Nuclear Operating Company

South Texas Project Electric Generating Station 4000 Avenue F – Suite A Bay City, Texas 77414

July 28, 2010
U7-C-STP-NRC-100175

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Response to Request for Additional Information

Reference:
1. Letter, Scott Head to Document Control Desk, "Response to Request for Additional Information," dated May 27, 2010, U7-C-STP-NRC-100119 (ML101530608).
2. Letter, Mark McBurnett to Document Control Desk, "Response to Request for Additional Information," dated January 20, 2010, U7-C-STP-NRC-100023 (ML100250138).

This letter revises the response to Request for Additional Information (RAI) 19-30 provided in References 1 and 2. The attachment addresses the following RAI:

19-30, Revision 2 Response

When a change to the COLA is indicated, it will be incorporated into the next routine revision of the COLA following NRC acceptance of the RAI response.

There are no new commitments in this letter

If you have any questions regarding this submittal, please contact Scott Head at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

D091
NRO

STI 32707935

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 7/28/10

MA McBurnett
Mark McBurnett
Vice-President, Oversight and Regulatory Affairs
South Texas Project Units 3 & 4

dws

Attachment:
RAI 19-30, Revision 2 Response

cc: w/o attachment except*
(paper copy)
Director, Office of New Reactors
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Kathy C. Perkins, RN, MBA
Assistant Commissioner
Division for Regulatory Services
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

Alice Hamilton Rogers, P.E.
Inspection Unit Manager
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

C. M. Canady
City of Austin
Electric Utility Department
721 Barton Springs Road
Austin, TX 78704

*Steven P. Frantz, Esquire
A. H. Gutterman, Esquire
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Ave. NW
Washington D.C. 20004

*Rocky Foster
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852

(electronic copy)
*George F. Wunder
* Rocky Foster
U. S. Nuclear Regulatory Commission

Steve Winn
Joseph Kiwak
Eli Smith
Nuclear Innovation North America

Peter G. Nemeth
Crain, Caton & James, P.C.

Richard Peña
Kevin Pollo
L. D. Blaylock
CPS Energy

RAI 19-30

QUESTION

At the staff audit of the South Texas Projects Unit 3 and Unit 4 PRA on September, 23, 2009, the staff reviewed the calculation, "External Flooding Event Breach of the Main Cooling Reservoir (MCR)". The calculation was dated April 20, 2009 and was referenced in the applicant's RAI response to 19.01-10 which discussed the PRA for external flooding due to MCR breach. The staff then reviewed Section 2.4S.4.1.2 of the FSAR which evaluates postulated failure of the MCR. Based on staff review of these two documents, the staff requests that the applicant address the following questions:

1. Section 2.4S.10 of the FSAR states: "All safety-related facilities in the power block are designed to be water tight at or below elevation 40.0 ft MSL. All water tight doors and hatches are normally closed under administrative controls and open outward. ... An MCR embankment breach near the STP 3 & 4 power block area would not provide sufficient time for implementation of emergency operating procedures or flood warning systems. As all water-tight doors and hatches are to remain in a closed position, no emergency operating procedures or plant Technical Specifications (plant shutdown), which are discussed in Subsection 2.4S.14, are required for implementation of flood protection measures." The MCR external flooding PRA analysis described in Section 19R of the FSAR is not consistent with the above statement in that under Section 19R the water tight door between the service building and the control building is normally open and takes credit for emergency operating procedures and operator action to close this water tight door during MCR breach. Please clarify this inconsistency and revise the FSAR as appropriate.

2. In STP's response to RAI 19.01-10, STP stated that the overtopping, slope protection erosion, and sliding failure modes are not applicable to the MCR design. Please justify why these failure modes are not applicable to the MCR design, and provide the basis for the reductions in dam failure frequency as a result of excluding these failure modes. In your discussion on why the MCR cannot overtop, please include the following information:

    a. The maximum pumping capacity to the MCR from the Colorado River and the maximum discharge capacity to the Colorado River.
    b. The frequency at which the MCR levels are monitored and how this information is alarmed/displayed in the control room.
    c. The procedures used to control MCR level, and the response procedures if MCR level becomes too high.

3. Section 19R.7.4.1 of the FSAR states: "A breach of the main cooling reservoir could occur suddenly or progress over many minutes." This section of the FSAR also discusses other dam breaches noting that the failure time of most breaches is 15 minutes to 1 hour, and some breaches become fully developed in as little as 6 minutes. A sudden breach of the MCR (e.g., seismic liquidfication) may not provide sufficient time for the

operator to close the water tight door between the service building and the control building (i.e., basic event OCD = 1.0). Please address the external flooding analysis due to sudden MCR breaches.

4. Please assess the impact of Category 4 and 5 hurricanes on the frequency of MCR breach. Address how a storm surge from such a hurricane would affect the MCR levee system and the exterior side of the reservoir that has no liner.

