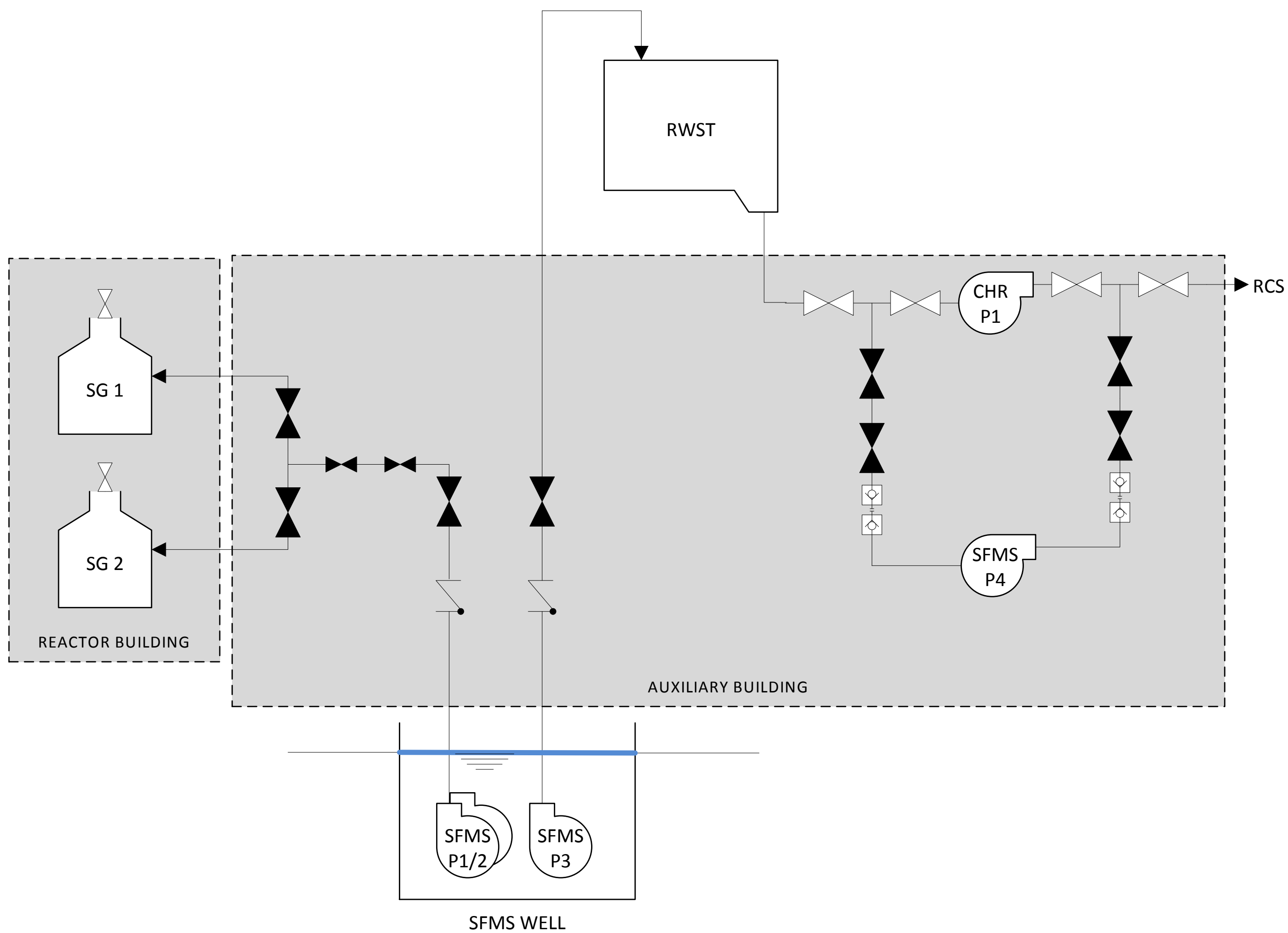
Functional Description of Severe Flood Mitigation System (SFMS)

Component	**Function**
Two 250 gpm capacity SFMS well water pumps 1&2 and piping	Redundant SG makeup capability
One 50 gpm capacity SFMS well water pump 3 and piping	Makeup to RWST
One 25 gpm positive displacement SFMS pump 4 and piping	RCS Makeup
SFMS Fuel oil pump and hoses	Transfer of fuel from external tank / truck to day tank
Well and groundwater	Water source for SG feed
Two SFMS Diesel Generators (redundant power supply)	To provide emergency AC power following an SBO
SFMS Motor Control Center and Power Distribution Panels	Power distribution and connection to SFMS AC loads
SFMS Battery and Charger	Power distribution and connection to SFMS DC loads
SFMS 120V Inverter	Power distribution and connection to SFMS uninterruptible loads
SG ADVs/MSSVs	Used for steam relief paths
Mechanical gauging devices/equipment	Keep ADV/MSSVs open
Manual valves	Complete connection between SFMS well pumps 1,2 and 3, SG feed and RWST connection; connection of the SFMS makeup pump 4 to the RCS.
SFMS Building	House and protect SFMSDGs, and staff for event duration.
SFMS Well Pumps 1,2 &3 and SFMS Make-up pump 4 discharge flowmeters	Devices to confirm continued effectiveness of strategy
DG Fuel Level (Local on tank.)	Monitor SFMSDG Fuel Oil Level
Commodities • Food • Potable water	Support for site personnel
Instrument Panel • SG Level and Pressure • RCS Temperature and Pressure • Containment Pressure • Pressurizer Level • Refueling Water Storage Tank Level	Instrument feed routed to and displayed at SFMS facility

Comment [Edits113]: Editorial: It would be helpful if the terminology used in the different tables was consistent or a unique numerical identifier was used consistently. For example, different names/words are used in different tables (and the text) to refer to the same equipment:

Table	DGs	Pumps
Table 3-1	Two SFMS Diesel Generators (redundant power supply)	Two 250 gpm capacity SFMS well water pumps 1&2 and piping One 50 gpm capacity SFMS well water pump 3 and piping
Table 4-1	Diesel Generators SFMS DG 1&2	Submersible Well Water Pumps SFMS 1,2,&3
Table 4-1A,B	SFMS Diesel Generators	Submersible Well Water Pumps 1,2,&3
Table 4-2	SFMS Diesel Generators	SFMS Well Water Pumps
Table 4-3	SFMS DG-1/2	SFMS P-1,2,3,4
Table 4-4	SFMS DG-1&2	SFMS P-1,2,&3

FIGURE 3-4 – Simplified Diagram of SFMS Auxiliary Water Distribution



~~9.~~4. System Capability/Reliability Assessment

Comment [Request114]: Request: The integrated assessment ISG Section A.1.2.1 includes the following:

The availability and reliability of active components (e.g., pumps, valves) should be justified using:

- *operational data*
- *performance criteria (e.g., see Table A1)*
- *consideration of operational requirements:*
  - *surveillance*
  - *inspection*
  - *design control*
  - *maintenance*
  - *procurement*
  - *testing and test control*

If applicable, licensees should further use the following to justify the availability and reliability of active components and features:

- *incorporation of equipment in plant programs (e.g., whether the component is included in established plant equipment reliability programs or subject to 10 CFR Part 50, Appendix B)*
- *conformance to consensus standard developed for similar uses, including emergency uses (e.g., standards developed by the National Fire Protection Association for fire protection equipment)*

In addition, when information is available, the reliability of active components (e.g., failure to start on demand and failure to run once started) should be quantitatively evaluated and documented based on operating experience, testing, and other available information using traditional probabilistic risk assessment or statistical techniques. In some cases, this information may not be available. In this case, tests or analyses may be appropriate to support quantification of reliability. If information is not available and testing is not feasible, the integrated assessment submittal should: (1) describe why quantification of equipment reliability is not possible or necessary; and (2) justify why the equipment can be reasonably credited despite these limitations.

It is not clear to staff that all aspects of Section A.1.2.1 are addressed in the example and it does not appear that the user would understand all the considerations that should be applied.

Editorial suggestion to address above request:
To ensure that all sections are addressed by the user in an actual submittal (even if a particular criteria is not addressed in the example), consider including separate subsections for each item.
Ex:
4.1 Overview
4.2 Operational data
4.3 Performance criteria [this is where table A-1 would be included]
4.4 Incorporation in existing plant programs (if applicable)
...

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--- Preparer's Note ---

A detailed evaluation, in accordance with Appendix A of JLD-ISG-2012-05, should be provided for each component or class of components that are required to change state and not part of normal plant safety related equipment. A typical list of components for this example is provided below. However, only a small set of components (the first 3 components of Table 4-1) were fully evaluated for the purpose of this example. The following is a representation as to what may be included in the remainder of the reliability assessment section. In the table below, the parenthetical "not provided in example" will be required information for a complete IA but will not be included in this example.

--- --------------------- ---

This section provides the technical support for assessing the capability and reliability of the key components credited in the current scenario.

4.1 Severe Flood Mitigation System Reliability Assessment

Each active component or class of components included in the mitigation system is included in Table 4-1. The components shown include all components that change state or are required to be positioned prior to use. These components are then compared with the criteria included in Table A.1 of Appendix A of the ISG. Tables 4-1A through 4-1C illustrate the component's capability assessment and reliability assessment of key active components is provided in Tables 4-2.

A review of Table A.1 of the ISG indicates that all the functional, operational, unavailability and storage characteristics expectation are met (See Tables 4-1A, 4-1B, and 4-1C below). The following is an example as to what may be included in the remainder of the reliability assessment section. The only component that does not have a table provided in the section below is the ADVs. These will be operated well in advance of the flood water arrival and all normal plant equipment will be available. Therefore, it is concluded to be highly reliable.

All components supporting the mitigation of severe floods are maintained to ensure that the equipment is reliable and available. To ensure these components are periodically maintained, surveilled, and tested, they are included within plant maintenance programs.

Comment [Suggest115]: Suggestion: In the preparer's notes for each section in the example, consider adding a reference to the items from the IA ISG that the section is intended to address.

For example, this section of the example is intended to address the following items section 7.2 of the IA ISG:

- An evaluation of the reliability of active components
- Demonstrate that any credited equipment will be functional, available, and accessible when needed (e.g., that it is located above the flood elevation or is protected by flood protection that is reliable and has margin), throughout the entire flood event duration, and that it can be deployed when necessary.
- Justify the availability and reliability of each active component as described in Section A.1.2.1 of Appendix A to this guidance.
- Qualitatively assess operational requirements such as surveillance, inspection, design control, maintenance, procurement, and testing (e.g., whether or not equipment is included in established plant equipment reliability programs).
- Demonstrate that all credited equipment and features (e.g., engineered structures, pumps, and other components) are capable of performing their design function and that they have the appropriate factors of safety.
- Consider other quantitative and qualitative attributes that provide confidence in the reliability of equipment, availability of resources, and feasibility and reliability of any credited actions.

