Response to Action Item 19-26 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-26 (AI 19-26)

Page 19.1-198 states "These probabilities [for failure of hydrogen control] are believed to be conservative, but additional calculations are needed to confirm." What is the basis for stating these probabilities are conservative? When will the additional calculations be completed?

Response

The hydrogen calculations to support the assumptions were not complete at the time of the initial submittal, so this key assumption was made to bound the effect of hydrogen-induced containment failure. The calculations are now complete. The results confirm that the assumptions made were conservative, and the DCD (See Attachment 1) and notebook APR1400-K-P-NR-013762-P are updated to document the basis for the conservative assumptions (See Attachment 2).

Note: Attachment 2 is placed in the electronic reading room.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model. However, the notebook APR1400-K-P-NR-013762-P will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DCD TIER 2

Attachment 1 – Section 19.1.6.2.2.5 DCD Markup for Question PRA-26

[Section 19.1.6.2.2.5, Page 19.1-198]

B. For the LPSD PRA, a detailed evaluation of hydrogen effects in containment was performed. The analysis considered various LPSD accident sequences with and without cavity flooding, containment sprays, hydrogen igniters and PARs. Deflagration was considered occur early and/or late, depending on conditions in containment, but was found not to have any significant contribution to containment failure probability. The analysis determined that with either the igniters or PARs available, neither global nor local hydrogen concentrations exceed 10%. Without igniters or PARs, some scenarios yield higher hydrogen concentrations and the potential for detonation or deflagration to detonation (DDT), though in most cases the pressure transient is not large. The LPSD Level 2 conservatively treats the potential for containment failure due to hydrogen detonation or DDT by increasing the conditional probabilities of containment failure (given PARs failure and other conditions) above the probabilities developed for the at-power PRA. Failure of hydrogen control from PARs and/or igniters is assumed to yield a conditional probability of containment rupture due to hydrogen detonation of 0.1, plus another conditional probability of containment rupture due to hydrogen burn of 0.1 or 0.01, depending on the accident conditions.

Response to Action Item 19-53 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-53 (AI 19-53)

It is unclear why some reactor trip sequences do not appear to include the consequential LOOP event. Also, it is unclear from the information in the DCD, how the consequential LOOP was modeled for LOCA and other events that may actuate the ESF.

Response

Consequential LOOP is evaluated for all modeled initiating events in the APR1400 full power internal events PRA.

Consequential LOOP is modeled as a top event in the “transient” event trees (e.g., general transients, loss of condenser vacuum, loss of DC bus A or B, loss of feedwater, etc.) Consequential LOOP is modeled in these transient event trees as a transfer to the "GRID-LOOP" event tree for these events since the LOOP event tree is more indicative of the accident sequence progression. That is, the accident sequence success (and failure) paths are the same for these transient events and consequential LOOP events (i.e., successful mitigation requires either successful secondary cooling, or successful feed and bleed with subsequent long-term heat removal) and by transferring to the GRID-LOOP event tree, allows for subsequent consideration of SBO events. Subsequent failure of all four DGs can transfer from the GRID-LOOP event tree to the GRID-SBO event tree which considers the use of the AAC, and the possibility of offsite power recovery.

For the other events including SGTR and LOCAs, LSSB’s, etc. the accident sequence progression is significantly different than it is for GRID-LOOP, and this sequence information would be lost if there were a transfer to the GRID-LOOP tree. Hence, the conditional loss of offsite power is modeled within the fault trees supporting the event tree top events for these initiators (fault tree gate GNP-GRID). GNP-GRID, which incorporates the probability of consequential LOOP given a reactor trip, directly fails offsite power in the AC power fault trees by failing power to the UATs and SATs. Note that by not transferring to the GRID-LOOP event tree, there is no subsequent transfer to the GRID-SBO event tree if all four DGs fail, and therefore, neither the AAC nor the possibility of offsite power recovery is considered (e.g., SLOCA with subsequent SBO is considered a non-recoverable core damage sequence). This may be conservative, but generally, the small IEFs associated with these type initiators coupled with the likelihood of a conditional LOOP <u>and</u> the low probability of failing all four DGs makes these cutsets non-risk significant.

Since this modeling is consistent with modeling of consequential LOOP in PRAs for many U.S. Nuclear Power Plants, no changes to the DCD are deemed necessary at this time.

Response to Action Item 19-53 Section 19.1

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-55 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-55 (AI 19-55)

It is unclear how the house load operation (HLO) described in DCD Page 19.1-20 is modeled or assumed in the PRA.

Response

DCD sub-section 19.1.3.1.i describes APR1400 design features for the AC Power System including house load operation (HLO); however, HLO is not credited in the PRA. Section 19.1.3.1 of the DCD is revised to reflect this (See Attachment 1.)

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DCD TIER 2

Attachment 1 – Section 19.1.3.1 DCD Markup for Question /PRA-55

[Section 19.1.3.1, Page 19.1-20]

All safety-related SSCs are powered from the Class 1E 4.16 kV power system, either directly or through transformers if a lower voltage is needed. The arrangement of EDGs, electrical distribution system, and supported loads is completely independent of each other. If power from both the UATs and SATs is lost, the normal power source to the Class 1E power system is also lost, and the Class 1E buses are provided by the EDGs. In addition, the non-safety AAC power source is provided to cope with an SBO condition.

When the main generator is isolated from the transmission system due to an out-of-step condition, system disturbance, or operator action, the plant can be aligned for house load operation (HLO). During HLO, both the non-Class 1E and Class 1E power systems are fed from the main generator through the UATs if the main generator is not connected to the grid. The HLO is intended as a temporary measure when the transmission system is unavailable due to a short-duration system disturbance. Once the transmission system is restored, the main generator is resynchronized to the transmission system and normal operation is resumed. Note that HLO is not credited in the APR1400 PRA.

j. Emergency Diesel Generators (EDGs)

Four redundant Class 1E EDGs are provided to supply onsite power to the Class 1E power system. Following the loss of voltage or prolonged degraded voltage condition on a Class 1E bus, the incoming breaker for the Class 1E switchgear is tripped, all the loads (except the 480V load center) are shed, including the non-Class 1E loads fed from the Class 1E bus, before the EDG is started. Once the EDG has reached rated voltage and speed, it is connected to the bus, restoring power in a sequence. Non-Class 1E loads fed from the Class 1E bus with isolation breakers may be reconnected manually, if sufficient spare capacity is available.

Response to Action Item 19-63 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-63 (AI 19-63)

Section 19.1.4.1.1.1, what is meant by CCF potentials?

Response

CCF potentials is meant to imply the evaluation of potential common cause failures (CCF) causing systems failures or partial system failures resulting in initiating events. For example, CCF of both “A” train CCW pumps results in a partial loss of CCW event (PLOCCW) due to loss of CCW flow to the RCPs, however, CCF of both “B” train CCW does not result in an initiating event. Furthermore, CCF of one CCW pump in each train does not result in an initiating event. Therefore, loss of two CCW pumps due to CCF has the potential to result in an initiating event, but not all CCF events result in an initiator. The DCD is revised to more clearly state the intention as described above (See Attachment 1).