5. Please provide your data sources for dam failures that include infantile dam's failures that were used to support your reduction factor for satisfactory operation of the MCR for five years. Based on staff review of dam failures from the National Performance of Dams Program (NPDP), developed by the Department of Civil and Environmental Engineering at Stanford University, including the Taum Sauk dam failure in 2005, the inclusion of infantile dam failures would result in generic dams break frequencies greater than 1E-4 per year. In addition, it appears that the reduction you credited for satisfactory operation of the MCR seems to be double-counting. Please address these issues in your response.

6. Please justify the factor of three reduction you used, based on the assumption that the location of a breach is limited to a thousand foot section. Please explain why any thousand foot section in the 16,250 foot perimeter facing the safety related buildings can not cause a flood.

7. Please assess the impact of a MCR breach during cold shutdown and refueling if secondary and primary containment has open penetrations to facilitate maintenance. Please consider the elevations of these penetrations in your assessment.

8. Please document if the assumptions, insights, or conclusions in the referenced calculation change given the revised MCR breach evaluation in Section 2.4.4.1.2 of the FSAR.

9. The staff needs more information on the probability (basic event- OCD) of the operator failing to close the single normally open flood door between the service building and the control building. To justify the human error probability 0.1, please provide the following information:

   a. The criterion that you will supply to the guard at security house to determine if the MCR has breached.

   b. The process by which these procedures will be controlled.

   c. The potential for ambiguous visual indication on the occurrence of a MCR breach including: the occurrence of local ponding due to heavy rains and the ability of the guard to identify increased flood levels due to reduced visibility during heavy rain storms, fog, etc., particularly at night time.

d. Section 19R.7.5.1 of the FSAR states: "...a minimum available warning time from water at the South Security Gate House, approximately El. 32.0' MSL, to water at the entrances to safety-related buildings, El. 35.0' MSL. At least 30 minutes is available for operator action to close the normally open access door between the Service Building and the Control Building once water reaches the South Security Gate House." Please sufficiently justify the operator action time of at least 30 minutes.

REVISION 2 RESPONSE

Based upon discussions and feedback provided by the NRC during a Chapter 19 Open Items meeting and further discussions during a subsequent Open Items phone call, the response provided to Request for Additional Information (RAI) 19-30 in U7-C-STP-NRC-100023, dated January 20, 2010, (ML100250138) is revised as indicated below. The Revised Response provided to RAI 19-30 in U7-C-STP-NRC-100119, dated May 27, 2010 (ML101530608) is replaced in its entirety by the information provided below. This revision incorporates the basis for screening the Main Cooling Reservoir breach and other external flood events described and analyzed in FSAR Section 2.4S from FSAR Appendix 19R. In addition, the status of all watertight doors is changed from Normally Open to Normally Closed.

Based on the change in watertight door status, the following COLA Sections will be revised.

FSAR Section 2.4S.10 will be revised as shown below.

2.4S.10 Flooding Protection Requirements

~~An MCR embankment breach near the STP 3 & 4 power block area would not provide sufficient time for implementation of emergency operating procedures or flood warning systems.~~ As all water-tight doors and hatches are normally closed, no emergency operating procedures or plant Technical Specifications (plant shutdown), which are discussed in Subsection 2.4S.14, are required for implementation of flood protection measures.

FSAR Section 2.4S.14 will be revised as shown below.

2.4S.14 Technical Specifications and Emergency Operation Requirements

Specific flood protection measures are described in Subsection 2.4S.10. To withstand the static and dynamic forces as a result of the MCR embankment breach, watertight flood protection measures and structural measures are applied to any STP 3 & 4 facilities that have an open passageway to any safety-related facility. Since all watertight doors and hatches for these facilities, at or below 40.0 ft. MSL, are ~~to remain in a closed position~~ normally closed under administrative control, no emergency operating procedures or plant technical specifications (plant shutdown) are required for implementation of flood protection measures.

FSAR Appendix 19R will be revised as shown below.

19R.6.4 Operator Actions

STP DEP T1 5.0-1

The following site-specific supplement addresses the STP 3&4 design that has all openings to safety-related buildings below the Design Basis Flood (DBF) level closed.

(4) ~~Ensure that the~~ ~~*Close*~~ Verify all *watertight doors at* the *entrance to the control room and* Reactor Building *areas* are closed *if floods in the turbine building result in service building flooding.*

19R.7 External Flooding Evaluation

Summarized in the sections below is the probabilistic risk assessment (PRA) external flooding ~~PRA analyses~~ assessment for the STP 3 & 4 plants. External flooding is defined as intrusion of water from sources outside of plant buildings such that the ability of the plant to achieve safe shutdown is affected. ~~The analysis determined the potential core damage frequency (CDF) that could result from external flooding events for each of the new units and was developed assuming that the watertight doors providing normal access to the main control room and the two watertight doors in the Reactor Building Access Corridor are is open. This assumption provides a conservative and bounding assessment of risk from external flooding because the administrative controls will require the doors to be closed except when in actual use.~~

19R.7.1 Methodology

STP DEP T1 5.0-1

The "Addenda to ASME/ANS RA-S-2008, Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, ASME/ANS RA-Sa-2009" (Reference 19R-5), contains screening criteria for external events other than fire and seismic events in Subsection 6-2.3. In NUREG-1407 (Reference 19R-6), the NRC recommended a similar set of screening criteria for the Individual Plant Examination of External Events (IPEEE) required of all operating nuclear power plants.