Table 4-1
Active Components Credited in SFMS Design

Component	Number	Manufacturer Identification /Plant ID	Table
Diesel Generators SFMS DG 1&2	2		See Table 4-2X
Submersible Well Water Pumps SFMS 1,2,&3	3		See Table 4-2X
Portable RCS Make Up Pump SFMS 4	1		See Table 4-2X
SFMS Battery and Charger	1		See Table 4-2X (Not provided in example)
Inverter	1		See Table 4-2X (Not provided in example)
SFMS MCC Breakers, Controls and Monitoring Meters	1	Generic item	See Table 4-2X (Not provided in example)
SFMS Distribution Panel Breakers	3		See Table 4-2X (Not provided in example)
Installed Lighting (plant egress/ingress and SFMS)	Various	Generic Plant Item	See Table 4-2X (Not provided in example)
Portable Lighting	Various		See Table 4-2X (Not provided in example)
SFMS Instrumentation Panel with instruments	1		See Table 4-2X (Not provided in example)
Manual Valves (connection points)	9		See Table 4-2X (Not provided in example)
SFMS Diesel Fuel Oil Transfer Pump	1		See Table 4-2X (Not provided in example)
ADVs/MSSVs	2		Components will be actuated under normal plant conditions and operated within design limits.

Comment [Clarify116]: Clarification needed: Given that the pumps have different capacities, is it appropriate to include them as a single line item in this table?

Table 4-1A
Assessment of Active Components
Comparison of System Capability to Table A.1 of JDL-2012-ISG-05 Appendix A
(EXAMPLE TABLE)

Table 4-1A
Assessment of Active Components
Comparison of System Capability to Table A.1 of JDL-2012-ISG-05 Appendix A
(EXAMPLE TABLE)

Component: **SFMS Diesel Generators**

Functional characteristics 1. Equipment is capable of performing its required function (e.g., functional requirements such as pump flow rate, pump discharge pressure are met).	Each SFMSDG is sized to power all required loads on the SFMS MCCwith 25% margin. Functional characteristics of DG is included in [Appendix] SFMSDGs are air cooled and have no external dependency other than fuel. Each SFMS DG is redunedant to each other and key components and repair manuals are available within the SFMS facility should on site repair be needed Compatible DGs are available at Resource Center for replacement should that be necessary.
2. Equipment is in satisfactory condition.	SFMSDG is maintained per manufacturer's specifications Functional tests occur every [ ] per Procedure XX to ensure functionality. One full system functional test is conducted annually. Performance testing occurs every [ ] per procedure. Maintenance and testing at this frequency is intended to ensure high reliability of components
3. Functionality of the equipment may be outside the manufacturer's specifications if a documented engineering evaluation justifies that the equipment will be functional when needed during the flood event duration.	Equipment is commercial grade and will be operated within manufacturer's specifications. **[Preparer: Note any exceptions].** Equipment tested periodically (See above).
4. There is an engineering basis for the functional requirements for the equipment which: 1. Is auditable and inspectable; 2. is consistent with generally accepted engineering principles; 3. defines incorporated functional margin; and 4. is controlled within the configuration document control system.	DG functional requirements Controlled by Engineering Processes. [Note procedures and support/sizing calculations are provided in the reference section]] After 3 days, replacement DGs and pumps will be available
Operational Characteristics 1. Equipment is covered by one of the following: a. existing quality assurance (QA) requirements in Appendix B of 10 CFR Part 50; existing fire protection QA programs; or b. a separate program that provides assurance that equipment is tested, maintained, and operated so that it will function as intended and that equipment reliability is achieved. 2. Testing (including surveillances)	**[Provide manufacturer characteristics data and DG loading.]** See Appendix Equipment is covered under a separate classification within the plants maintenance program that provides assurance that equipment is tested, maintained, and operated so that it will function as intended and that equipment reliability is achieved. Applicable procedures include: **[List]**

Comment [Suggest117]: Suggestion: Add dependency on air and ventilation/cooling.

Comment [Suggest118]: Suggestion: Explain what is meant by "key components?"

Comment [Clarify119]: Clarification needed: The RRCs are assumed available after 72 hrs. What is the implications of the RRCs for the equipment in the first 72hrs?

Comment [Clarify120]: Clarification needed: What does this statement mean? Is this referring to the RRCs available after 72hrs?

Table 4-1A
Assessment of Active Components
Comparison of System Capability to Table A.1 of JDL-2012-ISG-05 Appendix A
(EXAMPLE TABLE)

a. Equipment is initially tested or other reasonable means should be used to verify that its performance conforms to the limiting performance requirements. b. Periodic tests and test frequency are determined based upon equipment type and expected use. Testing is done to verify design requirements and basis are met. The basis is documented and deviations from vendor recommendations and applicable standards should be justified. c. Periodic inspections address storage and standby conditions as well as in-service conditions (if applicable). d. Equipment issues identified through testing are incorporated into the corrective action program and failures are included in the operating history of the component. 3. Preventive maintenance (including inspections) a. Preventive maintenance (including tasks and task intervals) is determined based upon equipment type and expected use. b. The basis is documented and deviations from vendor recommendations and applicable standards should be justified. c. Periodic testing addresses storage and standby conditions a well as in-service conditions (if applicable) d. Equipment issues identified through inspections are incorporated into the corrective action program and failures are included in the operating history of the component.	Equipment is initially tested to verify that its performance conforms to the limiting performance requirements (See Procedure XXX, state requirements SFMSDGs are subjected to a [quarterly sequential] test program (Procedure Xxx). Testing is done to verify system functionality (i.e., component starts and runs for [ ] hours). Test program designed to avoid excessive SFMSDG wear. The basis for the test program is contained documented in Reference XX. No deviations from vendor recommendations and applicable standards are taken. Preventive maintenance is performed in accordance with manufacturer's specifications. Administrative controls exist such that Equipment issues identified through testing or inspections are incorporated into the corrective action program and failures are included in the operating history of the component.
Unavailability Characteristics 1. The unavailability of equipment should be managed such that loss of capability is minimized. Appropriate and justifiable unavailability time limits are defined as well as remedial actions. A replacement would be for equipment that is expected to be unavailable in excess of this time limit or when a flood event is forecasted. 2. A spare parts strategy supports availability considerations. 3. The unavailability of installed plant equipment is controlled under existing plant processes such as technical specifications.	Unavailability of any one SFMSDG is limited to [x] weeks. Note during low reservoir water conditions and with communication from the dam owner longer outages may be established. Unavailability under no circumstances (without replacement) will exceed [x] weeks. To minimize time for repair adequate spare parts for active components are maintained in a storage area adjacent to the SFMS building.
Equipment storage characteristics 1. Portable equipment is stored and maintained to ensure that it does not degrade while being stored and that it is accessible for maintenance and testing. 2. Credited active equipment is protected from flooding. It is accessible during a flooding event. Alternatively, credited active equipment may be stored in locations that are	The SFMSDGs are located in a building designed to ASCE 7-10 located at 915 ft. elevation (above maximum elevation of re-evaluated hazard SFMSDG are permanently installed and positioned in an operational condition within the SFMS structure. Transportation considerations are therefore not applicable. Actions to implement the system are discussed in Section 7.

Comment [NRCedit121]: Editorial: Consider replacing with a generic placeholder (e.g., [x])

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Table 4-1A **Assessment of Active Components** **Comparison of System Capability to Table A.1 of JDL-2012-ISG-05 Appendix A** **(EXAMPLE TABLE)**	
neither protected from flooding nor accessible during a flood if adequate warning of an impending flood is available and equipment can be relocated prior to inundation. a. Consideration should be given to the transport from the storage area recognizing that flooding can result in obstacles restricting normal pathways for movement. b. Manual actions associated with relocation of equipment should be evaluated as feasible and reliable (see Appendix C to the ISG guidance). 3. A technical basis is developed for equipment storage that provides the inputs, assumptions, and documented basis that the equipment will be protected from flood scenario parameters such that the equipment could be operated in place, if applicable, or moved to its deployment locations. This basis is auditable, consistent with generally accepted engineering principles, and controlled within the configuration document control system.	

Table 4-1B **Assessment of Active Components** **Comparison of System Capability to Table A.1 of JDL-2012-ISG-05 Appendix A** **(EXAMPLE TABLE)**	
Component: Submersible Well Water Pumps 1,2,&3	
Functional characteristics 1. Equipment is capable of performing its required function (e.g., functional requirements such as pump flow rate, pump discharge pressure are met).	**To be Completed by Utility**
2. Equipment is in satisfactory condition.	
3. Functionality of the equipment may be outside the manufacturer's specifications if a documented engineering evaluation justifies that the equipment will be functional when needed during the flood event duration.	
4. There is an engineering basis for the functional requirements for the equipment which: ~~1.~~a. Is auditable and inspectable; ~~2.~~b. is consistent with generally accepted engineering principles; ~~3.~~c. defines incorporated functional margin; and ~~4.~~d. is controlled within the configuration document control system.	
Operational Characteristics 1. Equipment is covered by one of the following: ~~1.~~a. existing Quality Assurance (QA) requirements in Appendix B of 10 CFR Part 50; existing fire protection QA programs; or ~~2.~~b. a separate program that provides assurance that equipment ~~3.~~c. is tested, maintained, and operated so that it will function as intended and that equipment reliability is achieved. ~~4.~~2. Testing (including surveillances) ~~1.~~a. Equipment is initially tested or other reasonable means should be used to verify that its performance conforms to the limiting performance requirements. ~~2.~~b. Periodic tests and test frequency are determined	

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Table 4-1B Assessment of Active Components Comparison of System Capability to Table A.1 of JDL-2012-ISG-05 Appendix A (EXAMPLE TABLE)	
based upon equipment type and expected use. Testing is done to verify design requirements and basis are met. The basis is documented and deviations from vendor recommendations and applicable standards should be justified. ~~3.~~c. Periodic inspections address storage and standby conditions as well as in-service conditions (if applicable). ~~4.~~d. Equipment issues identified through testing are incorporated into the corrective action program and failures are included in the operating history of the component. ~~5.~~3. Preventive maintenance (including inspections) ~~1.~~a. Preventive maintenance (including tasks and task intervals) is determined based upon equipment type and expected use. ~~2.~~b. The basis is documented and deviations from vendor recommendations and applicable standards should be justified. ~~1.~~a. Periodic testing addresses storage and standby conditions as well as in-service conditions (if applicable). ~~3.~~c. Equipment issues identified through inspections are incorporated into the corrective action program and failures are included in the operating history of the component.	
Unavailability Characteristics	
Equipment storage characteristics	

Table 4-1C **Assessment of Active Components** **Comparison of System Capability to Table A.1 of JDL-2012-ISG-05 Appendix A** **(EXAMPLE TABLE)**	
Component: **Special Tools. Special tools include mechanical devices for opening MSSVs, and mechanical equipment for locking open/blocking ADV/MSSV closure**	
Functional characteristics 1. Equipment is capable of performing its required function (e.g., functional requirements such as pump flow rate, pump discharge pressure are met).	Mechanical device is designed and tested to perform its intended function. Design details of these special tools are included in Engineering Calculation XXXXX.
2. Equipment is in satisfactory condition.	Special tools associated with supporting the severe flood program are maintained by procedure MST-XXX, stored in a protective manner and surveilled x times per year. Use of special tools/components is demonstrated during yearly severe flood drills.
3. Functionality of the equipment may be outside the manufacturer's specifications if a documented engineering evaluation justifies that the equipment will be functional when needed during the flood event duration.	Not applicable
4. There is an engineering basis for the functional requirements for the equipment which: ~~1.~~a. Is auditable and inspectable; ~~2.~~b. is consistent with generally accepted engineering principles; ~~3.~~c. defines incorporated functional margin; and ~~4.~~d. is controlled within the configuration document control system.	Design details for components are identified in the following Engineering Calculations : ~~1.~~• Engineering Calculation -XXXXX-XXXX Equipment is included within the plant maintenance program which includes procedures for routine maintenance, periodic surveillance and implementation (see above).
Operational Characteristics	Not applicable
Unavailability Characteristics	Equipment tagged and stored in TB and is only used for this single function. Likelihood of a repair condition is very low for this component, Therefore unavailability is low.
Equipment storage characteristics	Stored in a readily accessible locked bin. Key to bin is available in the control room. Metal clippers are available if necessary for backup access. Transport to location of use will be performed while site remains dry. No obstacles expected. Transport via site pick-up trucks.