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Section 19.1.4.1.1.1 DCD Markup for Question PRA-63

[Section 19.1.4.1.1.1., page 19.1-36]

A thorough and systematic search is performed to define the spectrum of initiating events that could occur at an APR1400 plant. This list of accidents includes both design basis events (e.g., LOCAs, SGTR, and LOOP), as well as beyond design basis events (e.g., ATWS and SBO).

Potential initiating events are identified based on generic industry lists of initiating events, review of plant-specific system and design features including the potential for common cause failures to result in an initiating event, system interfaces~~,~~ and spatial interactions~~, and CCF potentials~~. For each of the potential initiating events identified, a qualitative evaluation is performed to assess the applicability of the event to the APR1400 design.

New initiators unique to the APR1400 design are also identified. Initiating events that are the result of support system failures or transients, called special initiators, are also considered through review of the existing design information.

Response to Action Item 19-64 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-64 (AI 19-64)

Section 19.1.4.1.1.1, what new initiators unique to APR1400 were identified?

Response

Although a search of unique initiators, including a review for special initiators, was made during the searches and reviews discussed in Section 19.1.4.1.1.1, no initiators unique to the APR1400 were identified. Section 19.1.4.1.1.1 of the DCD is revised to more accurately state this fact (See Attachment 1).

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DCD TIER 2

Attachment 1 – Section 19.1.4.1.1.1 DCD Markup for Question PRA-64

[Section 19.1.4.1.1.1, page 10.1-36]

A thorough and systematic search is performed to define the spectrum of initiating events that could occur at an APR1400 plant. This list of accidents includes both design basis events (e.g., LOCAs, SGTR, and LOOP), as well as beyond design basis events (e.g., ATWS and SBO).

Potential initiating events are identified based on generic industry lists of initiating events, review of plant-specific system and design features, system interfaces, spatial interactions, and CCF potentials. For each of the potential initiating events identified, a qualitative evaluation is performed to assess the applicability of the event to the APR1400 design.

~~New initiators unique to the APR1400 design are also identified.~~ Initiating events that are the result of support system failures or transients, called special initiators, are also considered through review of the existing design information for all APR1400 support systems. These special initiators are important as they both: 1) cause an initiating event, and 2) fail a support system required to mitigate the initiator; if they do not meet both of these criteria, they are screened from being a special initiator. Hence, systems can be screened if they do not result in a plant trip, or if they do not support any mitigation function. System failures which may result in a plant trip, but do not support any mitigation function are categorized as a general transient. Systems which were not screened by the criteria stated above are instrument air, component cooling water and essential service water. The resultant special initiators include loss of instrument air (LOIA), and both partial and total losses of either the component cooling system (PLOCCW and TLOCCW) or the essential service water system (PLOESW and TLOESW).

Although a search of unique initiators was made during the searches and reviews described above, no initiators unique to the APR1400 were identified.

The list of potential initiating events is grouped into similar functional categories to reduce the complexity of the PRA. The initiating event frequency for each of these groups is then quantified.

Response to Action Item 19-72 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-72 (AI 19-72)

Section 19.1.4.1.1.2, it is unclear how the event sequence model structure is developed and where it is documented and how the results are used.

Response

For each initiating event, the progression of potential scenarios leading to either a safe state or to core damage is modeled using an event tree. A set of key safety functions must be satisfied in order to prevent core damage; these functions are included as top events. The order of system and operator functional responses are generally ordered in the event trees in sequential order based on the timing of the accident scenarios as they develop. The accident sequence analysis is developed and documented in the Accident Sequence Analysis Notebook (APR1400-K-P-NR-013102-P).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-76 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-76 (AI 19-76)

Section 19.1.4.1.1.2, it is unclear how the containment cooling function modelled in the event trees is used to prevent core damage.

Response

As stated in Section 19.1.4.1.1.2, bullet f. of the DCD (page 19.1-39), the containment cooling function is needed in those scenarios in which RCS heat is transferred to the containment, either due to a LOCA or due to use of the POSRVs.

Failure of containment heat removal results in containment failure due to overpressurization. Failure of the containment is assumed to lead to failure of the SI system which leads to core damage in these scenarios. This is described in Section 4.1.5 of the Accident Sequence Notebook APR1400-K-P-013102-P. Section 19.1.4.1.1.2 of the DCD is revised to clarify this (See Attachment 1).

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Section 19.1.4.1.1.2 DCD Markup for Question PRA-76

[Section 19.1.4.1.1.2., page 19.1-39]

e. RCS heat removal – This function can be achieved by secondary heat removal to relieve steam and inject feedwater into the SGs. The feed and bleed operation may be able to perform this function.

f. Containment heat removal – This function is needed in those scenarios in which RCS heat is transferred to the containment, either due to a LOCA or due to use of the POSRVs. Failure of this function leads to containment failure which is assumed to result in failure of the SI system which leads to core damage in these scenarios.

For each initiating event, progression of potential scenarios leading to either a safe state or to core damage is modeled using an event tree. Functions required for mitigating the accident and for preventing core damage are included across the top of the event tree. Fault trees are used to quantify the probability of failure of each of the functions.

Response to Action Item 19-91 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-91 (AI 19-91)

DCD Page 19.1-62 states, "the RCP seal LOCA probability, given a total loss of seal cooling and the RCP trip, is assumed to be equal to 1 × 10-3 per pump." It is unclear how this relates to the basic event, SEAL-AFSUC, which appears to have a assumed failure probability of 4E-3.

Response

There are 4 reactor coolant pumps (RCPs). Key assumption d. in Section 19.1.4.1.2.5 (page 19.1-62) states that the RCP seal LOCA probability is 1E-3 per pump. Basic event SEAL-AFSUC represents the total seal LOCA probability of 1E-3/pump * 4 pumps = 4E-3.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-123 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-116 (AI 19-123)

Neither the DCD nor the PRA notebooks appear to provide a qualitative evaluation of seismic/fire interaction (NUREG-6850, Task 13), particularly related to impact on suppression systems.

Response

A Seismic-Fire Interaction Assessment (NUREG/CR-6850 Task 13) was not performed at the time the Fire PRA was performed since most of the information required can only be obtained via walkdown, and/or plant specific fire and seismic procedures. Since the plant is in the design certification stage confirmatory walkdowns could not be performed, and the necessary plant specific procedures and other information related to assessing fire brigade response are not yet available.

To support this request a Seismic-Fire Interaction Assessment was performed based on existing design documentation. This document APR1400-K-P-NR-013455-P is now available for review in the electronic reading room.

Section 19.1.5.2 of the DCD is revised to provide a summary of the analysis and results of the Seismic-Fire Interaction Assessment (See Attachments 1, 2, 3, 4, 5 and 6). In addition, two PRA documents, the PRA Summary Report, APR1400-E-P-NR-14001-P, (See Attachment 7), and the LPSD FPRA report, APR1400-K-P-NR-013758-P, (See Attachments 8 and 9) are revised to reflect the new Seismic-Fire Interaction Assessment.