In ASME/ANS RA-Sa-2009, Subsection 6-2.3, the fundamental criteria for screening external events other than fire and seismic events are as below:

> "There are three fundamental screening criteria embedded in the requirements here, as follows. An event can be screened out either

a. if it meets the criteria in the NRC's 1975 Standard Review Plan (SRP) or a later revision; or
b. if it can be shown using a demonstrably conservative analysis that the mean value of the frequency of the design-basis hazard used in the plant design is less than ~10^{-5}/yr and that the conditional core damage probability is <10^{-1}, given the occurrence of the design-basis hazard event; or
c. if it can be shown using a demonstrably conservative analysis that the CDF is <10^{-6}/yr."

The STP design for safety-related systems, structures and components satisfies the requirements of Standard Review Plan 3.4.2, Revision 3 which was in effect at the time of the Combined License Application. Criterion (a) of ASME/ANS RA-Sa-2009 Subsection 6-2.3 is satisfied for the external flood scenarios and these events are screened from detailed quantitative evaluation.

~~To develop the external flooding analysis for STP 3 & 4, the following steps were performed:~~

- ~~Identification and screening of external flooding initiating events.~~
- ~~Quantification of external flooding initiating event frequency.~~
- ~~Analysis of external flooding accident sequences and development of event trees.~~
- ~~Quantification of external flooding core damage frequency.~~

~~Details of these steps are provided in the subsections that follow.~~

~~19R.7.2 Identify and Screen Initiating Events~~

~~STP DEP T1 5.0-1~~

~~External flooding at the STP site potentially can be initiated by several basic sources: river flooding which includes ice flooding, upstream dam breaks and landslides, tsunamis, hurricane surge, intense rainstorms, and onsite sources including Main Cooling Reservoir breach and failure of an ultimate heat sink (UHS). Events from these sources could, potentially, be related. For example, a storm could cause both a breach of an upstream dam and local flooding at the site. These correlated flooding events are analyzed in Section 2.4S of this application. This analysis considers independent and correlated flooding events.~~

~~Ice flooding of the Colorado River adjacent to the STP site is not considered a potential hazard because the warm temperatures of the area and the tidal effects that are felt on the river in the area. Therefore, ice flooding is screenedexcluded as a potential initiating event.~~

Based on analysis performed for STP 1&2 (Reference 19R.7-119R-1), landslides are not considered a threat to the STP site. Therefore, landslides are screenedexcluded as potential external flooding initiating events.

Analysis for STP 1 and 2 Units 3 and 4(Reference 19R.7-1) also concluded that tsunamis cannot affect the site. Therefore, tsunamis are screenedexcluded from consideration as initiating events.

The storm surge or seiche resulting from a hurricane could potentially cause flooding at the STP site. However, the maximum water level at the STP site that would be expected from such an event would be elevation 26.7431.1 feet. Since this elevation is below grade level, hurricane storm surge or seiche can beis excluded as an external flooding initiating event.

Intense precipitation can result in flooding local to the STP site because plant buildings will be constructed so that all external entrances are at least one foot above the flood level expected from a probable maximum precipitation event. Since the maximum flood level expected from intense precipitation is one foot below grade level for Units 3 and 4, intense local precipitation is screened from consideration as an external flooding initiating event.Section 2.4S.2.3 of this COLA determined the maximum height of floodwater from a probable maximum precipitation (PMP) event at 36.6' MSL. Section 2.4S.4 identifies the grade at the center of the site as 36.6 dropping to 32' at the perimeter of the site. ANS 2.8-1992 (Reference 19R-4) defines PMP as the estimated depth of precipitation for a given duration, drainage area, and time of year for which there is virtually no risk of exceedance. Using example methodology of Appendix B to ANS2.8-1992, floods from PMP events that potentially challenge safety related SSCs are screened from further consideration due to the very low frequency of exceedance. The results of intense precipitation events that approach the PMP depth are bound by the design basis flood level of 40.0' MSL based on the MCR breach analysis.

The normal operating elevation is 26 feet for the essential cooling pond (ECP) of Units 1 and 2. Since this elevation is below the nominal grade elevation for the STP site, failure of the ECP is excluded as an external flood initiating event.

The UHS basin for each unit contains a large volume of water. The 6 ft. thick reinforced concrete walls of the UHS basins are designed for seismic and other design basis loadings. However, in the event of a postulated failure of the wall the water in the UHS basin above the ground elevation can escape and flood the surrounding areas. It is unlikely that any failure of the UHS basin walls would result in a large rapid water release. Any failures of the structure would be expected to be small such that site drainage systems would be capable of preventing the water from reaching other safety-related buildings onsite. Therefore, failure of the UHS is screened from further consideration as an external flooding initiating event.