[Add additional tables, as needed]

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2 Maintenance, Testing and Survaillance

-- Preparer's Note --

This section provides important highlights of the programs for equipment relied upon to support the external flood mitigation strategy. INCLUDE LISTING and brief description of relevant aspects OF MAINTENANCE, TESTING / Surveillance AND IMPLEMENTATION PROCEDURES USED IN PREPARING FLOOD MITIGATION EQUIPMENT.

Any standards or references used to demonstrate reliability should be verified to be the latest version, if available.

-- -------------------- --

All components used for the flood mitigation process are commercial grade, and operated within expected component capacities. Components are non-safety grade, but are maintained in accordance with a site program for equipment important to safety. Components receive periodic preventive maintenance in accordance with manufacturer specifications. Active components are tested [annually], prior to flood season, to ensure system is operational and can be operated within expectations.

An adequate supply of replacement parts (or spare components) is available on site to address any operational failures. Plant staff has the necessary skills and training to implement any repairs/replacements. Repair parts are stored in a flood and seismically secure location and can be accessible within a short time of their need. As a consequence of the equipment and spare part availability, long term failures of active components used for decay heat removal are not considered risk significant. Table 4-2 provides a summary of the maintenance, testing and surveillance programs governing the use these systems and components.

Table 4-2
List of Governing Procedures

System/Component	Maintenance Procedures	Surveillance /Testing
SSCs used to support normal operation and shutdown (e.g. SDC system, Instrument air compressors, etc.)	Equipment treatment consistent with 10CFR50.65. Specific maintenance procedures include MA-XXX, etc.	Surveillance and testing consistent with applicable codes and standards, technical specification requirements and other regulatory restrictions for specific equipment
SFMS	Maintenance procedures invoked based on type of component and manufacturer recommendations.	ST-SFMS-XXX provides overall system surveillance and test requirements for the integral system and strategy.
SFMS Diesel Generators	MA-SFMS-EDG-XXX. Includes instructions to check,lubricate,replace key components based on manufacturer recommendations	ST-EDG-XXX. Procedure includes staggered [quarterly] testing of DGability to start and run for [30] minutes. One [24] hour DG is performed [yearly].

Comment [Clarify122]: Clarification needed: Does "within expected component capacities" mean "within manufacturers' capacities/specifications"?

Comment [Suggest123]: Suggestion: Include a placeholder to show that the name of the program (or some sort of reference) should be included in an actual submittal.

Comment [Suggest124]: Suggestion: Consider adding a footnote that a sunny-day failure is not related to flood season (even though the equipment is tested prior to a that time).

Comment [Clarify125]: Clarification needed: Where on site? In an accessible area?

Comment [Clarify126]: Clarification needed: "any operational failure" seems like a very broad claim. Please explain.

Comment [Clarify127]: Clarification needed: What is meant by "short time?"

Comment [Clarify128]: Clarification needed: It is not clear what is meant by "long term failure" not being "risk significant." For example, is "long-term" relative to the flood event duration or relative to the maintenance cycle? Moreover, failure of components involved in the flood mitigation strategy necessarily will increase the risk associated with the event.

Comment [Suggest129]: Suggestion: Specify which codes and standard (or put in placeholder text that indicates that such information should be provided) or consider a reference to other documents that describe the codes and standards.

Table 4-2 List of Governing Procedures		
System/Component	Maintenance Procedures	Surveillance /Testing
	to ensure high reliability.	
SFMS Well Water Pumps	MA-SFMS-WWP-XXX	ST-WWP-XXX. WWPs are tested for ability to start periodically and maintained periodically refurbished during low challenge seasons
DG Fuel Oil and FOTP	MA-SFMS-FOTP-XXX	ST-FOTP-XXX. Oil quality checked [monthly]. FOTP and associated lines checked to ensure clear of debris and functional

4.3 Component Reliability Estimates

--- Preparer's Note ---

This section provides available quantitative information on the reliability of components involved in the successful operation of the SFMS. Information reported in this section includes estimates of component failure to start (per demand) and run time failure rates. This information may be established from information available from the equipment manufacturer, data obtained from generic reliability data books on similar components operated in similar environments and may be Bayesian updated based on past experience with these or similar components. Reliability estimates should consider the component operational environment, any relevant plant operational experience and maintenance regimen.

It should also be noted that the plant equipment used for extreme flood mitigation may not have sufficient reliability data and it may not be as rigorously developed as nuclear grade safety related equipment. Therefore, the information shown in this section should only be provided if it is available and applicable.

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Tables 4-1a through 4-1x provide a qualitative process for confirming that equipment assigned to external flood mitigation have high reliability and availability. Section 4-2 identifies the various programs that define the treatment regime for these components and highlights the key aspects of those specific programs. While reliability of these components is expected to be high, no specific reliability values or component failure rates are identified. This section provides estimates of the component failure rates. While normal plant SSCs are tracked on plant specific and industry-wide bases, considerable information is available for estimation of component reliability. However, many of the components used in the SFMS are new to nuclear plant applications and may not have the advantage of a pedigreed reliability database. Where available, applicable manufacturer provided reliabilities are

Comment [Request130]: Request: Note that the integrated assessment ISG (section A1.2.1) states what should be provided if reliability cannot be quantified:
"In this case, tests or analyses may be appropriate to support quantification of reliability. If information is not available and testing is not feasible, the integrated assessment submittal should: (1) describe why quantification of equipment reliability is not possible or necessary; and (2) justify why the equipment can be reasonably credited despite these limitations."

reported. However, for many active components of the SFMS no specific reliability values are available. In those instances, reliabilities of key active components are obtained from generic estimates of commercial grade equipment of similar classes and sized components. The reliability estimates for SFMS components are presented in Table 4-3. Use of commercial grade component reliability data is judged to overestimate failure rates for nuclear applications as these components will be subject to improved maintenance, surveillance and test programs.

Table 4-3
Reliability Evaluation of Key Systems/Components Credited in Flood Mitigation System Design

Component	Failure Rate	Basis
SFMS P-1,2,3,4	1x 10^{-4}/hour	Mean failure rate based on generic value estimated from operation of low pressure, low flow, low pressure electric driven pumps. Considers data from IEEE, NPRDS and ORECA.
SFMS P-1,2,3,4	0.001	Manufacturer provided information. The pumps are subject to plant testing and maintenance program (see Table 4-2).
SFMS DG-1/2 fail to run	5 x10^{-5}/hr	Mean failure rate based on generic failure values of low voltage, low power DG. Considers data from IEEE, NPRDS and ORECA.
SFMS DG-1/2 fail to start	0.01	Mean failure to start based on engineering judgment. SFDG included in periodic maintenance program.
Failure rate of Electrical cable or connectors	--	Specific reliability of components are unavailable however, reliability traditionally very high.
Failure of SFMS Storage Tank) to Feed SFMSDG (manual valve fails to open)	0.001	Manual valve connection. Typical of Generic data. Valves surveilled routinely and tested periodically.

Comment [Suggest131]: Observation: Staff observed that these failures rates appear to be low. Consider data available, for example, in NUREG/CR-6928 (e.g., Table 5-1 from the document)

Comment [Clarify132]: Clarification needed: Specify what this failure rate is this intended to show (e.g., failure to run for each individual pump, common cause, something else?)

Comment [Clarify133]: Clarification needed: Specify what this failure rate is intended to show (e.g., failure to start for an individual pump?)

Comment [Suggest134]: Suggestion: Connector and cable failure rates are rarely used, but switches and breakers may be more appropriate.

4.4 Equipment Dependencies

Knowledge of equipment dependencies is important in assessing overall system reliability and in identifying potential common cause issues. Equipment dependencies associated with components in the flood mitigation strategies have been identified for the following components:

ADVs
SFMS DGs (SFMS DG-1,2)
Well water pumps (SFMS P-1,2,3)
Instrumentation

These dependencies are identified in Table 4-4 below.

Atmospheric Dump Valves: Atmospheric dump valves are used to depressurize the SGs and cool down the RCS in a controlled manner. The ADVs are opened by air operated valves that receive air supply from the normal instrument air (IA) system. In preparation for a flood event, the ADVs will be opened and mechanically prevented from closing via use of specially designed tool prior to the flood waters reaching the site.

SFMS DGs (SFMS DG-1,2): The operability of SFMS DGs are critical to the flood mitigation strategy. The DGs are air cooled and may be started using a self-contained starter system. DGs are run on standard diesel fuel. An adequate fuel supply is assured by the large amount of fuel inventory in the SFMS fuel oil tank and the operability of a diesel driven Fuel oil transfer Pump. Procedures are available to refill the fuel oil tank via external oil tanker trucks and gravity feed procedures are in place to assure a continuous supply of oil to the SFMS DG should the FOTP fail. While building HVAC is available once the DGs are operating, an adequate operational environment may be established by manual operation of building vents. As the DG is housed above the flood plain in an ASCE-7-10 structure, the DGs are well protected from the effects of the flood and any associated harsh environment.

Comment [Clarify135]: Clarification needed: Specify number of gallons and number of hours (or provide a reference to a an evaluation where this information is located).

SFMS Well Water Pumps (SFMS P-1, 2, & 3): are rugged and designed to operate submerged. The pumps depend on the groundwater for an inventory source. Pumps are electrically driven and are powered by the SFMS DGs. Fill and soil surrounding the pump provide adequate filtration of water into the pump to prevent clogging of the intake filter. Well water pumps SFMS P-1 and 2 are to be turned on prior to site flood and will continue to operate throughout the event. Flow control is available through a remotely operated flow control valve. SFMS P-3 is an alternate means to refill of the RWST and is not anticipated to be used unless RWST inventory runs low. Operators will place the pump into operation, if needed, and terminate its use after the RWST has been refilled in accordance with TS.

Comment [Clarify136]: Clarification needed: Add step(s) for connecting feedwater or opening a valve. Currently, the step suggests pumping against a dead head. Also, clarify where flow is going and whether the connection with the feedwater system is a permanent modification or done "on the fly."

RCS Portable Inventory Makeup Pump (SFMS P-4): This pump is a low capacity, moderate pressure electrically driven submersible pump and will be staged on the 875' elevation of the auxiliary building. The pump takes suction from the RWST and pumps into the cold leg of the RCS. It is powered from the SFMS DGs and remotely operated by the plant staff located in the SFMS building.