Note: Attachments 7, 8, and 9 are placed in the electronic reading room.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model; however, there is a new fire PRA document, APR1400-K-P-NR-013455-P. In addition, two existing PRA documents, the PRA Summary Report, APR1400-E-P-NR-14001-P, and the LPSD FPRA document, APR1400-K-P-NR-013758-P, will be revised to reflect the new Seismic-Fire Interaction Assessment.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

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Attachment 1 – Section 19.1.5.2.1.1 DCD Markup for Question PRA-116

[Section 19.1.5.2.1.1, page 19.1-133]

Regarding Task 12, the HRA was performed using the screening analysis described in NUREG-1921 (Reference 42). After the initial quantification, detailed HEP analysis was performed on the top 10 HFEs when ranked by Fussell-Vesely importance. These 10 HEPs were incorporated in the final quantification.

Regarding Task 13, two main inputs to the seismic-fire interactions assessment are unavailable at this time. The first is that since the plant is currently in the design certification stage, there is no plant to perform exploratory and confirmatory walkdowns. In addition, at this time there are currently no post-seismic event safe shutdown procedures, post-fire event safe shutdown procedures, or any other fire brigade response procedures available for review. Therefore, the seismic-fire interactions assessment is currently performed using available design documentation only.

19.1.5.2.1.2 Key Assumptions

Various assumptions and engineering judgments provide a basis for the internal fire analysis.

Attachment 2 – Section 19.1.5.2.1.2 DCD Markup for Question PRA-116

[Section 19.1.5.2.1.2, page 19.1-136]

o. It is assumed that automatic suppression systems are designed so that, if successfully activated, they will extinguish the fire prior to additional damage beyond the ignition source itself. Hence, if the ignition source is not a fire PRA-credited component, successful operation of the automatic suppression system will result in a general transient (likely a manual trip) with no PRA-credited equipment damaged. If the ignition source is a PRA-credited component, and the automatic suppression system successfully operates, the fire-induced initiator will be dependent upon the ignition source (e.g., fire in dc bus A will result in LODCA initiator), but will only involve the failure of the ignition source. Failure of an automatic suppression system is assumed to result in full room burnout and possible spread to adjacent compartments.

p. Since there is currently no plant for exploratory or confirmatory walkdowns, and since there are currently no post-seismic or post-fire safe shutdown procedures, or fire brigade response procedures, it is assumed that an adequate assessment of seismic-fire interactions can be performed using design and other PRA documents. It is assumed that the COL applicant will re-perform this analysis when the plant is complete, and when the procedures are available.

19.1.5.2.1.3 Analysis Details

Task 1, Plant Boundary and Partitioning, is conducted in two parts. The first activity involves definition of the global plant analysis boundary, which is defined to be the plant protected area and switchyard; however, it does not include all of the licensee-controlled areas. Notable facilities that are located within the licensee-controlled area but not in the global plant analysis boundary include the engineering building, wastewater treatment

APR1400 DCD TIER 2

Attachment 3 – Section 19.1.5.2.1.3 DCD Markup for Question PRA-116

[Section 19.1.5.2.1.3, page 19.1-142]

etc.). Potential MCA compartments are screened if the exposed compartment has no PRA-credited equipment since the resulting cutsets will be non-minimal to the exposing single-compartment scenario. In addition, potential scenarios involving either the main turbine building (F000-TB) or the containment building (F000-C01) are screened due to the size and geometry, which preclude the formation of a hot gas layer or oil fire spread. In total, 1,055 unscreened MCA scenarios are identified and evaluated. MCA scenarios account for about 14 percent of the CDF and 13 percent of the LRF.

For Task 13, a six step seismic-fire interaction qualitative analysis has been performed via a document review (Reference 7). The document review was necessary due to the fact that the APR1400 is in the design stage and therefore, exploratory or confirmatory walkdowns are not possible. Furthermore, there currently are no post-seismic event or post-fire safe shutdown procedures available for the review.

It was determined in Step 1 that all equipment credited in the SMA is within one of seven seismic Category I buildings, the Auxiliary Building, the Reactor Containment Building, the EDG Building, the Div. I and Div. II CCW Heat Exchanger Buildings and the Div. I and Div. II ESW Buildings.

Step 2 identified that due to the seismic ruggedness of restraints on flammable liquid and gas tanks and piping, electrical cabinets, flammable liquids lockers, and the control of transient flammable gases (e.g., acetylene-oxygen units for welding and cutting maintenance activities) that there were no fire ignition sources unique to a seismic event within those seven buildings; hence, the impact of seismically induced fires is considered to be negligible for the APR1400.

Steps 3 and 5 determined that based on plant design, detector types used, and the seismic ruggedness of the fire protection system components within the seven buildings, the impact of seismically induced suppression system failures or spurious operations would have little impact on safe shutdown following a seismic event.

Steps 4 and 6 determined that although the fire brigade should have access to plant areas containing seismic safe shutdown equipment, and they should have ready access to firefighting equipment, the possibility of multiple spurious false alarms caused by lofted dust setting off photoelectric smoke detectors could impair the ability of the fire brigade to quickly respond to actual seismically induced fires.

In conclusion, the design of the APR1400 minimizes the potential for seismically induced fires to compromise post-earthquake safe shutdown capability; however, when the post-Seismic event and post-Fire safe shutdown procedures are developed, consideration should be given to the potential for multiple spurious alarms from photoelectric detectors [COL 19.1(19)].

19.1.5.2.2 Results from the Internal Fire Risk Evaluation

The internal fire risk evaluation is performed using the design-specific fire protection features in Chapter 9, Appendix 9A and the internal events PRA model of Subsection 19.1.4.

Attachment 4 – Section 19.1.6.3.1.3 DCD Markup for Question PRA-116

[Section 19.1.6.3.1.3, page 19.1-215]

The potential for failure of barriers was evaluated in accordance with the methodology in NUREC/CR-6850, and considering Key Assumptions in Subsection 19.1.6.3.1.2). Risk-significant barriers can be identified by reviewing the importance analysis for the basic events associated with the barrier failures. Specifically, the RAW value of the barrier failure basic event enumerates the risk impact of the failed barrier, and helps identify which barriers are important to fire risk.

As previously stated in paragraph f. of Subsection 19.1.6.3.1.1, the seismic-fire interactions analysis performed for the FP-FPRA is applicable to LPSD POSs; however, when developed, the APR1400 procedural guidance for LPSD maintenance activities in areas containing seismic or fire safe shutdown equipment should [COL 19.1(18)]:

1) ensure the seismic ruggedness of temporary ignition sources, or minimize the duration of temporary ignition sources,

2) ensure the seismic ruggedness of temporary equipment in fire compartments containing potential seismic-fire ignition sources,

3) ensure the seismic ruggedness of temporary equipment near fire protection equipment, and

4) either minimize the duration of activities which could impact manual firefighting, or provide alternative firefighting equipment (e.g., pre-stage portable smoke removal equipment, pre-stage additional firefighting equipment, etc.)

The LPSD Fire Level 2 analysis follows a similar approach as described for the LPSD internal events (Subsection 19.1.6.4.1), with some differences noted here. POS 1-4A and 13-15 are treated similar to the internal events LPSD Level 2.