The STP site is located on the Colorado River at river mile 16.4, upstream from the Gulf of Mexico. The potential for dams upstream of the site to cause plant flooding was evaluated as part of the original licensing for Units 1&2. The analyses for Units 1&2 (Reference 19R.7-119R-1) for failure of Mansfield dam show that a maximum flood level of 32.0 ft MSL is expected at the STP site from a single upstream dam break. Since this level is below the elevation of Unit 3&4 plant buildings, single upstream dam breaks can be screened from further consideration as external flooding initiating events.

Section 2.4S.3 of the COLA determined the maximum height of floodwater from a probable maximum flood (PMF) event on the Colorado River at 26.1 ft MSL. The still water elevation of this event is lower than the still water elevation for the multiple cascading dam flood event of 32.5 ft MSL, so no wave runup was determined in 2.4S.3. As the water level from the PMF event is lower than the multiple cascading dam failure flood event, the PMF on the Colorado River is screened from further analysis.

In addition the potential flooding effects from multiple, cascading failures of Colorado River dams upstream of the STP site has the potential to affect safety-related structures. ThatThe analysis described in Chapter 2.4S.4.3.1 shows that a peak still water elevation of 34.1 feet with wave runup to the 43.7 foot elevation. Therefore32.5 ft MSL and a wave runup of 1.9 ft for a resulting flood elevation of 34.4 ft MSL. As the building entrances are above this water level, multiple, concurrent dam failures are not considered as an external flooding initiating event.

The Main Cooling Reservoir (MCR) is formed by a 12.4 mile, earth filled embankment enclosing 7,000 acres of surface area at a normal operating level of 49.0 MSL with a capacity of 175,000 acre feet. The embankment, about 2100 feet south of the south face of the plant power block, rises an average of 40.0 feet above the natural ground surface. Breach of the MCR produces the critical flood levels at the STP site. Therefore, MCR failure is considered as an external flooding initiating event.

19R.7.3 Quantification of External Flooding Initiating Event Frequency

STP DEP T1 5.0-1

The analysis of the frequency for MCR failures begins with the frequency developed as part of the Unit 1&2 IPEEE analysis. That value has been updated to reflect MCR operating experience since completion of the IPEEE. The initiating event frequency for MCR failures that could impact Units 3&4 is determined to be very low.

The frequency of multiple, concurrent upstream dam breaks considers the failure of three dams, the S. W. Freese, Buchanan, and Mansfield Dams. The analysis assumes that the first dam failure can occur randomly and that the second and third failures are dependent on the previous dam failures. The sequence of events analyzed begins with failure of the S. W. Freese Dam which began operation in 1990.

Downstream of the S. W. Freese Dam is the Buchanan Dam. It is assumed that failure of the Buchanan Dam is dependent on the failure of the S. W. Freese Dam. Table 19R-4 gives values for common cause factors. Although not considered a common cause failure in the traditional sense, the second and third dam failures are analyzed using the common cause factors from Table 19R-4. Using the Beta factor from Table 19-4, failure of the Buchanan Dam, given failure of the S. W. Freese Dam is calculated.

Failure of the third dam, the Mansfield Dam, given failure of the first two dams, is calculated using the Gamma factor given in Table 19R-4. The frequency of multiple concurrent dam failures considered as external flooding initiating events is calculated to be very low.

The UHS is waterproof up to the site design basis flood level. As there are no openings in the Cooling Tower or the RSW Pump House below the site design basis flood level, the UHS is screened out from the consideration of flooding caused by the design basis flood.

19R.7.4 Accident Sequence Analysis
STP DEP T1 5.0-1

The subsections that follows summarizes the accident sequence analysis for the twoone events considered as an external flooding initiating events.

19R.7.4.1 Main Cooling Reservoir Breach
STP DEP T1 5.0-1

Note that this analysis is developed assuming that the watertight door providing normal access to the main control room is open. This assumption provides a conservative and bounding assessment of risk from external flooding because the watertight door to the main control room would be closed except for intermittent ingress and egress (Refer to FSAR Section 2.4S.10).

A breach of the main cooling reservoir could occur suddenly or progress over many minutes. A discussion of previous dam breaches notes that the failure time of most breaches is 15 minutes to one hour from the time of inception to completion of the breach. However, some breaches became fully developed in as little as 6 minutes while others took more than 7 hours. It was also noted that half the breaches identified occurred in less than 1.5 hours. Therefore, it is concluded that, while there is a good deal of uncertainty and variability associated with the breach time, 15 minutes to one hour would likely be conservative. Breach width was also noted to be typically 2 to 5 times dam height (Reference 19R.7-219R-2). The timing of the breach along with the width of the breach affects the height of water that reaches plant buildings. Smaller breaches or breaches that take longer to develop would result in a lower level of water on plant buildings. For smaller and slower developing breaches, it can be expected that water would not rise above grade elevation on plant buildings. For larger and faster developing breaches, water level on plant buildings would be higher. The analysis, originally documented in the IPEEE of Units 1&2 (Reference 19R.7-319R.3), considered that failures of the MCR are equally likely to occur anywhere along the perimeter and excluded from consideration that portion of MCR failures that would direct water away from plant buildings. MCR failures that would result in water flowing away from the site would not be considered as external flooding initiating events, consistent with the analysis presented in Reference 19R.7.319R.3. This assumption is considered reasonable since the land around the MRCMCR generally slopes southward towards the Colorado River. This analysis assumed that any breach of the main cooling reservoir that is included in the initiating event definition is sufficiently large that water level will rise above the entrances to plant buildings. This analysis also assumed that the main cooling reservoir breach would cause a loss of offsite power either because of failure of the switchyard equipment or the plant auxiliary transformers that are impacted by the floodwaters. Furthermore, this analysis assumed that the loss of offsite power is not recoverable for several days.