Instrumentation: Instrumentation panels in the SFMS are powered by dedicated instrument batteries. Once the SFMS DGs are operating, the batteries receive a continuous charge from a charging system

Table 4-4 Dependencies/Support Systems for Active Flood Mitigation Components			
Component	**Primary Support Systems**	**Secondary Support Systems**	**Additional**
ADVs	IA-01 MD-1 (initial 24 hours preparations	BAT-1 N2-01 MSSVs (initial 24 hours preparations)	Mechanical device to open and prevent closure
SFMS DG-1&2	SFMS DG Fuel Oil Day Tank and SFMS Fuel Oil Tank	SFMS Fuel Oil Tank Truck	Fuel Oil Truck with compatible connecting hose Gravity feed available
SFMS P-1,2,&3	SFMS DG-1 /SFMS MCC Instrumentation Groundwater	SFMS DG-2/SFMS MCC	Once SFMS pumps are operational and system operation is confirmed, continued operation is not prevented by unavailability of instrumentation.
SFMS P-4	SFMS DG-1/SFMS MCC RWST	SFMS DG-2/SFMS MCC	SFMS P-3 may be used to provide make-up to the RWST in the event significant levels of injection are required.
Instrumentation	SFMS DC-Distribution Panel SFMS DG-1 & MCC	SFMS DC-Distribution Panel SFMS DG-2 & MCC	
IA –Plant Instrument Air Compressor BAT – Plant Battery N2 - Nitrogen Bottle MD – Mechanical Device			

Comment [Clarify137]: Clarification needed: How would flows and levels be monitored and adjusted or maintained in this situation?

~~2.~~5. Event Timeline and Resource Loading

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-- Preparer's Note --

The intent of section 5 is to provide information regarding the timing of events and key actions for the mitigation strategy. Two representations have been included to demonstrate an option with a greater level of detail in Table 5-1 and graphical concise representation in figure 5-1. These figures have been provided to give examples of methods to convey the necessary information about the strategy.

The preparer must factor all resources required on site and this resource loaded schedule should not be limited flood specific actions. In instances where multiple safety and non-safety activities are being performed, administrative guidance on task prioritization and resource allocation should be provided. Also include administrative guidance that will be used for employing resources. It is not the intent of this example to discuss any other non-essential actions. This discussion should include expectations to ask for exemptions from normal workrule requirements. While an exemption will not be necessary if an Emergency is declared, the time period just before and just after a flood will have to be carefully managed in accordance with Part 26 to avoid fatigue-related errors.

This section provides information regarding the scenario timeline of hazard and plant responses. A tabular timeline is provided (see table 5-1) with links to supporting sections where supplementary supporting information may be found. A graphical display is also provided (see figure 5-1) which expands on the details regarding how plant manpower resources are used throughout the scenario. This section also includes consideration of resources required to achieve the key safety functions, alternative resources to perform investment protection and related functions not directly related to protecting the reactor core or spent fuel. The distribution of resource capabilities area also provided to demonstrate that ample staff will be available to perform the critical protective and mitigation activities.

The graphic timeline visually demonstrates the activities required for flood mitigation before, during and following the event. This timeline starts with the actual dam breach and shows the activities that are required by procedure following the initiation of the event. Each task's duration is shown in both tabular and graphical format with grey cells indicating the time required to perform the action. A "float indicator" is shown immediately below each task to indicate the amount of time allotted before an action becomes unfeasible to complete. The green cells indicate that the action can be started anytime within this range and be completed successfully along with all its critical path predecessors. The orange cells indicate that less than 1 hour is available prior to the action becoming unfeasible. The red cells indicate if the action is not started prior to the event progressing into this range, that action is not anticipated to be successful. Light grey cells reflect performance of a non-safety activity. For simplicity these activities have been lumped into two activities.

Comment [Clarify138]: Clarification needed: The light grey cells in Fig 5-1 seems to show recovery actions rather than non-safety activities (e.g., activities for asset protection). Should non-safety activities be included due to resource allocation issues?

The chart above the timeline graphically depicts the event progression with relation to WSE at the site. The base flow indicates normal water level conditions and the blue cells indicate WSE at a given time. Critical elevations are depicted next to the WSE "ruler" and include descriptions. A resource chart is included below the timeline. This chart breaks down the different personnel required at the site during a flood event and indicates the number available at various skill levels. The loaded portion of the chart indicates the number of staff required for every given time slice.

The time line is based on the expected times for task completion. Time estimates have been validated by site exercises. Margins for completing actions may be ascertained by identifying the green bars in the Figure 5-1. Detailed discussion of feasibility and reliability of safety related actions are further discussed in Section 7.0. The work schedules were developed in accordance with 10CFR 26.205 and it was determined that no exemptions will be needed. The SFMS building will remain accessible throughout the entire flood event duration, allowing periodic shift changes.

TABLE 5-1
Detailed Timeline of Scenario

Time (hrs)	River Level	Action Identifier	Action	Procedure	Impact	Detailed Description Location or Evaluation
Pre-Event	890	PF-001	United States Army Corps of engineers (USACE)notifies state emergency organization that the dam is in distress and that they are entering emergency procedures	USACEProcedure XXX - State ERO Procedure XXX	State ERO must notify the utility in accordance with agreement XXX	Pre-Event action not explicitly included in HRA
Pre-Event		PF-002	State emergency organization notifies Utility Management contactof increased river flow and dam situation	State ERO Procedure XXX - Agreement Letter XXX	Continual monitoring and communication will occur with dam owner hourly	Pre-Event action not explicitly included in HRA
Pre-Event		PF-003	Plant Management notification of situation is initiated and key plant personnel notified of a potential issue. Site enters unusual event	AOP XXX	Continual monitoring and communication will occur with dam owner hourly	Pre-Event action not explicitly included in HRA
0	890		Dam Breach Occurs – USACE Notifies Utility	USACEProcedure XXX - State ERO Procedure XXX - AOP XXX - Step X.X		Section 7
1		PF-004	Plant Staff Monitors River Levels Upstream of site and downstream of dam. Confirms increase in river level past setpoint XX.	AOP XXX Step X.X	ALERT Status Declared - ERO Activated - Plant Shutdown Ordered	Section 7

TABLE 5-1

Detailed Timeline of Scenario

Time (hrs)	River Level	Action Identifier	Action	Procedure	Impact	Detailed Description Location or Evaluation
1.25			Plant Begins Emergency Shutdown	AOP XXX - Step X.X (requirement to begin shutdown) - Abnormal Shutdown Procedure Steps X.X-X.X (For Shutdown)		Emergency shutdown actions are proceduralized and trained upon. Actions are taken well in advance of the impending flood under nominal stress. conditions
1.5			Plant Reaches Hot Shutdown	AOP XXX Step X.X (TS Req X.X)		
2		PF-005	Command and Control transferred to Site Director	Emergency Plan Procedure XXX Steps X.X-X.X	EPP developed to respond to this flooding event and the NTTF Rec. 9.2 EP	Section 7
		XF-001	Staffing levels are determined and work is planned	Steps X.X-X.X		Section 7
3		XF-002	Test SFMS DG-1&2	AOP XXX Steps X.X-X.X		Section 7
		XF-003	Test Submersible Pumps SFMS P-1,2,3	AOP XXX Steps X.X-X.X		Section 7
		XF-004	Stage and align Portable Pump SFMS P4 for make up to RCS and test	AOP XXX Steps X.X-X.X		Section 7

TABLE 5-1
Detailed Timeline of Scenario

Time (hrs)	River Level	Action Identifier	Action	Procedure	Impact	Detailed Description Location or Evaluation
4			Install Flood Barriers	AOP XXX Steps X.X-X.X	These Steps are not critical to the success of the strategy. Only used for asset protection	
4.5			Place plant on shutdown cooling and continue to cool	AOP XXX Steps X.X-X.X (TS Req XXX)	Plant will continue to cooldown in accordance with TS Req. XXX	
6			Plant Reaches Cold Shutdown	TS Req. XXX	Cooldown conditions are defined as RCS temp below 150F and pressure below 100 psia	
			RCS is borated to refueling concentrations	AOP XXX Steps X.X-X.X		
		XF-005	24 Hour Schedules are Developed and implemented	AOP XXX Steps X.X-X.X - EPP XXX Steps X.X	Compliance is required in accordance with 10CFR 26.205	Section 7
		XF-006	Additional XXX gallons of fuel ordered for SFMS DG-1&2	EPP XXX Steps X.X-X.X		Section 7
10		XF-007	Open ADVs & Confirm Availability	AOP XXX Steps X.X-X.X		Section 7
		XF-008	Jack Open ADVs to prevent closure	AOP XXX Steps X.X-X.X		Section 7
11			Confirm ADVs Unvailable	AOP XXX Steps X.X-X.X	Alternate Success Path Only if ADVs are Unavailable	Figure 6-2

Comment [Edits139]: Editorial: Change to "block"

TABLE 5-1
Detailed Timeline of Scenario

Time (hrs)	River Level	Action Identifier	Action	Procedure	Impact	Detailed Description Location or Evaluation
			Dispatch Crew to MSSVs	AOP XXX Steps X.X-X.X		Figure 6-2
11.5			Manually open MSSVs	AOP XXX Steps X.X-X.X		Figure 6-2
12			Confirm MSSVs are available Mechanically Prevent MSSVs from closing	AOP XXX Steps X.X-X.X		Figure 6-2
16			Flood Barrier Installation Complete	AOP XXX Steps X.X-X.X		
			Install Portable Lighting	AOP XXX Steps X.X-X.X	Only for personnel safety. Essential lighting will be powered from SFMS.	
21		XF-009	Fully Staff SFMS	AOP XXX Steps X.X-X.X	Essential personnel in SFMS building for duration of event	Section 7
22	894	XF-010	Remove Electrical Power from Plant Equipment Below max WSE	AOP XXX Steps X.X-X.X (Flood Waters are predicted to exceed height of barriers within 8 hours)		Section 7
		XF-011	Open Manual Valves to connect SFMS P-1,2,3 well pumps to feedwater lines and RWST.	AOP XXX Steps X.X-X.X		Section 7