Attachment 5 – Section 19.1.9 DCD Markup for Question PRA-116

[Section 19.1.9, page 19.1-236]

COL 19.1(15) The COL applicant is to develop a configuration control program requiring that, during Modes 4, 5, and 6, the watertight flood doors and fire doors be maintained closed in at least one quadrant. Furthermore, the COL applicant is to incorporate, as part of the aforementioned configuration control program, a provision that if the flood or fire doors to this designated quadrant must be opened for reasons other than normal ingress/egress, a flood or fire watch must be established for the affected doors.

COL 19.1(~~15~~16) The COL applicant is to develop outage management procedures that limit planned maintenance that can potentially impair one or both SC trains during the shutdown modes.

COL 19.1(~~16~~17) The COL applicant is to develop procedures and a configuration management strategy to address the period of time when one SC train is unexpectedly unavailable (including the termination of any testing or maintenance that can affect the remaining train and restoration of all equipment to its nominal availability).

COL 19.1(18) The COL applicant is to develop outage procedures to ensure that in fire compartments containing post-seismic or post-fire safe shutdown equipment that: 1) the seismic ruggedness of temporary ignition sources is adequate, or that the duration that these temporary ignition sources are in these areas is minimized, 2) the seismic ruggedness of temporary equipment such as scaffolding in fire compartments containing potential seismic-fire ignition sources, or near fire protection equipment is adequate, and 3) either the duration of activities which could impact manual firefighting is minimized, or alternative firefighting equipment (e.g., pre-stage portable smoke removal equipment, pre-stage additional firefighting equipment, etc.) is supplied.

COL 19.1(19) When developing post-earthquake safe shutdown procedures, the COL applicant should consider the potential for multiple spurious alarms from photoelectric detectors following a seismic event.

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Attachment 6 – Table 19.1-4 DCD Markup for Question PRA-116

[Table 19.1-4, page 19.1-283]

Table 19.1-4 (25 of 25)

No.	Insight	Disposition
Risk Insights from PRA Models		
58	The fire PRA assumes that the fire barrier management procedures used during LPSD will include directions to provide reasonable assurance that breached risk-significant fire barriers can be closed in sufficient time to prevent the spread of fire across the barrier. The procedural direction is to include the use of a fire watch whose duties are commensurate with the risk associated with the barrier. For example, for fire barriers that separate two fire compartments that both contain no equipment or cables necessary to prevent core damage or large early release during LPSD conditions, or have been demonstrated to have low risk significance, there will at least be a roving fire watch to check the barrier during rounds. For fire barriers separating fire compartments that contain equipment or cables necessary to prevent core damage or large early release during LPSD conditions, and have been demonstrated to be risk significant with respect to fire, a permanent fire watch will be established until the barrier is reclosed. In the latter case, the fire barrier management procedure is to direct that hoses or cables that pass through a fire barrier use isolation devices on both sides of a quick-disconnect mechanism that allow for reclosure of the barrier in a timely fashion to re-establish the barrier prior to fire spread across the barrier.	Subsection 19.1.6.3.1.2 COL 19.1(11)
59	The fire PRA assumes that the design documents are adequate to perform a qualitative seismic-fire interaction assessment. For verification, the COL applicant is to perform confirmatory walkdowns as required to support the assessment. Details of the seismic-fire interactions walkdown are to be developed by the COL applicant. In addition, the COL applicant is to: • establish a fire protection program, including organization, training, and qualification of personnel, administrative controls of combustibles and ignition sources, firefighting procedures, and quality assurance. • address the design and fire protection aspects of the facilities, buildings and equipment, and a fire protection water supply system, which are site specific and/or are not a standard feature of the APR1400. • describe the provided apparatus for plant personnel and fire brigades such as portable fire	COL 19.1(4) COL 9.5(1) COL 9.5(2)

	extinguishers, self-contained breathing apparatus, and radio communication systems. • address the final FHA and FSSA based on the final plant design, including a detailed post-fire safe-shutdown circuit analysis. • provide the fire brigade radio systems. • ensure that post-earthquake safe shutdown procedures consider the potential for multiple spurious alarms from photoelectric detectors following a seismic event.	COL 9.5(3) COL 9.5(4) COL 9.5(7) COL 9.1(19)
60	The LPSD SFIA assumes that procedural guidance is developed to ensure that in fire compartments containing post-seismic or post-fire safe shutdown equipment that: • the seismic ruggedness of temporary ignition sources is adequate, or that the duration that these temporary ignition sources are in these areas is minimized, • the seismic ruggedness of temporary equipment such as scaffolding in fire compartments containing potential seismic-fire ignition sources, or near fire protection equipment is adequate, and • either the duration of activities which could impact manual firefighting is minimized, or alternative firefighting equipment (e.g., pre-stage portable smoke removal equipment, pre-stage additional firefighting equipment, etc.) is supplied.	Subsection 19.1.6.3.1.3 COL 19.1(18)

Response to Action Item 19-129 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-122 (AI 19-129)

The assessments and results provided in the “Peer Review Report for the APR1400 DC PRA” (Item 5 of the KHNP ERR) are not consistent with the information provided in Table 19.1-1 of the APR1400 DCD “Characterization of PRA Relative to Supporting Requirements in ASME PRA Standard.”

Response

The peer review for the APR1400 DC PRA was performed only for the at-power internal events Level 1 PRA (including LERF) and the internal flooding Level 1 PRA (including LERF). Peer reviews for other PRAs such as internal fire PRA were not performed. KHNP plans to perform self-assessments (i.e., gap analyses) for other PRAs, including internal fire PRA and PRA-based SMA using the ASME/ANS PRA Standard as endorsed by RG 1.200 and DC/COL-ISG-028, and these self-assessments will be performed as a part of next PRA update.

To address the inconsistencies between Table 19.1-1 and the “Peer Review Report for the APR1400 DC PRA” (Item 5 of the KHNP ERR), Table 19.1-1 is revised as shown in Attachment 1.

This response also addresses the issues identified in PRA-15 (AI 19-15) and PRA-16 (AI 19-16).

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Section 19.1.6 DCD Markup for Question PRA-122

[Table 19.1-1, Pages 19.1-241 through 243]

Table 19.1-1 (1 of 3)

Characterization of PRA Relative to Supporting Requirements in ASME PRA Standard

Technical Area	APR1400 PRA Characteristics
Initiating Events Analysis (IE)	Comprehensive, systematic search made for initiating events. Most aspects of the IE analysis satisfy Capability Category I~~I~~ or greater. Elements of the PRA that cannot meet at least Category I~~I~~ until later stages of design, construction, and operation include the following: • Plant-specific operating experience is not available for review, although experience of current plants was considered~~ (IE-A3, IE-A7)~~. • Operators are not yet available to be interviewed~~ (IE-A6)~~. • Initiating event frequencies reflect generic data~~ (IE-C1)~~. • The ability to capture plant-specific information in the assessment of recovery actions is limited~~ (IE-C9)~~.
Accident Sequence Analysis (AS)	Response to the initiating events was first delineated via the use of event sequence diagrams (ESDs), and these were used to define core damage sequences via the construction of event trees. Most aspects of the accident sequence analysis satisfy Capability Category I~~I~~. Elements of the PRA that cannot meet at least Category I~~I~~ until later stages of design, construction, and operation include the following: • The functions and structure of the accident-sequence models reflect expectations of plant-specific operating practices, based on those of current plants~~ (AS-A5)~~.
Success Criteria (SC)	Success criteria reflect design-specific calculations performed using the MAAP4 and RELAP5 computer codes. These calculations are equivalent to the requirements for Capability Category I~~I~~. An exception is as follows: • Plant-specific operating philosophy and procedures are not available to confirm the bases for success criteria~~ (SC-A6)~~.