A breach of the main cooling reservoir would cause water to flow across lighted roadways and open areas between the main cooling reservoir and the plant. Security personnel are stationed such that they have a clear view of these areas. On seeing the developing breach or water flow, they would notify the main control room in accordance with their training and procedures.

ExternalWith the exception of the normally open access door to the control building from the service building, external access points to the control and reactor buildings are provided with normally closed, watertight barriers or doors designed to withstand the maximum loadings of any potential main cooling reservoir breach. All these doors are alarmed at the central alarm station so it is unlikely that one would be left open. Failure of any one of these doors would allow water to enter the building and flow through drains, stairways, and non-watertight doors to the essential electrical switchgear rooms below grade. Since there are no internal watertight barriers to protect the rooms on lower elevations from water entering the upper elevations, it is conservatively assumed that failure of one of the watertight doors on the reactor building would result in core damage.

The normal access to the main control building is via the service building through a watertight door on the 2950 mm elevation. As discussed above, this analysis assumes that this door is open. The door is oriented such that water external to the control building will seal the door. In addition, there are other normally closed watertight doors that provide access to the control building from the service building and that are located either at or below grade. Since the service building is not designed to withstand flooding, it is assumed that a main cooling reservoir breach would result in water entering the service building. If any one of the doors from the service building to the control building is not closed or fails, then water could enter the control building and cause failure of all three divisions of reactor cooling water (RCW) or DC power since these are located below grade. Since there are no internal watertight barriers to protect the rooms below grade in the control building, it is conservatively assumed that failure of one of the watertight doors on the control building would result in core damage.

The turbine building and service building are not designed to withstand the effects of a failure of the main cooling reservoir. Therefore, it is conservatively assumed that any equipment in the turbine building or service building is failed by the flooding caused by a breach of the main cooling reservoir. PRA-related equipment housed in the turbine building includes the condensate and feedwater systems and the combustion turbine generator (CTG).

When notified of a main cooling reservoir breach by security personnel, the operators in the main control room staff would ensure that the normally open, watertight control room access door is closed. Closing this door prevents water from entering the control building. As discussed above, failure to close this door would result in submerging the control building and is conservatively assumed to result in core damage.

If the door to the main control room is closed, then the event progresses as a loss of offsite power since it is assumed that the MCR breach causes a loss of offsite power. Because of the loss of offsite power, all equipment powered from non-essential electrical buses is initially lost. The loss of offsite power would result in the EDGs starting and loading to their respective essential electrical buses. The CTG would be failed by the flood so failure of all three EDGs would result in a station blackout (SBO). For this analysis, a SBO is conservatively assumed to be non-recoverable and result in core damage.

If one or more EDG starts and loads its respective buses, then the reactor can be brought to safe shutdown using equipment powered from the essential AC buses.

The accident progression for this event tree is similar to that of a loss of offsite power. However, for the main cooling reservoir breach, it is assumed that offsite power is not recovered and that failure to insert control rods or a subsequent station blackout would result in core damage.

19R.7.4.2 Multiple, Concurrent Upstream Dam Failures

STP DEP T1 5.0-1

Note that this analysis is developed assuming that the watertight door providing normal access to the main control room is open. This assumption provides a conservative and bounding assessment of risk from external flooding because the watertight door to the main control room would be closed except for intermittent ingress and egress (Refer to FSAR Section 2.4S.10).

The accident progression for multiple, concurrent upstream dam failures is similar to that of the main cooling reservoir breach except for timing. Since the last dam that would fail, the Mansfield Dam, is nearly 300 miles upstream of the STP site, flood waters from that dam failure would not reach the STP site for many hours. In that time, closure of the normally open main control room access door would be assured. In addition, compensatory actions such as sandbagging or installation of other temporary flood barriers can be installed around access doors. These additional compensatory actions, however, are not quantified as part of this analysis. This analysis also assumes that the flooding that results from multiple, concurrent upstream dam failures will cause a loss of offsite power either because of failure of the switchyard equipment or the plant auxiliary transformers that are impacted by the floodwaters. Furthermore, this analysis assumed that the loss of offsite power is not recoverable for several days.