TABLE 5-1
Detailed Timeline of Scenario

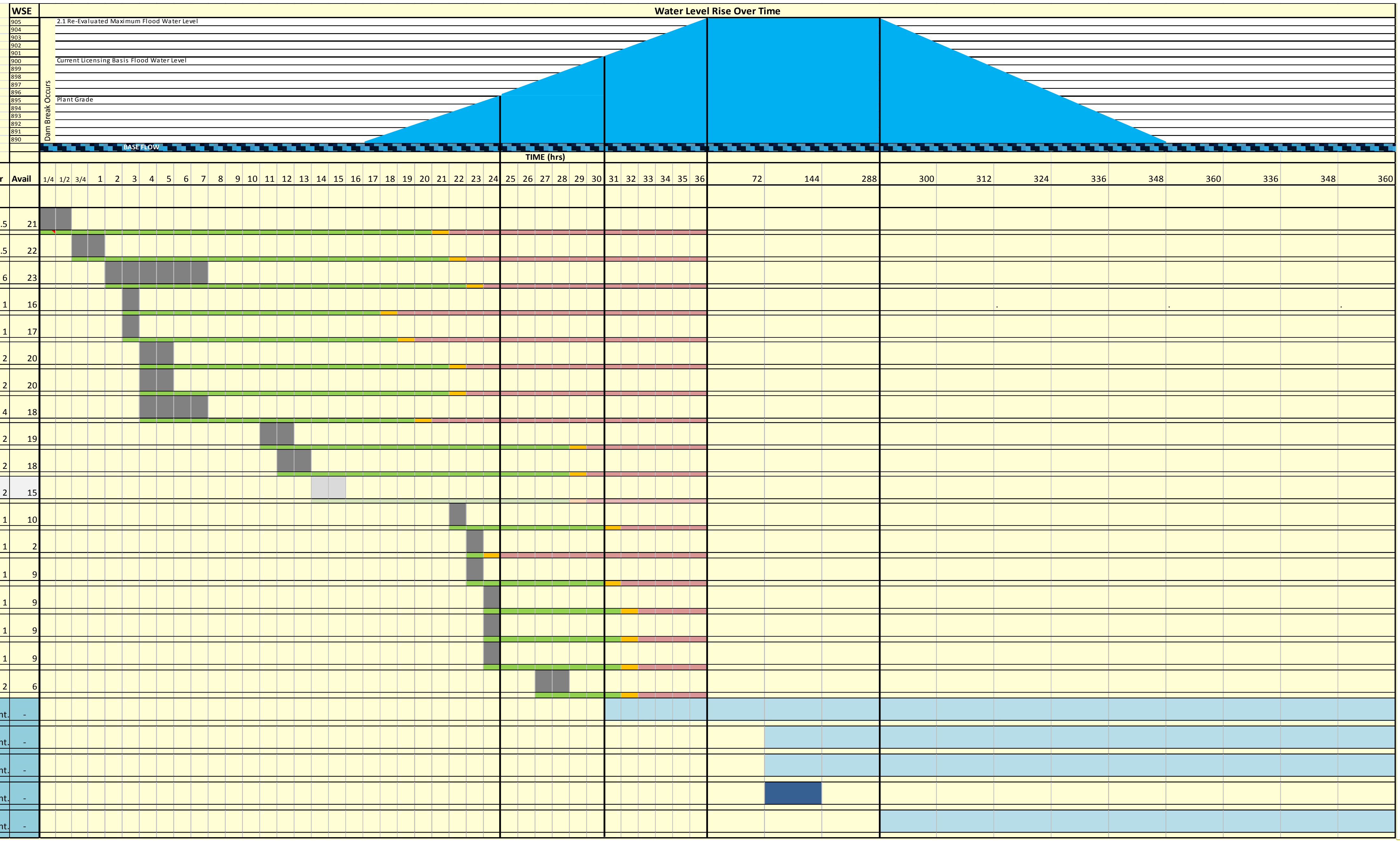
Time (hrs)	River Level	Action Identifier	Action	Procedure	Impact	Detailed Description Location or Evaluation
23		XF-012	Place the SFMS equipment into operation Includes: SFMS DG 1, SFMS P1,3 & 4	AOP XXX Steps X.X-X.X		Section 7
24	895	XF-013	Disconnect Switchyard from grid	AOP XXX Steps X.X-X.X (When flood waters reach 895 ft.)	Normal power assumed lost after this action and all subsequent actions rely on emergency power	Section 7
26	896	XF-014	Discontinue shutdown cooling	AOP XXX Steps X.X-X.X	RCS will heat up to allow SG heat removal	Section 7
30	900	XF-015	Maintain SG levels	AOP XXX Steps X.X-X.X	SG level will be monitored from dedicated SFMS Instrumentation Panel from the SFMS Building This step will place the plant in a safe stable state for the entire flood event duration	Section 7
32	902				Switchyard ~~Innudated~~Inundated	
36	905				Maximum WSE Reached	
72	905	XF-016	RRC becomes available to the SFMS Facility	Per Agreement XXXX		Agreement in Appendix X [Not provided in this example]

Comment [Clarify140]: Clarification needed: Table 4-4, third row indicates that loss of instrumentation will not affect shutdown. Is this correct?

TABLE 5-1 Detailed Timeline of Scenario						
Time (hrs)	River Level	Action Identifier	Action	Procedure	Impact	Detailed Description Location or Evaluation
108	905	XF-017	Refuel SFMS DG 1&2 every 12 hrs or as needed	AOP XXX Steps X.X-X.X		Section 7
132	904		Site prepares to implement post-flood recovery plan	FRP XXX		
252	899	XF-018	Site post-flood recovery procedure activated	FRP XXX		Section 7
348	895		Flood water completely recedes from site	FRP XXX		
349	895		Regional response center fully supports site recovery	Per Agreement XXXX		

Figure 5-1 - Scenario Timeline

ID	Task Names	Dur	Avail
-	DAM BREAK OCCURS		
PF-001	Dam Operator informs Station Personnel of Breach	0.5	21
PF-002	Operators Confirm River Rise	0.5	22
PF-003	Operators being emergency shutdown procedure	6	23
XF-001	Command and control transferred to Site Director	1	16
XF-002	Staffing levels determined and work planned	1	17
XF-003	Test SFMS DG-FL-1/2	2	20
XF-004	Test SFMS Well Pumps P-1/2	2	20
XF-005	Stage and align portable pump for RCS make up	4	18
XF-006	Operators Open ADVs and confirm availablility	2	19
XF-007	Jack open ADVs to prevent re-closure	2	18
ALT A-1	Open MSSVs and prevent re-closure	2	15
XF-008	Fully Staff SFMS Facility	1	10
XF-009	Remove power to equipment below max WSE	1	2
XF-010	Open manual valves to align SFMS pumps	1	9
XF-011	Start SFMS DG-FL-1/2	1	9
XF-012	Start SFMS well pumps	1	9
XF-013	Start portable pump for RCS make up	1	9
XF-014	RCS heats up to restore SG heat removal	2	6
XF-015	Operators maintain SG level, pressure & temp	Cont.	-
XF-016	Operators refuel SFMS DGs	Cont.	-
XF-017	Restaff + change shifts	Cont.	-
XF-018	Regional Response Center Available	Cont.	-
XF-019	Initiate post-flood recovery plan	Cont.	-



Timeline Legend

(green)	More than 1 hour available prior to start of activity to complete the action (and its predecessors) within time available
(yellow)	Less than 1 hour available prior to start of activity to complete the action (and its predecessors) within time available
(pink)	Action (or its predecessors) cannot be completed in time available if started within this timeframe
(blue)	Long Term Repeatable Actions

Comment [Suggest141]: Suggestion: consider noting where staff will be stationed during the event.

TABLE 5-2

RESOURCE LOADING FOR ENTIRE FLOOD DURATION

TIMELINE		1/4	1/2	3/4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	72	144	288	300	312	324	336	348	360	336	348	360
RESOURCES	Avail	REQUIRED																																																		
Senior Reactor Operator	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Critical		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Non-Critical		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Reactor Operator	17	6	6	6	6	6	6	6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Critical		3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Non-Critical		3	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mechanical Maintenance - Super	9	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Critical		2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Non-Critical		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mechanical Maintenance - Craft	67	28	28	28	28	28	28	28	28	28	10	10	10	10	10	10	10	14	14	14	16	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Critical		18	18	18	18	18	18	18	18	18	8	8	8	8	8	8	8	12	12	12	14	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Non-Critical		10	10	10	10	10	10	10	10	10	2	2	2	2	2	2	2	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Electrical Maintenance - Super	8	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Critical		3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Non-Critical		1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electrical Maintenance - Craft	34	18	18	18	18	18	18	18	18	14	6	6	6	6	6	6	6	12	12	12	12	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Critical		14	14	14	14	14	14	14	14	12	4	4	4	4	4	4	4	10	10	10	10	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Non-Critical		4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Equipment Operator	9	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Critical		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Non-Critical		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: This table intends to demostrate the total number of personnel available and required for all activities proposed during the flood event, not just resources for flood specific activities

~~3.~~6. Scenario Success Path Progression

Comment [Suggest142]: Suggestion: Consider moving this section to the front of the document to provide the user/reviewer with road map up front.

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--- Preparer's Note --

The objective of the scenario-based evaluation is to demonstrate that there is high confidence that key safety functions can be maintained during the reevaluated flood hazard. The process is required to be systematic, rigorous and conservative. To accomplish this task, a success path for the scenario has been developed to illustrate the key components that must change state, operator actions required to carry out the strategy and flow paths to show the progression of the actions for the flood event duration. This success path has been developed to satisfy the requirement for "logic structures" as the goal is to conservatively demonstrate a highly reliable strategy for the key steps in the overall flood mitigation strategy. This section should tie the entire analysis together and include pointers to the locations of the detailed analysis justifying the conclusions drawn in this section.

The following discussion focuses only on strategies associated with mitigating extreme flood hazards under conditions where the RCS is intact. Adjustments to these strategies may be necessary to address external flooding mitigation during other modes of operation (e.g. refueling). Additional strategies will also be required to describe actions taken to maintain spent fuel pool cooling and inventory.

Note that this example focuses on an illustration of discussion on mitigation strategies for an external flood scenario with emphasis on describing the success path and one simple recovery action. In developing external flood mitigation strategies, plants should consider consequences of failure of equipment and/or implementation actions and consider the appropriateness of reasonable back-up mitigation strategies.

--- --------------------- --

This section provides an overview of the plant flood mitigation strategy and its role in ensuring that the key plant safety functions are retained for the duration of the flood event. Maintaining the following five safety functions will ensure the integrity of the fission product barriers and keep the core in a cool, stable state. Each function has a detailed discussion on its role and the steps required to successfully implement the strategy. A success path (Figure 6-1) has been developed to visually represent the required elements for the strategy to be carried out successfully. Each element represented in the strategy is described in greater detail in Table 6-1 and the location of detailed analysis supporting the conclusions is contained for each element in Figure 6-1.

6.1 Key Plant Safety Functions

The primary focus of flood protection and mitigation strategies is to ensure that the plant can be placed in a safe stable state throughout the duration of the flood event. A review of all relevant plant safety functions has been performed. Based on that review the plant has determined that the key safety functions to be ensured are:

- ~~1.~~ Reactivity control
- ~~1.~~ Reactor inventory control
- ~~2.~~ Decay heat removal
- ~~3.~~ Reactor Pressure control
- ~~4.~~ Containment Integrity

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6.1.1 Reactivity Control

The advance notice available prior to the flood reaching the site enables the plant staff to conduct an orderly emergency shutdown without reliance on abnormal operating procedures. Operators will follow plant procedure SD-XX to insert control rods, stopping the chain reaction and using the shutdown cooling system to decrease the temperature of the RCS. Inventory make up will be provided using the station's normal charging pump and boron will be added, as directed in the procedure. All of these actions will be completed well in advance of the floodwaters reaching the site.

The plant will be maintained in a cooled condition (RCS temperatures less than 250 F) throughout the entire flood event duration and at that temperature RCP seal integrity is expected. Although the need for make-up is unlikely, the strategy includes the potential for direct RCS make-up using pump, SFMS P4. It is staged in the bottom of the auxiliary building with pre-aligned piping to allow direct injection from the RWST into the RCS (See Section 3). To ensure reactivity control is maintained, any make-up to the RCS will be made using borated water. Prior to the onset of the flood event the initial RWST inventory will be filled with borated water and maintained towards the upper band of the Technical Specification Maximum Level. The initial RWST inventory has been evaluated to be adequate to make-up RCS leakage for a period in excess of 200 days. Unborated makeup may be supplied at a rate in excess of the RCS boil-off rate. Should additional inventory be required in the long term, provisions have been made with the Regional Resource Center to provide a mobile boration unit.