Table 19.1-1 (2 of 3)

Technical Area	APR1400 PRA Characteristics
Systems Analysis (SY)	The systems analyses were accomplished via the construction of detailed fault trees. These fault trees reflect the design details available. Aspects that do not meet at least Capability Category I~~I~~ because of the state of the design include the following: • Since the plant has not yet been constructed, it is not possible to collect information on the as-built, as-operated systems ~~(SY-A2)~~. • Although it is reasonable to infer testing and maintenance practices and system operating procedures from operating plants, these elements do not yet exist ~~(SY-A3)~~. • Plant walkdowns cannot be conducted until the plant is constructed ~~(SYA4)~~. • The ability to address spatial and environmental hazards is limited for a plant in the design phase ~~(SY-B8)~~. • There is not yet operating procedures or actual system operating experience that can be documented ~~(SY-C2)~~.
Human Reliability Analysis (HRA)	HRA necessarily relies on significant plant-specific information that is not yet available. The nature of the human reliability analysis and the areas in which compensatory steps are addressed is summarized in Subsection 19.1.2.
Data Analysis (DA)	Parameter estimates necessarily reflect generic data. These data were obtained from available relevant sources. Specific requirements for which the data analysis does not meet at least Capability Category I~~I~~ include the following: • The lack of plant-specific operating experience precludes the development and use of a plant-specific database or of specialization of generic data based on plant experience via Bayesian analysis ~~(DA-C2 through DA-C13; DA-D1 and DA-D4)~~.

Table 19.1-1 (3 of 3)

Technical Area	APR1400 PRA Characteristics
Internal Flooding (IF)	Some aspects of the internal flooding analysis are limited by the lack of plant-specific details. Specific areas in which the internal flooding analysis does not meet at least Category I~~I~~ include the following: • Plant information reflecting as-built, as-operated conditions does not yet exist ~~(IF-A3)~~. • Walkdowns cannot be conducted until the plant is constructed ~~(IF-A4, IFB3a)~~. • Some sources of flooding will account for plant/site-specific features not yet available ~~(IF-B1)~~. • Conservative assumptions were made with respect to propagation pathways and areas that could be affected ~~(IF-C1 and IF-C~~.
Quantification (QU)	The quantification was performed by solving the overall core damage model using the linked fault-tree approach. The quantification satisfies at least Category I~~I~~ for each of the supporting requirements.
LERF (LE)	A detailed assessment of containment response and release frequency was conducted. The assessment satisfies at least Capability Category I~~I~~ for the supporting requirements, except for such aspects as system failure analysis and human reliab~~A~~ility analysis. A detailed assessment of containment response and release frequency was conducted. The assessment satisfies at least Capability Category I~~I~~ for the supporting requirements, except for such aspects as system failure analysis and ~~human reliabalysis and~~ human reliability analysis, as addressed for technical areas SY, HF, and DA above.

Response to Action Item 19-138_19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-131 (AI 19-138)

Item 11 of KHNP ERR, “Risk Management Procedure, DC-DG-03-24_rev_0,” it is unclear who is responsible to make the decision as to whether or not the risk assessment is needed, the question is asked in the first diamond box of Attachment 7.1 “Flow Chart for the Risk Management.”

Response

The responsibilities for risk management engineering are described in Section 5.0 of the “Risk Management Procedure.” The Project Manager (PM) is responsible for the overall configuration control of the risk management engineering process and products. But the risk & PRA management manager (RPMM) is responsible for the decision making for risk assessment. “Risk Management Procedure, DC-DG-03-24, Rev. 1” will be revised and uploaded in KHNP ERR (The draft Rev.1 was uploaded in Item 11 of KHNP ERR).

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA model.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Response to Action Item 19-155 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-148 (AI 19-155)

"Section 19.1.5.3.1.5 of APR1400 DCD Rev. 0 states that “A minimum break size of 0.082 cm (0.032 in) is used when any break flow range does not include a lower limit. . .Each pipe segment is evaluated against its minimum and maximum estimated break size (EBS) for consistency. If the nominal pipe size is too small to contribute to flooding at the minimum EBS rate for any segment, then the segment screens out,” but samples of pipes which were screened out based on minimum EBS were not provided.

Response

The DCD Section 19.1.5.3.1.5 is revised as shown in Attachment 1.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DCD TIER 2

Attachment 1 – Section 19.1.5.3.1.5 DCD Markup for Question PRA-148

[Section 19.1.5.3.1.5, Page 19.1-157]

The following assumptions are used in the definition of internal flooding initiating event frequencies:

a. The fire protection (FP) and circulating water (CW) systems are assumed to have an infinite volume of water. All remaining systems that represent internal flooding sources are considered to have finite sources of water supply.

b. A minimum break size of 0.082 cm (0.032 in) is used when any break flow range does not include a lower limit.

c. Each pipe segment is evaluated against its minimum and maximum estimated break size (EBS) for consistency. If the nominal pipe size is too small to contribute to flooding at the minimum EBS rate for any segment, then the segment screens out. As an example, consider an event involving a break of fire protection piping which defines the minimum flow for the event as 500 gpm. For the fire protection system, any pipe with a nominal size of 1.5 inches or smaller would release less than 500 gpm even if the pipe was completely and cleanly severed.

Response to Action Item 19-156 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-149 (AI 19-156)

Section 19.1.5.3.1.5 of APR1400 DCD Rev. 0 states that the conditions assumed for main steam and connected systems were "35.2 kg/m3 at 69.3 kg/cm2g (2.20 lbm/ft3 at 985 psig)," but the basis was not provided.

Response

The DCD Section 19.1.5.3.1.5 is revised as shown in Attachment 1.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Section 19.1.5.3.1.5 DCD Markup for Question PRA-149

[Section 19.1.5.3.1.5, Page 19.1-158]

h. The water density is assumed to be 999.6 kg/m^3 (62.4 lbm/ft^3) (using the ASME steam table value at standard temperature and pressure [STP] for most systems). This value is assumed to vary negligibly at all system conditions that can be potential flood contributors, with the following exceptions taken from Table 10.1-1 of the DCD:

1) Feedwater discharge: 829.8 kg/m^3 at 232.2 °C and 91.4 kg/cm^2g (51.8 lbm/ft^3 at 450 °F and 1,300 psig)

2) Main steam and connected systems: 35.2 kg/m^3 at 69.~~3~~ 74 kg/cm^2g (2.20 lbm/ft^3 at ~~985~~ 992 ~~psig~~psia)

i. Some segments of normally pressurized systems (e.g., drain lines downstream of an isolation valve) are normally isolated that are screened out.