External access points to the control and reactor buildings are provided with normally closed, watertight barriers or doors designed to withstand the maximum loadings of any potential main cooling reservoir breach, a more severe event than multiple, concurrent upstream dam failures. All these doors are alarmed at the central alarm station so it is unlikely that one would be left open. Failure of any one of these doors would allow water to enter the building and flow through drains, stairways, and nonwatertight doors to the essential electrical switchgear rooms below grade. Since there are no internal watertight barriers to protect the rooms on the lower elevations from water that entered the upper elevations, it is conservatively assumed that failure of one of the watertight doors on the reactor building will result in core damage.

The normal access to the main control building is via the service building through a watertight door on the 2950 mm elevation. In addition, there are other normally-closed watertight doors that provide access to the control building from the service building and that are located either at or below grade. Since the service building is not designed to withstand flooding, it is conservatively assumed that the flooding that results from multiple, concurrent upstream dam failures would result in water entering the service building. If any one of the doors from the service building to the control building fails, then water could enter the control building and cause failure of all three divisions of reactor cooling water (RCW) or DC power since these are located below grade. Since there are no internal watertight barriers to protect the rooms below grade in the control building, it is conservatively assumed that failure of one of the watertight doors on the control building will result in core damage.

The turbine building and service building are not designed to withstand flooding. Therefore, it is conservatively assumed that any equipment in the turbine building or service building is failed by the flooding caused by multiple, concurrent upstream dam failures. PRA-related equipment housed in the turbine building includes the condensate and feedwater systems and the combustion turbine generator (CTG).

When notified of an upstream dam failure, steps will be taken (Refer to Section 19.9.3) to ensure that the watertight main control room access door will be closed prior to flood waters reaching the STP site. Since many hours are available to effect this action and the action is simple and visually verifiable, the probability of failing to ensure closure of the door is considered sufficiently small as to be neglected. Closing this door prevents water from entering the control building.

Since the flooding is assumed to cause a loss of offsite power, all equipment powered from non-essential electrical buses would be lost. The loss of offsite power will result in the EDGs starting and loading to their respective essential electrical buses. The CTG is conservatively assumed failed by the flood so failure of all three EDGs would result in a station blackout (SBO). For this analysis, a SBO is assumed to be nonrecoverable and results in core damage.

If one or more EDG starts and loads its respective buses, then the reactor can be brought to safe shutdown using equipment powered from the essential AC buses.

The accident progression for this event tree is similar to that of a loss of offsite power. However, for multiple, concurrent upstream dam failures, it is assumed that offsite power is not recovered and that failure to insert control rods or a subsequent station blackout result in core damage.

19R.7.5 Summary of Accident Sequences

STP DEP T1 5.0-1

The subsections that follows summarize the determination of the accident sequences developed for the two eventsone event considered as an external flooding initiating events. Determination of the CDF made use of the existing ABWR PRA logic models and used a process similar to that used to quantify the internal flooding events.

19R.7.5.1 Main Cooling Reservoir Breach Accident

STP DEP T1 5.0-1

Four accident sequences lead to core damage. Core damage results if any one of the top events fails. Development of each of the top events is discussed below.

IEBMCR – Breach of Main Cooling Reservoir

This Initiating Event represents the main cooling reservoir breach. This event is described above.

~~***OCD – Operator Action To Close Control Room Watertight Access Door or RB/CB External Doors Fail***~~

~~This top event represents failure of the watertight doors to prevent flood waters from entering either the control building or the reactor building. Failure of this top event can occur from two causes. First, the operators can fail to close the normally open, watertight door that provides main control room access from the service building. As described in section above, security personnel are stationed such that they will have a clear view of the area between the main cooling reservoir and plant buildings. This analysis assumes that the security staff is trained and that procedures are in place for them to alert the control room if there are indications of a breach of the main cooling reservoir. Procedures are also assumed to be in place to direct that the main control room access door be closed immediately on notification of a potential external flooding event (Refer to Section 19.9.3). Furthermore, the analysis assumes that the area between the main cooling reservoir and plant buildings is lighted to an extent that any flow of water from a breach of the main cooling reservoir would be clearly visible to the security personnel at night.~~

~~As discussed above, development of a main cooling reservoir breach is expected to take from 15 minutes to one hour. The main cooling reservoir breach analysis described in Section 2.4S.4 was used to develop a minimum available warning time from water at the South Security Gate House, approximately El. 32.0' MSL, to water at the entrances to safety-related buildings, El. 35.0' MSL. At least 30 minutes is available for operator action to close the normally open access door between the Service Building and the Control Building once water reaches the South Security Gate House. Once the security staff notifies the control room of the breach, closing and securing the watertight door takes less than one minute. Therefore, it is assumed that a moderate and adequate amount of time is available to effect the actions to close the control room access door. Then the failure probability for this event was assigned using the values in the Standard Safety Analysis Report (SSAR) Table 19R-4.~~

~~Even if operator action to close the normally open door is successful, failure of any one of the watertight doors that allow access to the reactor building or control building could randomly fail. Using the values in the SSAR Table 19R-4, the probability of random door failures that allow water to enter either the control building or the reactor building was calculated.~~

~~The total probability of failing to isolate the control and reactor buildings from a main cooling reservoir breach is the sum of the operator failure probability and the random door failure probability.~~

~~***C – Failure To Insert Control Rods***~~

~~This top event represents failure to insert the control rods on the loss of offsite power caused by the external flooding event. The probability of this event is taken from the internal events PRA models.~~

PO1 - SRVs Fail To Open (After Scram)
This top event represents failure of the safety relief valves (SRVs) to open after a reactor trip. The probability of this event is taken from the internal events PRA models.