Comment [Clarify143]: Clarification needed: Is this an area that is expected to flood?

6.1.2 Reactor Inventory Control

In an analogous fashion to reactivity control, RCS inventory control is addressed in two phases. The early phase response relies on injection from the RCS charging system. As low temperature operation associated with the RCS cooldown strategy also provides a high degree of confidence that RCP seals remain integral (based on calculation XXX), no RCS inventory loss is anticipated during the flood scenario. Prior to the flood reaching the site, inventory is added to the RCS to accommodate shrinkage of the RCS inventory during plant cooldown. This process follows plant procedure NOP-XXX and all equipment is available throughout the shutdown. As stated above, the RCS temperature and pressure is expected to be low enough that RCP seal leakage is considered negligible. An assessment of seal elastomer performance is provided in Reference XX and under the post-flood operational conditions it indicates that upper stage elastomers will be capable of ensuring seal integrity for the full duration of the flood event. As a precaution, the plant flood program plans to accommodate potential RCS inventory loss, via inventory makeup is provided by SFMS P4. This pump has been sized such that it is capable of delivering borated water to a depressurized RCS at rates in excess of that possible from a single RCP seal failure. Details on the pump capabilities are provided in Sections 3 and 4. Inventory levels in the RCS are monitored by reference to the pressurizer level.

Comment [Clarify144]: Clarification needed: Clarify whether this implies the low leak rate assumed early is not a critical parameter because this pump can keep up with a larger leak.

6.1.3 Decay Heat Removal

The most important function of the SFMS is to ensure that heat may be reliably removed from the core and the RCS for the duration of the flood event. Early in the event, prior to the arrival of floodwaters at the site, heat removal from the RCS proceeds using normally available decay heat removal systems. To establish desired plant shutdown conditions, the RCS is placed on shutdown cooling and the RCS temperature is decreased to the point where heat may be removed by a depressurized steam generator. Once the plant is in a stable shutdown condition and the RCS temperature decreasing, the plant staff will focus on depressurizing the SGs to atmospheric conditions. Flood response procedure (AOP-XXX) provides instructions for the operator to depressurize the SGs via use of the atmospheric dump valves and "gagging" the valves open via use of a mechanical device (MD-1). During this preparatory phase, lost SG inventory is replenished via the auxiliary feedwater system via water from the condensate storage tank. Plant operators are instructed to establish steam generator liquid levels at the [the upper band on narrow range steam generator level instrumentation (available within the MCR and SFMS building]. In accordance with the procedure AOP-XXX, the SG is expected to align the SFMS components and transition from reliance on AFW flow and the CST to one of two submerged well water pumps (SFMS Pumps 1 or 2). It is anticipated that that plant will continue to remove decay heat with these pumps for the duration of the flood event. The well water pump injection piping includes flow control valves which may be adjusted from the SFMS building by the operating staff. Prior to arrival of the floodwaters AOP-XXX instructs the operator to turn off the SDC system, monitor the RCS temperature and adjust the flow control valve to maintain a constant SG level (indicative of a balance between decay heat removal and SG steam release). Operators are instructed to expect a gradual plant heatup and stabilize the RCS temperature below a temperature of 250 F. This temperature is chosen so that the operators can establish adequate decay heat removal while ensuring RCP seals (a potential cause of RCS inventory loss) will retain their integrity with adequate margin throughout the entire ~~flood event~~flood event. These operational temperatures have been confirmed by analysis (Reference XX). Minor deviations from this target are not expected to have a significant impact on event mitigation as the RCS pressure will be low and as a result of ambient heat loses to the containment, temperature of the elastomers in the upper seal stages are will be substantially cooler than the RCS fluid.

Flow control valves are included in the SFMS design to allow operators some control of the RCS cooling process; however they are not considered critical to the overall SFMS function. To ensure a successful event outcome the flow control valves are designed to fail in the "as is" condition. While operation of the flow control valves periodically during the flood event is desirable, the impact of valve failure would be, over time, to increase the quality of the steam generator discharge. To accommodate the resultant liquid carryover into the main steam lines, several liquid drains located at various locations along the bottom of the main steamline ~~were are~~will be maintained in the open condition. Assuming a balance flow condition at one day following shutdown, and a constant flowrate to the SGs, the exit steam generator mixture quality after two weeks would be ~0.5 and 0.25 after 6 months. Should liquid accumulate in the steam line, static structural analyses indicate the piping and supports are capable of supporting the potential loading.

Comment [Edits145]: Editorial: "Gagging" is the term typically used for forcing the valves to remain closed (generally for high pressure tests of the system). "Blocked open" is a better description for what is being done here.

Comment [Edits146]: Editorial: This sentence is not clear. What is meant by "the SG is expected to align"?

Comment [Edits147]: Editorial: change to "remotely adjusted"

Comment [Clarify148]: Clarification needed: Clarify whether this is flow to SGs from SFMS pumps.

Comment [Clarify149]: Question: What happens if they fail closed? Do they fail "as is" for loss of power? Any other possibility? Any automatic responses in the remote operation control circuitry? Switch failure drives valve closed?

Comment [Clarify150]: Clarification needed: This statement appears to support water collection in steam lines from moisture carry over in steam. Drain lines referenced in previous sentence

Adequate decay heat removal is indirectly assessed via monitoring pressurizer and SG levels. As the SG is intended to be operated in a saturated depressurized condition, tracking of SG temperature is not very informative. RCS hot leg temperatures are initially monitored in the control room during the initial plant cooldown. Once the SFMS has been actuated RCS temperature would be expected to increase until an equilibrium is reached between the RCS and SG. Analyses suggest that during these conditions natural circulation temperature differentials are on the order of 10-20 ^{o}F. As pressure drops in the steam discharge piping is expected to be no larger than several psi, the expected post-flood RCS temperature and pressure would be less than 250^{o}F and 40 psia respectively. At these operating conditions RCP seal elastomers have no significant environmental challenge.

6.1.4 Reactor Pressure Control

Reactor pressure control is identified as a key safety function in Reference 1. This function is implicitly met by satisfying reactivity control and the RCS heat removal safety functions. In the context of the long term operational state maintaining the RCS pressure low provides additional margin to leaks from the RCS. Reactor pressure, along with other RCS attributes is directly monitored in the SFMS building. Thermal hydraulic analyses (Reference XXX) demonstrate plant mitigation strategies can effectively maintain the desired RCS conditions provided RCS leakage is controlled and well water pumps remain operational.

6.1.5 Containment Integrity

Prior to the onset of flooding AOP-XXX instructs the operator to ensure the containment is closed with only penetrations involved in maintaining and monitoring plant safety functions active. While containment pressure is monitored in the SFMS building no on-site provisions are available to actively reduce containment pressure using containment sprays or fan coolers. As long as the RCS remains cooled and inventory losses are restricted to identified leakage, no challenge to containment integrity is expected throughout the flood event duration. Should containment heat removal be required later in the scenario, connections points for portable equipment to tie into these systems have been identified.

6.2 Plant Operational States During the Flood Event

The strategy discussed in this integrated assessment will initially perform an emergency plant shutdown taking the plant for full power to shutdown cooling entry conditions. Once in shutdown cooling the plant will continue with the cooldown until the RCS reaches approximately 150^{o}F at an RCS pressure of about 100 psia. The pressurizer level will be maintained half full. Component cooling water will also be maintained to ensure RCP and associated seals are well cooled. This state will be maintained until the operators are instructed to transition from shutdown cooling heat removal to reliance on the steam generators.

Comment [Clarify151]: Clarification needed: What provides the instruction to the operators? How is the need for the transition communicated to the operators? What procedures are utilized?
In addition, provides references to associated manual action evaluations (if applicable).

At the time of transition to SG cooling the SG inventory has been fully established and the steam generator has been depressurized and cooled o about 150^{o}F. In addition, the RWST is maintained to maximum TS levels and maximum boron concentration.

Once the transition to SG heat removal is complete the decay heat will begin to heat the RCS which in turn will heat the SG inventory. The depressurized SG will begin to boil when the SG inventory reaches saturation conditions. The RCS will stabilize at an RCS hot side temperature of about 220-230^{o}F and a steam generator temperature around 212 ^{o}F. SG feed will be initially established to allow steam heat removal. RCS pressure will initially increase as the RCS expands but, without heaters, will lose pressure as the pressurizer cools. While a level will be maintained in the pressurizer, a controlling pressurizer bubble may develop in the upper head. Plant specific analyses confirm that transition to this condition will not impact the ability of the plant to remove decay heat and ensure a covered core.

Comment [Clarify152]: Clarification needed: Why not maintain RCS inventory using SFMS pump 4?

6.3 Scenario Success Path

Figure 6-1 contains all the key steps in the success of the flood mitigation strategy. It includes operator actions and key equipment necessary to perform and maintain the plant safety functions for the entire duration of the event. Each element has detailed calculations in Sections 7 & 8 to document the conclusion for high reliability of components and operator actions, respectively. All the success path items correspond to the actions on the timeline in Figure 4-1.

The information in Figure 6-1 is presented in the form of a logical success path. It shows the key actions and systems that are required to carry out the flood mitigation strategy. Each item has been shown to be feasible and reliable, with margin. Based on time and resources available, all actions have greater than twice the amount of time required to complete the action in the scenario (see Figure 5-1 and Section 8). The components used in each system have had a systematic, rigorous and conservative evaluation of their reliability (See Section 4). The actions are well proceduralized, trained and executed periodically giving a high confidence that they can be carried out as intended within the timeframe required (see Section 8). Therefore, the conclusion can be made that success path shown is highly reliable in maintaining key safety functions for the entire flood event duration and the strategy can be implemented to protect the plant from a flood hazard as defined in this scenario.

In the event that the ADVs fail to open, an alternate strategy for providing depressurization and steam removal has been provided in Section 6.3.

The following table will describe in greater detail the information each success path element represents.