Response to Action Item 19-157 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-150 (AI 19-157)

Section 19.1.5.3.2.1 of APR1400 DCD Rev. 0 states that “[a]ll of the significant events that contribute to CDF are flooding events in the auxiliary building. Furthermore, all the events that contribute to CDF are breaks that are larger than the design basis break.” The breaks that are larger than the design basis break were not identified and it is not clear why the design basis break is smaller than these breaks.

Response

The DCD Section 19.1.5.3.2.1 is revised as shown in Attachment 1.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DCD TIER 2

Attachment 1 – Section 19.1.5.3.2.1 DCD Markup for Question PRA-150

[Section 19.1.5.3.2.1, Page 19.1-161]

19.15.3.2.1 Flooding Initiating Events

Significant flooding initiating events that contribute to the CDF and the LRF are shown in Table 19.1-64 and Table 19.1-65, respectively.

All of the significant events that contribute to CDF are flooding events in the auxiliary building. Furthermore, all the events that contribute to CDF are breaks that are larger than the design basis break. For moderate energy pipe breaks, such as fire protection, the design basis pipe break size is the one-half the diameter of the pipe multiplied by one-half the thickness of the pipe. The vast majority of initiating events that contribute to internal flooding core damage risk are caused by breaks in the fire protection system.

The largest contributor to CDF is a large fire protection system break in Quadrant B. This event begins with a break that propagates to and causes failure of Train B electrical equipment. Accumulation of water causes failure of the door between Quadrants B and D and the subsequent surge of water causes loss of Train D electrical equipment. Failure of secondary cooling and failure of equipment needed to support feed and bleed cooling result in core damage.

Response to Action Item 19-158 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-151 (AI 19-158)

The high winds, tornadoes, and external floods analyses documented in PRA notebook "External Events Risk Evaluation, APR1200-K-P-NR-01801-P" should also be summarized in APR1400 DCD Section 19.1.5.4 "Other External Events Risk Evaluation."

Response

The DCD Section 19.1.5.4 is replaced in its entirety as shown in Attachment 1.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DCD TIER 2

Attachment 1 – Section 19.1.5.4 DCD Markup for Question PRA-151

[Section 19.1.5.4, Pages 19.1-167 and 168]

19.1.5.4 Other External Events Risk Evaluation

~~External events considered are those whose cause is external to all systems associated with normal and emergency operations situations, with the exception of internal fires and floods. Some external events may not pose a significant threat of a severe accident. Some external events are considered at the design stage and have a sufficiently low contribution to plant risk.~~

~~The set of external events was taken from the ASME/ANS PRA Standard and represents a consensus listing of external events for nuclear power plant. Table 19.1-80 presents the screening analysis of these external events (based upon recommendations in the ASME/ANS PRA Standard). Those events that are not screened or subsumed within other hazard categories need to be addressed in a site-specific PRA.~~

~~Chapter 2 contains site-specific parameters for the following attributes.~~

~~a. Nearby industrial, transportation, and military facilities~~

~~b. Meteorology~~

~~c. Hydrologic engineering~~

~~d. Geology, seismology, and geotechnical engineering~~

~~Evaluation of potential accidents for the nearby industrial, transportation, and military facilities in Chapter 2 is a probabilistic and predictive approach that is to be followed and documented in the COLA to verify that a 1×10^{-7}/year occurrence rate has been demonstrated. For low probability events, where data may not be available, a 1×10^{-6}/year occurrence rate can be utilized when combined with reasonable qualitative arguments. Otherwise, a PRA may need to be performed to comply with the guidance of the ASME/ANS PRA Standard. The screening criteria for other external events need to be determined at the COL phase, with confirmation that the screening criteria are below the plant-specific risk target.~~

This section summarizes the analysis of hazards to the APR1400 design from external events other than plant fires and seismic events. The sections that follow detail the evaluation of external hazards.

19.1.5.4.1 Assumptions

The following assumptions were used to develop the APR1400 Other External Events analysis:

1. All SSCs that are modeled in the PRA are designed to withstand the design-basis tornado (DBT) and design-basis hurricane (DBH) including all effects, i.e., pressure loading, pressure drop and missile impacts.
2. The non-safety related systems, structures, and components (SSCs) are designed such that they will not collapse on or impact the seismic Category I structures containing SSCs (item 1 above) and will not generate missiles more damaging than the DBT and DBH missiles.

19.1.5.4.2 Analysis

The external hazard probabilistic risk assessment (PRA) methodology for currently-operating plants is described in a number of references. Examples include References 2, 4, and 40. The major elements of an external hazard PRA are:

- Initial screening of external hazards based on a set of qualitative criteria,
- Bounding analysis for the screened-in external hazards,
- Detailed PRA for the remaining external hazards.

The initial screening of external hazards is done by first enumerating all potential external hazards that may impact the plant and screen them out using a set of criteria based on magnitude, distance, frequency and severity of the hazard. For an existing plant, these hazards will have been studied during the site selection and plant design. For example, the following USNRC regulatory guides and standard review plan sections provide acceptable criteria for excluding certain external hazards from the design basis of the plant:

- RG 1.78, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release” (Reference 55)

- RG 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants" (Reference 56)
- RG 1.115, "Protection Against Low-Trajectory Turbine Missiles" (Reference 57)
- SRP Section 3.5.1.6, "Aircraft Hazards" (Reference 58)

For the screened-in external hazards, a bounding or demonstrably conservative analysis is done to show either 1) the mean value of the frequency of the design-basis hazard used in the plant design is less than 10^{-5}yr and the conditional core damage probability is less than 10^{-1}, given the occurrence of the design-basis hazard event or 2) the core damage frequency (CDF) from the external hazard is less than 10^{-6}/yr.

For the remaining external hazard, a detailed PRA is performed; the major elements of such a PRA are:

- Probabilistic external hazard analysis to develop a hazard curve depicting the annual frequency of exceeding different hazard intensities; the uncertainties in the data and model are propagated through the hazard analysis to derive a family of hazard curves with associated weights (or subjective probabilities)
- Fragility analysis to identify the SSCs that are susceptible to the effects of the external hazard and to determine the plant-specific failure probabilities as a function of the intensity of the hazard.
- External hazard plant response model to (a) develop a plant response model by modifying the internal events at-power PRA model to include the effects of the external hazard in terms of initiating events and failures caused; (b) quantify this model to provide the conditional core damage probability (CCDP) and conditional large ~~early~~ release probability (CL~~E~~RP) for each defined external hazard plant damage state and (c) evaluate the unconditional CDF and L~~E~~RF by integrating the CCDP/CL~~E~~RP with the frequencies of the plant damage states obtained by combining the results of hazard analysis and fragility analysis.
- While this methodology is equally applicable to new reactors under design certification, some key differences do exist.
- Most of the external hazards are location specific. Since the plant site is not known, initial screening of the external hazards cannot be performed. However, the combined operating license (COL) applicant is expected to select the site that meets the enveloping site parameters (DCD Table 2.0-1) and conforms to the NRC regulatory guides and SRP. This practice will provide the basis for screening of many external hazards.