SSD - Reactor Brought To Safe Shutdown Condition
This top event represents failure to bring the reactor to a safe shutdown condition. Since the main cooling reservoir breach is assumed to result in a non-recoverable loss of offsite power, this node is quantified using the existing TEO event tree sequences but accounting for the additional failures that would be caused by the flooding. Basic events that represent these additional failures were set to "True" for the quantification.

The 11 core damage sequences from TEO were quantified to produce the conditional probability of core damage given that an external flooding event occurred. The resulting probability is determined to be low.

Since failure of each of the top nodes on the IEBMCR event tree results in core damage and since each of the top nodes is independent of the others, the total CDF for a main cooling reservoir breach is the product of the initiating event frequency, the success probability of any previous nodes, and the top node failure probability. The total CDF for a breach of the main cooling reservoir is determined to be very low.

19R.7.5.2 Multiple, Concurrent Upstream Dam Failures Accident
STP DEP T1 5.0-1

Four accident sequences lead to core damage. Core damage results if any one of the top events fails. Development of each of the top events is discussed below.

IEDAM - Multiple Concurrent Upstream Dam Failures
This top event represents the failure of the three dams upstream of the STP site on the Colorado River. This event is described above.

WTDOOR - Reactor Building and Control Building External Watertight Doors Fail
This top event represents failure of the watertight doors to prevent flood waters from entering either the control building or the reactor building. Because of the long time available for notification and action following failure of the last dam on the Colorado River, it is assumed that the failure probability of operator action to close the normally open watertight door to the main control room can be neglected.

Any one of the nine watertight doors that allow access to the reactor building or control building could randomly fail. Using the values in Table 19R-4, the

~~probability of random door failures that allow water to enter either the control building or the reactor building is calculated.~~

~~C – Failure To Insert Control Rods~~
~~This top event represents failure to insert the control rods on the loss of offsite power caused by the external flooding event. The probability of this event is taken from the internal events PRA models.~~

~~PO1 – SRVs Fail To Open (After Scram)~~
~~This top event represents failure of the safety relief valves (SRVs) to open after a reactor trip. The probability of this event is taken from the internal events PRA models.~~

~~SSD – Reactor Brought To Safe Shutdown Condition~~
~~This top event represents failure to bring the reactor to a safe shutdown condition. This top event is described in Section 19R.7S.5.1.~~

~~Since failure of each of the top nodes on the IEDAM event tree results in core damage and since each of the top nodes is independent of the others, the total CDF for an external flooding event caused by multiple, concurrent upstream dam failures is the product of the initiating event frequency, the success probability of any previous nodes, and the top node failure probability. The total CDF for a breach of the main cooling reservoir is determined to be very low.~~

~~19R.7.5.3 Total External Flooding Event CDF~~
~~STP DEP T1 5.0-1~~

~~The total CDF from the external flooding events is obtained by summing the CDF from each of the events above and is determined to be very low.~~

~~19R.7.6 Important External Flooding-Related Design Features~~
~~STP DEP T1 5.0-1~~

~~There are several design features important to minimizing external flood-related risk. One is that all buildings are constructed with entrances at least one foot above the flood level that would result from a PMP related flood. This feature allows screening of most external flooding events. Another feature is that all plant entrances and penetrations located below the maximum flood level are protected by watertight barriers or doors. Also, a clear view is provided from plant buildings to the main cooling reservoir thereby allowing for timely notification to the main control room of a main cooling reservoir breach.~~

~~19R.7.7 Operator Actions Related to External Flooding~~
~~STP DEP T1 5.0-1~~

~~One operator action is important to external flooding risk. This action, timely closure of the watertight door at the entrance to the main control room is similar to the event included in section 19R.6.4. However, the cues to initiate the action for the external flooding events areevent is different than for internal flooding.~~

~~19R.7.8 External Flooding Reliability Goals (Input to RAP)~~

~~STP DEP T1 5.0-1~~

~~The results of the external flooding analysis show that watertight doors are important to reducing external flood-related risk. Watertight doors are included as input to the RAP because of internal flooding events. The information from Section 19R.6.5 related to watertight doors is also applicable to the external flooding events and is applied to all external watertight doors on the reactor and control buildings.~~

~~19R.7.9 Conclusions~~

~~STP DEP T1 5.0-1~~

~~The conclusions from the ABWR probabilistic external flooding analysis are that the risk from external flooding is acceptably low, even with the conservative assumption that the watertight normal access door to the control room is open. The risk from external flooding would be significantly lower if analyzed assuming that the door is closed, as described in FSAR Section 2.4S.10. It is also concluded that the incremental risk from external flooding events is within the goals for an increase in CDF or LERF.~~

19R.8 References

19R-5 Addenda to ASME/ANS RA-S-2008, Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, ASME/ANS RA-Sa-2009, American Society for Mechanical Engineers and American Nuclear Society, February, 2009.