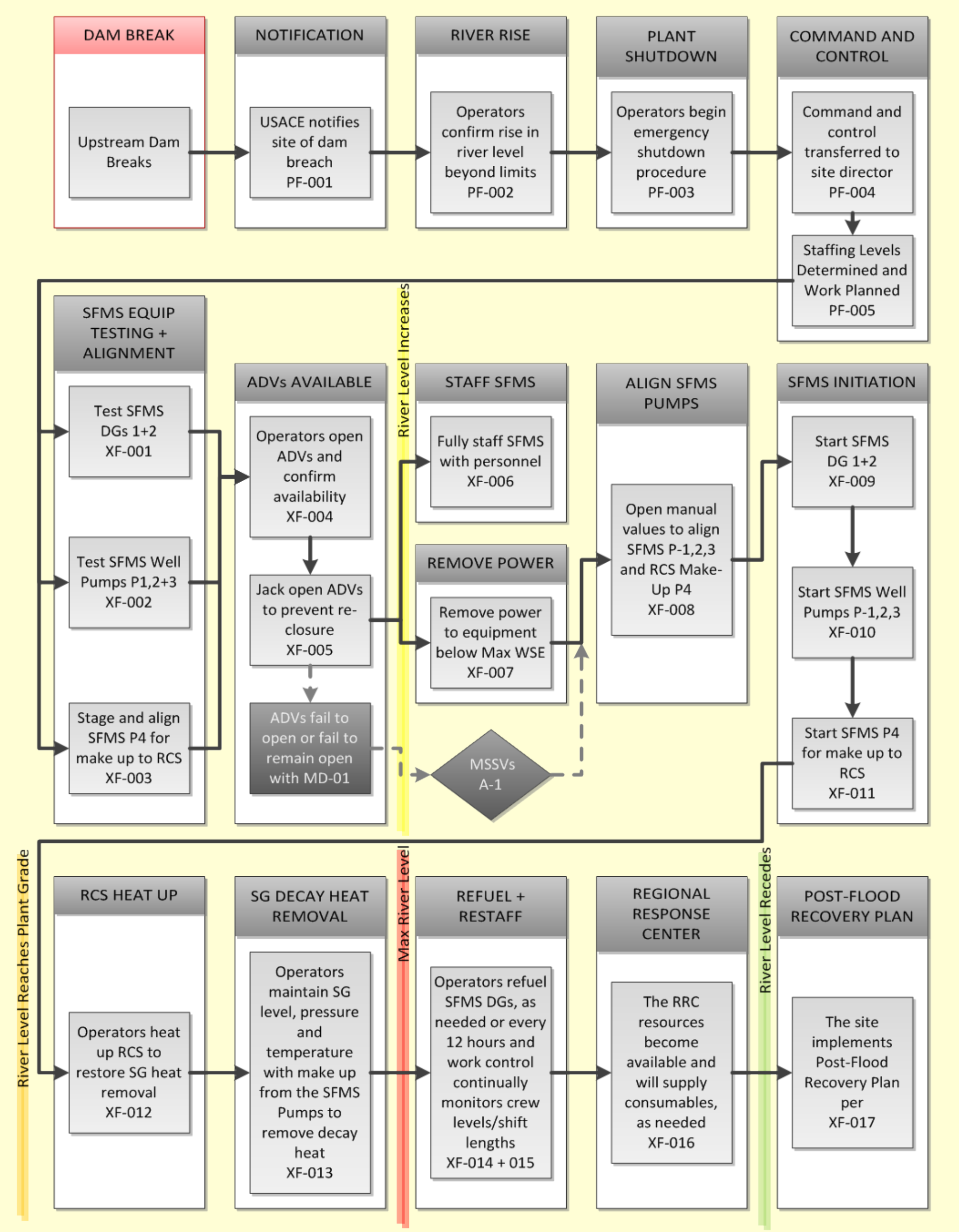
Table 6-1
Success Path Element Description

Success Path Element	Description
Dam Break	Event Occurs
Notification	USACE notifies site of dam breach in accordance with procedure (AOP-XXX) and agreement XXX.
River Rise	Operators will monitor several locations downstream of the dam and upstream of the site. Entry conditions and trigger points are found in AOP-XXX Steps X.X
Plant Shutdown	Operators begin to shutdown the reactor when entry conditions are realized. The shutdown will begin and finish well in advance of the flood waters, therefore normal plant operating procedures will be used to guide the shutdown.
Command and Control	Upon notification of the dam break, confirmation of the river rise and shutting the plant down, control of operations will be transferred to the site director to carry out the steps of AOP XXX. Staffing levels will be determined and work will be planned to allow all tasks to be done within the timeframe.
SFMS Equip Testing + Alignment	Operators will test the SFMS DG 1 & 2, and the well pumps SFMS P 1,2 & 3. The portable high pressure SFMS P4 will be staged in the Aux Bldg and connected, as directed in AOP-XXX (Figure 3-4). No valves will be opened at this time.
ADVs Available	Operators will fully open the ADVs and confirm they are available for decay heat removal. The ADVs will then be jacked open with MD-1 to prevent their closure throughout the entire event.

Table 6-1
Success Path Element Description

Success Path Element	Description
ADVs Fail	In the unlikely event that the ADVs fail to open using IA or fail while attempting to mechanically prevent their closure, an alternate success path (A-1) to depressurize the SG and remove steam is provided in Figure 6-2 and Table 6-2..
Staff SFMS	Site director will order the SFMS be fully staffed and prepared for the event prior to the arrival of flood waters.
Remove Power	Power will be removed from all equipment below the maximum WSE. Procedural guidance is provided in AOP-XXX Encl XXX to direct specific equipment items to be removed from service.
Align SFMS Pumps	Operators will open valves required to align the SFMS P 1,2,3 & 4 in accordance with AOP-XXX Steps X.X. Valves are shown on Figure 3-4.
SFMS Initiation	The SFMS equipment will be placed into service. Operators will start the SFMS DG 1&2 and load the SFMS MCC. The SFMS P 1,2,3+4 will be started and made available for makeup. Procedure AOP-XXX Steps X.X will be used to perform the SFMS initiation.
RCS Heat Up	Operators will follow AOP-XXX Steps X.X to allow the RCS to heat up to 250F. Once the minimum temperature is reached, decay heat removal will be restored through the steam generators.
SG Decay Heat Removal	Decay heat will be removed from the RCS by maintaining the level, pressure and temperature as directed in AOP-XXX Steps X.X. Make up will be provided to the primary and secondary side, as required, through the SFMS Pumps.
Refuel + Restaff	Consumables will be replenished for the entire flood event duration. The diesel generator fuel oil tank will be refilled, at least every 12 hours. Resources, work load and shift lengths will be monitored by the site director and TSC to ensure compliance with 10 CFR 2.XXX. This will place the plant in a safe stable state.
Regional Response Center	The RRC will be staffed and fully available prior to the flood waters receding from the site. Agreement XXX in Appendix X outlines the responsibilities and capabilities of the RRC. This includes provisions for additional staff, technical support, equipment and consumables.
Post-Flood Recovery Plan (PFRP)	After flood waters recede, the site will implement the post-flood recovery plan. The details of this plan are contained within PFRP-XXX.

Figure 6-1 – Scenario Success Path



Comment [Suggest153]: Suggestion: Other places in the document references the state notifying the site whereas this figure USACE notifies the site. Consistency suggested.

6.3 Alternate Success Path for Depressurization and Steam Release

An alternate strategy for SG depressurization and steam removal has been developed in the unlikely event that the ADVs fail to open or fail to remain open with the mechanical device (MD-01). The MSSVs have been identified as another means to depressurize and reject steam to the atmosphere. The actions and details for the strategy can be found below in Table and Figure 6-2. As this is an alternate strategy to the highly reliable primary success path shown in Figure 6-1, the actions will only be addressed in the timeline to confirm that the strategy is feasible. Additional details on the implementation can be found in AOP-XXX, Steps X.X. This strategy is periodically trained on an annual basis.

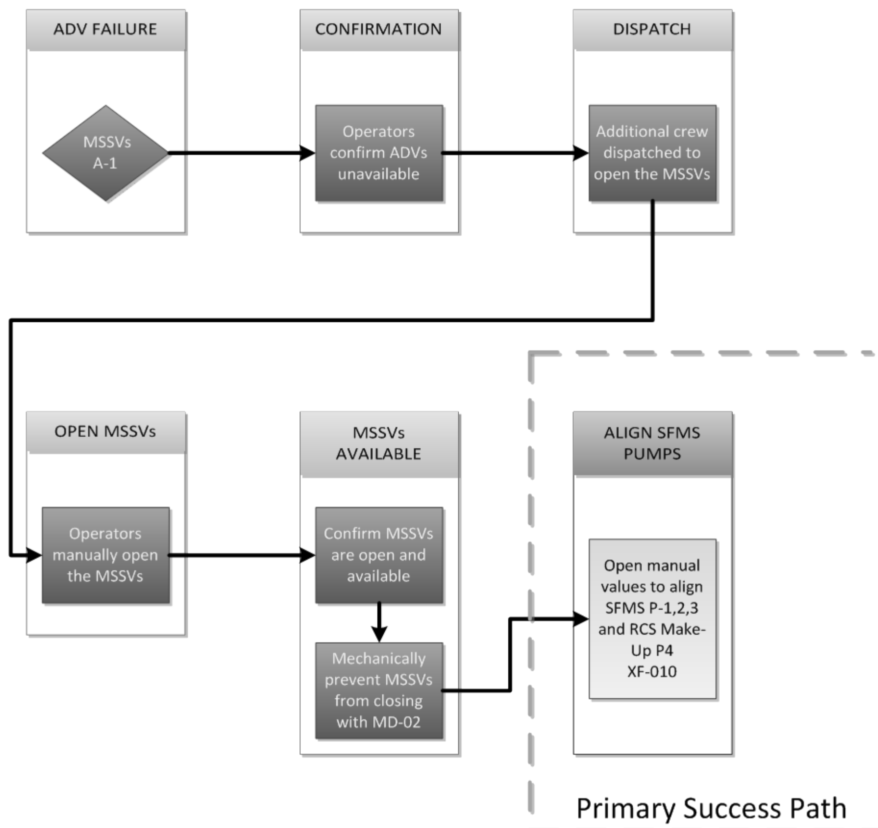
Table 6-1
Success Path Element Description

Success Path Element	Description
ADV Failure	ADVs are not available for SG depressurization and steam rejection
Confirmation	Operators confirm that the ADVs are not available
Dispatch	Dispatch an additional crew to the MSSVs
Open MSSVs	Operators open the MSSVs by manipulating the manual valves
MSSVs Available	Operators confirm that the MSSVs are open and available for steam rejection. The MSSVs will then be prevented from closing using a mechanical device (MD-02)
Align SFMS Pumps	The alternate success path then merges with the primary success path.

Comment [Edits154]: Editorial: This is a repeated header number

Comment [Clarify155]: Clarification needed: NRC staff would like to discuss this further during the public meeting. It is not clear to staff what is implied by this statement.

Figure 6-2 – Alternate Success Path (A-1)
Depressurization and Steam Release



6.4 Event Tree Logic

To clarify the impact of the actions on event success the scenario is cast in the form of an event tree. As actions are considered feasible and reliable, operational failures of equipment were primarily selected to illustrate failure branches. For simplicity of presentation, failure branches with highly reliable recoveries/proceduralized back-up plans are explicitly included. In this scenario, the developed failure branch occurs following the inability of the plant staff to create a steam release path using an ADV. A proceduralized back-up action to jack open the MSSVs is included in the event tree. Other “failure” branches are noted as potential low probability events but for the sake of clarity are not further developed. Top events on the event tree presented in Figure 6-3 are summarized below. A summary of the top events and success criteria are provided in Table 6-2. A discussion of low probability end states is provided in Table 6-3.