- The plant design will not have progressed to the extent that plant-specific fragilities of SSCs could be evaluated. Therefore bounding or demonstrably conservative analysis of many screened-in external hazards cannot be meaningfully done.

19.1.5.4.3 Initial Screening of External Hazards

For a selected site, the COL applicant will perform the initial screening of hazards complying with ASME/ANS PRA Standard Part 6 Addendum B and NRC RG 1.200 Revision 2.

External hazards screened out during the design stage are:

- Transportation accidents: DCD Section 2.2.3 requires the COL applicant to identify and evaluate potential accidents arising from nearby industrial, transportation (aircraft routes, highways, railways, navigable waters and pipelines), and military facilities. The COL applicant will select the design basis event following the standard review plan (SRP) Section 2.2.3 acceptance criteria. The following principal types of hazards will be considered.

  - Toxic vapors or gases and their potential for incapacitating nuclear plant control room operators
  - Overpressure resulting from explosions or detonations involving materials such as munitions, industrial explosives, or explosive vapor clouds resulting from the atmospheric release of gases (such as propane and natural gas or any other gas) with a potential for ignition and explosion
  - Missile effect attributable to mechanical impacts, such as aircraft impacts, explosion debris, and impacts from waterborne items such as barges
  - Thermal effects attributable to fires

  The identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the 10 CFR Part 100 limits is estimated to exceed the NRC staff objective of an order of magnitude of 10^{-7} per year. If data are not available to make an accurate estimate, this event probability could be of the order of magnitude of 10^{-6} per year if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The specific guidance in RG 1.76, RG 1.91 and SRP Section 3.5.1.6 are followed in this evaluation.

After an APR1400 unit~~s~~ is built at a site, the COL holder should complete the external hazard PRA conforming to RG 1.206; the screening of external hazards such as transportation accidents should be documented.

- Turbine Missile: The turbine generator layout for the APR1400 is considered to be a favorable orientation and excludes SSCs from low-trajectory turbine missile strikes. This conforms to RG 1.115. DCD Section 3.5.1.3 states that the probability of unacceptable damage resulting from turbine failure is less than 1×10^{-7} per year. Therefore, turbine missile is not considered as a design-basis event. The turbine missile hazard is also screened out in the PRA because of the low probability.

19.1.5.4.4 Bounding Analysis for Screened in External Hazards

Based on previous external hazard PRAs, the following hazards may not be screened using initial screening:

- Extreme Winds and Tornadoes
- External Flooding

19.1.5.4.4.1 Extreme Winds and Tornadoes

This group of external hazards includes tornadoes, hurricanes and thunderstorms. All potential sites for APR1400 are exposed to tornadoes and thunderstorms; coastal sites are in addition exposed to hurricanes.

DCD Section 3.3 describes the design basis for tornadoes and hurricanes. The design basis tornado (DBT) is selected as corresponding to Region I of RG 1.76. The maximum windspeed of the DBT is 230 mph and corresponds to a probability of exceedance of 10^{-7} per year. The design basis hurricane (DBH) is selected as having a maximum windspeed of 260 mph and corresponds to a probability of exceedance of 10^{-7} per year at most US coastal sites (except Southern Florida) as specified in RG 1.221. The standard plant structures (i.e., containment building, containment building internal structures, auxiliary building and emergency generator building and diesel oil fuel tank) will be designed to the maximum of the load effects from the

DBT and DBH with additional conservatisms in the structural acceptance criteria. The design against DBT also includes the effect of pressure drop as the tornado moves over the building.

DCD Section 3.5 describes how the APR1400 structures will be designed against the design basis missile spectrum for the DBT and DBH as specified in RG 1.76 and RG 1.221. The exterior walls and roof slabs of seismic Category I structures will be designed to withstand the local and global effects of these missiles.

The non-safety-related SSCs (e.g., Turbine Generator Building) adjacent to seismic Category I structures are designed such that they will not collapse on or impact seismic Category I structures. The COL applicant will provide reasonable assurance that site-specific structures and components not designed for extreme wind loads will not affect the ability of seismic Category I structures to perform their intended safety function and will not generate missiles with more severe effects than the missiles from the DBT and DBH.

The bounding analysis for extreme winds and tornadoes is based on the following assumptions:

1. All SSCs that are modeled in the PRA are designed to withstand the DBT and DBH including all effects (i.e., pressure loading, pressure drop and missile impacts).
2. The non-safety related SSCs are designed such that they will not collapse on or impact the seismic Category I structures containing SSCs (item 1 above) and will not generate missiles more damaging than the DBT and DBH missiles.

With these assumptions, the contribution to CDF and LERF from extreme winds is judged to be less than 10^{-7} per year and could be screened out from detailed PRA.

After an APR1400 unit~~(s)~~ is built at a site, the COL holder should confirm that the above assumptions are met and complete the external hazard PRA conforming to RG 1.206 and ASME/ANS PRA Standard Part 6 and 7 requirements.

19.1.5.4.4.2~~6~~ External Flooding

There are several types of external flooding phenomena that need to be considered, depending on the site where the APR1400 is located. These include both natural phenomena (high river or lake water, ocean flooding such as from high tides or wind driven storm surges, extreme precipitation, tsunamis, seiches, flooding from landslides, etc.), and man-made events (principally failures of dams, levees, and dikes). It is also important to consider rational probabilistic combinations of the above phenomena. The consequences of heavy rain and other flooding, such as water collected on rooftops and in low-lying plant area are also within the scope of external flooding PRA.

The maximum flood elevation is specified in DCD Table 2.0-1 as 1-foot below the plant grade in the vicinity of the SSCs important to safety. DCD Section 2.4 describes the flood analysis for different sources that the COL applicant has to perform in the site selection and design of the plant. It is expected that the COL applicant will make use of the on-going studies for reevaluation of external floods at current nuclear power plant sites in response to Fukushima NTTF Recommendation 2.1.

It is concluded that the external flooding will not be a significant contributor to CDF and LERF based on the site selection and design features implemented by the COL applicant.

After an APR1400 unit is built at a site, the COL holder should confirm that the above assumptions are met and complete the external hazard PRA conforming to RG 1.206 and ASME/ANS PRA Standard Part 6 and 8 requirements.

Attachment 2 – Section 19.1.10 DCD Markup for Question PRA-151

[Section 19.1.10, Page 19.1-240]

53. NUREG/CR-7150, "Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE)," May 2014.

54. [Already used]

55. Regulatory Guide 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room during a Postulated Hazardous Chemical Release."

56. Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes near Nuclear Power Plants."