19R-6 "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," Report NUREG-1407, U.S. Nuclear Regulatory Commission (1991).

FSAR Appendix 19K will be revised as shown below.

19K.10 Identification of Important Capabilities Outside the Control Room

The identified activities outside the control room are:

(8) ~~Closing the normally-open watertight door to the control room~~ Verifying all watertight doors are closed on notification of a main cooling reservoir breach.

FSAR Section 19.4 will be revised as shown below.

19.4.5 ABWR Probabilistic Flooding Analysis

The following site-specific supplement addresses probabilistic flooding analysis for external flooding.

The ABWR Probabilistic External Flooding Analysis screened all except twobut one external flooding events from consideration because flood waters would not rise to an elevation above the entrances to plant buildings. The two external flooding events with the potential to result in core damage are a)is a breach of the main cooling reservoir and b) multiple, concurrent failures of upstream dams.

BothThe external flooding events areevent is assumed to cause a non-recoverable loss of offsite power as well as fail all equipment in the turbine building and the fire protection pump house.

Failure of any watertight door to prevent external flood waters from entering the reactor building was assumed to result in core damage since the essential AC switchgear is located below grade and there are no internal watertight barriers that would prevent water that enters the reactor building from causing failure of all three AC divisions.

Failure of any watertight door to prevent water from entering the control building was assumed to result in core damage because all three essential DC divisions and the main control room are located below grade and there are no internal watertight barriers that would prevent water that enters the control building from failing all three DC divisions or the main control room. For a breach of the main cooling reservoir, timely operator action is required to close the normally open main control room access door. For multiple, concurrent upstream dam failures, many hours are available from failure of the last dam until flood waters reach the site. Therefore, the operator action to close the main control room access door for the multiple, upstream dam failures is considered assured.

Additionally, failures that resulted in a station blackout were assumed to be non-recoverable and result in core damage.

The total CDF from external flooding events is very small.

FSAR Section 19.8 will be revised as shown below.

19.8.5.3 Features Selected

STP DEP T1 5.0-1

Operator Check Watertight Doors are Dogged

The flooding analysis assumes that all watertight doors ~~except the normally open main control room access door,~~ *are closed and dogged to prevent floods from propagating from one area to another* or from outside to the inside. *The watertight doors are alarmed to alert security personnel that a watertight door is open but,* with the exception of the watertight doors in the RSW pump house, *will not alarm to indicate that a door is not dogged. To guard against a door being left undogged, operators should check the doors every shift to assure that they are closed and dogged.* The watertight doors in the RSW pump house are alarmed if open or if left undogged. All plant entrance doors located below the ~~maximum~~ design basis flood level are provided with normally closed watertight doors or other watertight barriers. The equipment access entrances to the emergency diesel generator rooms are provided with watertight blocks that are only removed for necessary maintenance.

View of the Main Cooling Reservoir

Plant buildings are located such that security personnel will have a clear and unobstructed view of the main cooling reservoir. Having such a view allows for prompt notification of the main control room so that ~~the~~ all ~~normally open~~ watertight doors ~~to the main control room~~ can be verified closed before failure of the main cooling reservoir could be expected to threaten the plant. The area between the plant and the main cooling reservoir is lighted so that clear views are provided at night.

Operator Actions to Ensure Integrity Against External Floods

In addition to having unobstructed views of the main cooling reservoir, security personnel will be trained to alert the main control room immediately to any indication of main cooling reservoir failure. On such notification, personnel in the main control room will ensure that ~~the access door is closed immediately~~ all watertight doors are verified closed. Also, all external doors located below the ~~maximum~~ design basis flood level will be verified closed ~~and verified~~ on notification of any upstream dam failures. The emergency procedures for Severe External Flooding ensure that watertight barriers are in place and external openings sandbagged prior to the arrival on site of high water levels from external flooding (COM 19.9-3).

FSAR Section 19.9 will be revised as shown below.

19.9.3 Event Specific Procedures for Severe External Flooding

(1) Procedures and training will be developed to ensure that observation of the main cooling reservoir is conducted such that main control room personnel will be alerted on indications of a main cooling reservoir breach. These procedures will also direct that ~~the main control room~~ all ~~access door~~ watertight doors will be verified closed immediately on receipt of such notification.

(3) Procedures will be developed to ensure that flood barriers and external watertight doors are verified closed on notification of Colorado River dam failures upstream of the site or upon notification of severe storms with a potential for significant rainfall.

FSAR Section 19.11 will be revised as shown below.

19.11 Human Action Overview

~~STP DEP T1 5.0-1~~

~~A new human action is modeled by the STP 3 & 4 external flooding analysis (Appendix 19R) to close the control room watertight access door in the event of an external flood. This action has been found to be important and meets the provisions identified in Subsection 19D.7 for important human actions and critical tasks. In addition, Subsection 19.9.3 documents the actions to be completed to ensure the human action's reliability.~~