Table 6-2 Summary of Top Events	
Top Event	**Description**
Dam Break Occurs	Initiating event
Pre Flood Activities	The plant receives notification from the USACE that the upstream dam has breached. The site will enter into AOP-XXX, confirm that the river level upstream is rising and transfer command and control to the site director to determine staffing/work load. This top event includes actions: PF-001, 002, 004 & 005. Detailed justification for high reliability and margin can be found in Sections 8 & 9.
Plant Shutdown	Operators will perform an emergency shutdown in accordance with AOP-XXX. This action will be performed well in advance of the flood waters arriving with nominal PSFs. This step includes action: PF-003
SFMS Test & Align	SFMS DGs and P-1,2,3 & 4 will be confirmed available in accordance with AOP-XXX. Operators will test and align the equipment as detailed in AOP-XXX. This top event includes actions: XF-001,002, & 003.
ADVs Available	The ADVs are opened under normal operating conditions with all normally available equipment well in advance of the flood waters arriving. Once the ADVs are confirmed open the operators will mechanically prevent its closure with a specially designed device MD-01 creating a permanent way to reject steam to the atmosphere. This event includes actions: XF-004 & XF-005
MSSVs Available	In the unlikely event that the ADVs are not able to be opened or prevented from reclosing, the MSSVs will be opened to create an alternate path for steam rejection and secondary side heat removal. This action has a success path developed in MSSVs A-1, but no detailed calculation have been provided. The steps are directed in AOP-XXX.
SFMS Start	Prior to the flood waters reaching the site, the SFMS system will be placed into service. The SFMS DGs will provide power and the SFMS P-1,2,3&4 will provide water in accordance with the description in Section 3. This event includes actions: XF-008, 009, 010, & 011.
SG DHR	When normal plant equipment is lost due to the flood barriers being overtopped at 900', decay heat removal will need to be transferred to the SG from the DHR system. Operators will increase the RCS temperature to 250F to re-establish heat removal through the SGs. From there, SG level, temperature and pressure will be monitored to continue to remove decay heat for the entire flood event duration. This event includes actions: XF-012 & 013
Safe Stable State	As the SFMS continues to remove decay heat, the only dependency will be diesel fuel oil and operators to monitor the SG parameters. AOP-XXX directs the DGs to be refueled when needed or every 12 hours. The site director will continue to plan work and monitor shift lengths to provide operators the appropriate work load. Once the flood waters recede the RRC and post flood procedure will be implemented. This event includes actions: XF-014, 015, 016 & 017.

Table 6-3: Summary of Low Probability End States		
End State	**Description of End State**	**Justification of Low Probability**
ES-001	Successful end state. All events in the scenario success path were executed successfully.	Not applicable-Success State
ES-002	This end state indicates early responses to the flood scenario are successful, however in the long term failures emerge in the basic strategy and RRC resources are inadequate to restore cooling in a timely fashion.	This is a low likelihood end state. Redundant DGs and pumps included in the SFMS will provide reliable performance for the duration of the flood event. At three days into the event the RRC is available to supplement plant capabilities and back-up random equipment failures. This support can include additional manpower, fuel resources and back-up equipment. Appropriate connections have been established for use of this equipment in a manner consistent with the plant mitigation strategy. These recovery actions are not developed in this logic tree.
ES-003	This sequence represents operator failure to maintain level and pressure in the steam generators or failure to recognize the need for make up to the RCS. This sequence assumes that all equipment is functional and working.	This endstate has been determined low likelihood. Procedures are well written and established to provide operators with the guidance they need to maintain level and pressure in the SGs. Operators are trained to recognize the need for RCS make up and have well written procedures to implement

Table 6-3: Summary of Low Probability End States		
End State	**Description of End State**	**Justification of Low Probability**
		a strategy.
ES-004	This end state represents the inability of operators to start all the SFMS equipment and keep it running, when needed. The equipment includes all equipment listed in Table 4-1, except the ADVs and MSSVs.	This is a highly unlikely sequence. All the equipment is well maintained within a program as equipment important to safety. The SFMS DGs and P-1&2 are redundant. Fuel is stored on site and agreements to ensure continuous fuel supply are in place. Adequate time margin exists to allow for repairs of alternate strategies, should a piece of equipment fail to perform its function.
ES-005 through ES-008	These end states are analogous to ES-001 through ES-004, with the exception that steam generator steam relief is accomplished via the MSSV path as opposed to the ADV.	Discussions provided above for ES-001 through ES-004 apply to respectively to statuses-005 through 008
ES-009	The flood mitigation strategy fails as a result of inability to establish a steam release path from the steam generator. This end state represents the failure of opening the MSSVs following the failure to open the ADVs.	Both actions are highly reliable and either action has a high probability of success. They will take place well in advance of the flood reaching the site. ADV actions involve normally available operational equipment and time to perform action is small fraction compared to the time available (See Section 7). The MSSV action is well proceduralized, trained upon and all necessary equipment to open the MSSVs

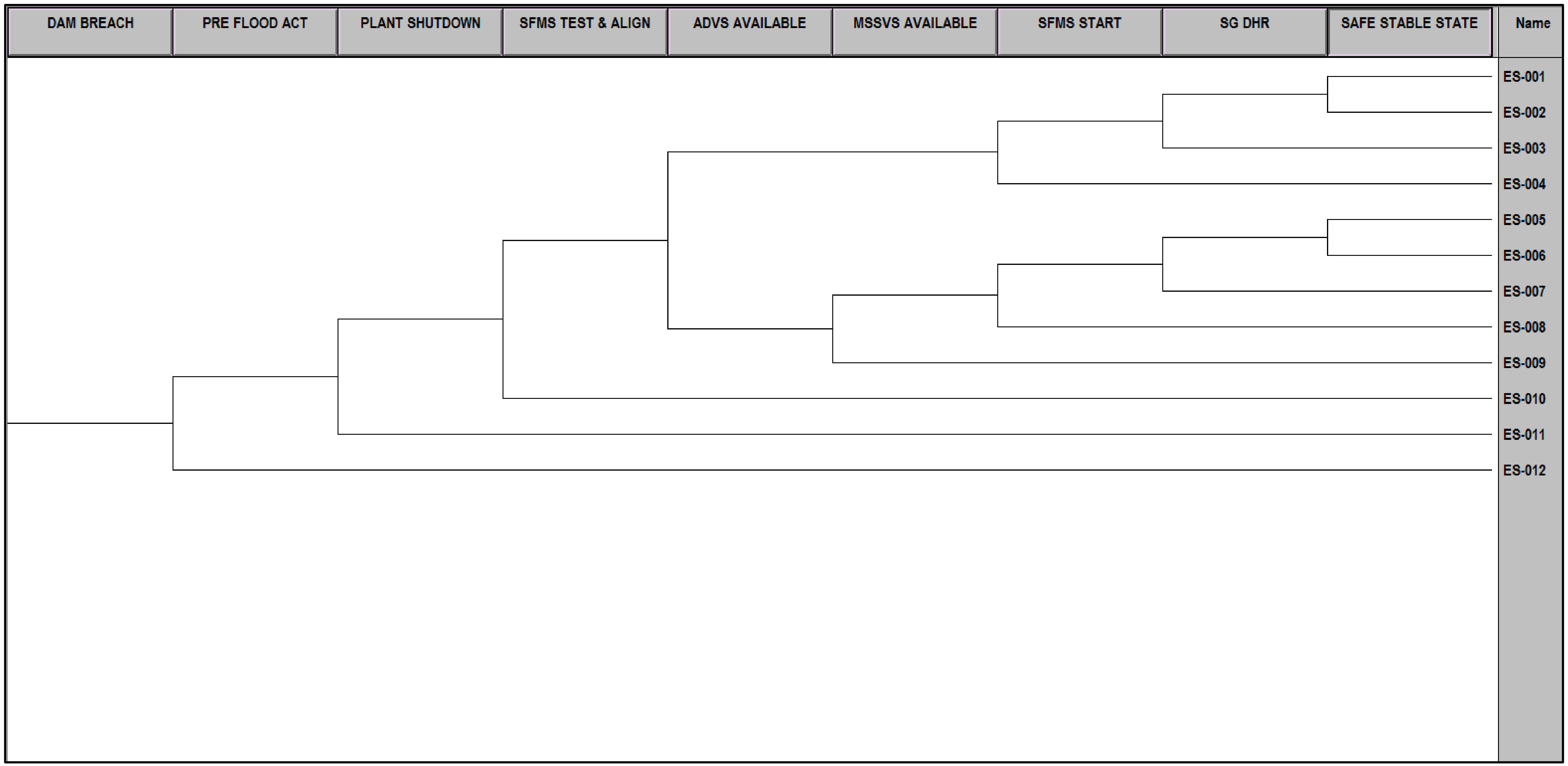
Table 6-3:
Summary of Low Probability End States

End State	Description of End State	Justification of Low Probability
		is available to the operators before the flood. The redundancy in two separate paths to release steam to the atmosphere makes this end state very unlikely.
ES-010	The sequence represents the failure to test and align the SFMS equipment. This includes not dispatching a crew to the SFMS building in a timely manner, inability to correctly align AC power and SFMS Pumps or failure to run of the SFMS DGs and P-1-4.	This is considered a very unlikely end state as the SFMS and associated flood mitigation components are considered important to safety and placed in appropriate preventive/corrective maintenance, surveillance and testing programs to ensure that these systems will be available when called upon. The facility is in a secure and environmentally protected environment. In addition, an adequate supply of parts and trained maintenance personnel are available on site to perform most repairs. The actual time to perform action is very short (under 30 minutes) and very well trained. Available time to perform action is expected to exceed 4 hours. Short term fuel supply is readily established via opening of fuel oil day tank shut-off valves and gravity feed to the DGs. On-site refill of the day tank may be accomplished via refill of the fuel oil transfer pump or direct refill via oil tanks.

Table 6-3: Summary of Low Probability End States		
End State	**Description of End State**	**Justification of Low Probability**
		Procedures to contact suppliers and procurement agreements are in place. Suppliers have been selected based on ability to reach SFMS building site during a flood and regional fuel resources are expected to be adequate based on traditional stored supply in region. Large quantity of available fuel on site provides a significant time buffer (margin) to accommodate delivery delays. A helipad is also available on site to support.
ES-011	This end state implies that the post flood action failed because the plant staff could not maneuver the plant to a cold shutdown condition.	This end state is not considered credible. This action occurs well in advance of the flood reaching the site. Shutdown action is performed periodically and is frequently a subject of training. Once the operators are notified to place the plant in cold shutdown the action to perform the shutdown is highly reliable. Time to plant shutdown is ample and all equipment used will be well within their design parameters.
ES-012	This end state is driven by USACE not notifying site of the impending hazard or the utility not activating the severe flood response plan in a timely manner.	This end state is considered incredible. The USACE monitors dams to ensure their integrity. Re-evaluation results are based on dam failure coupled with a severe

Table 6-3: Summary of Low Probability End States		
End State	**Description of End State**	**Justification of Low Probability**
		storm. The adverse weather condition would ensure USACE additional attention to dam integrity. USACE directly contacts plant management and control room. Once notified utility will follow standard emergency procedures. Time required to perform action is short (several minutes) and available margin is many hours (See Section 7). Sunny day dam failure without limiting antecedent and concurrent conditions will not result in flood level exceeding 905 ft.

Figure 6-3: Scenario Event Tree



THE REMAINING SECTIONS HAVE NOT BEEN REVISED

~~1.~~6 Scenario Human Reliability Assessments (HRA) [LATER]

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[LATER]

~~2.~~7 Timing Analyses and Treatment of Uncertainty [LATER]

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[LATER]

~~3.~~8 Conclusion [LATER]

Comment [NRC156]: Please note documentation sections 8.3 and 8.4 in addition to section 8.2, which addressed mitigation evaluations directly.

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References [LATER]

[LATER]