57. Regulatory Guide 1.115, "Protection against Low-Trajectory Turbine Missiles."

58. Standard Review Plan Section 3.5.1.6, "Aircraft Hazards."

Attachment 3 – ACRONYM AND ABBREVIATION LIST of Chapter 19 DCD Markup for Question PRA-151

[ACRONYM AND ABBREVIATION LIST of Chapter 19, Page xix]

DA	data analysis
DAS	diverse actuation system
DBA	design basis accident
DBH	design basis hurricane
DBT	design basis tornado
DC	direct current
DCD	Design Control Document
DCF	dynamic containment failure

Response to Action Item 19-160 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-153 (AI 19-160)

Internal Fire PRA - Volume IV (013404-P) reports an at-power fire CDF of 8.79E-06 per year which is not consistent with the DCD Section 19.1.5.2.2 "Results from the Internal Fire Risk Evaluation."

Response

The Internal Fire PRA documentation originally loaded into the ERR (Revision 0) was a previous version which did not have the final Fire PRA information. The following (Revision 0A) Internal Fire PRA reports have been uploaded to the ERR:

- APR1400-K-P-NR-013401-P, Rev. 0A, Internal Fire PRA Volume I
- APR1400-K-P-NR-013402-P, Rev. 0A, Internal Fire PRA Volume II
- APR1400-K-P-NR-013404-P, Rev. 0A, Internal Fire PRA Volume IV

Revision 0A of the Internal Fire PRA - Volume IV contains the correct FPRA results. These results match the DCD.

	APR1400-K-P-NR-013404-P	Section 19.1.5.2.2 of DCD
CDF	1.86E-06/yr	1.9E-06/yr
LRF	1.69E-07/yr	1.7E-07/yr

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-175 Section 19.2

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # SA-14 (AI 19-175)

Figure 19.1-47 has numerous typos - meridional, probability, and personnel are all spelled wrong in various locations.

Response

Figure 19.1-47 will be revised with the correction (see Attachment 1).

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Figure 19.1-47 DCD Markup for Question SA-14

[Figure 19.1-47, page 19.1-1416]

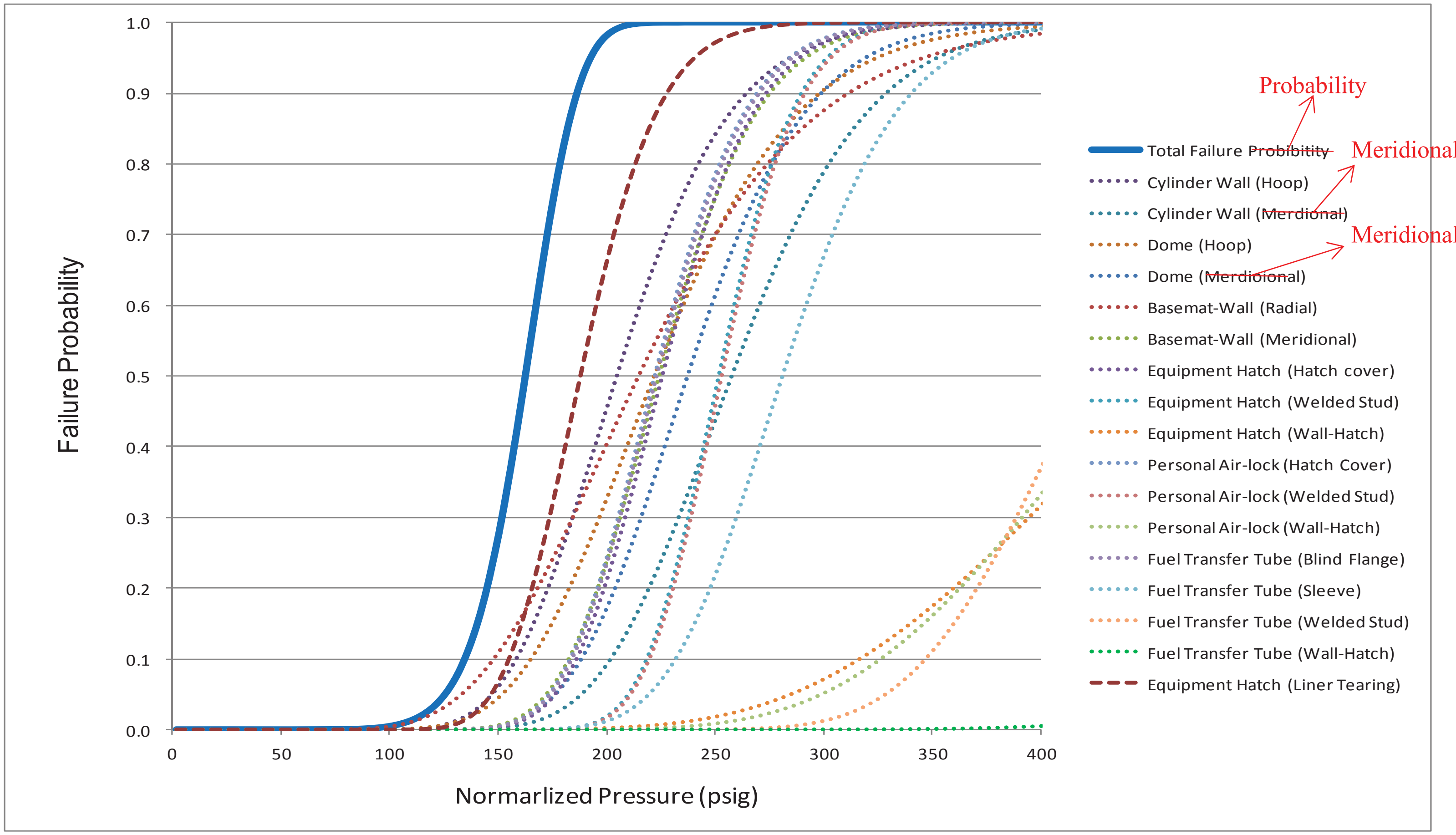

Figure 19.1-47 Total Containment Fragility Curve

Response to Action Item 19-183 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-164 (AI 19-183)

Figure 6.2-8 BMT DET in APR1400-K-P-NR-013602-P, Revision 0, a sequence with a wet cavity condition and no debris coolability, has a probability of 0.99 high heat transfer rate to water. This high value for high heat transfer rate contradicts dry cavity and no debris coolability conditions.

Response

The DET top event "Debris Coolability" is referring to the prior CET top event DBCOOL. A failure of DBCOOL meant that containment overpressurization was still possible. A failure of that DBCOOL does not mean that BMT will occur.

In the DET, the conditional probability of BMT, given a dry cavity is 1.0 (100% chance of BMT, 0% chance of no BMT). Therefore, this is not contradicted by the wet cavity condition having a conditional probability of BMT less than 1. The value is low (0.01), based on the evaluation in Section 6.2.8, which found that a heat transfer rate to the water would have to be less than about 0.236 MW/sq meter to result in BMT. This was compared to the experimental test results that estimated the heat transfer rate in this condition to be at least 0.25 to 0.5 MW/sq meter. Because the expected result is for BMT to not occur, the event was evaluated as Not Likely, which yields a 0.01 probability per the APR1400 Level 2 methodology. The text is revised to clarify the meanings (see Attachment 1, which is placed in the electronic reading room).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the notebook APR1400-K-P-013602-P will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-184 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-165 (AI 19-184)

Page 1 of 2 of Figure 6.2-7 in APR1400-K-P-NR-013602-P, Revision 0, shows the probability of LCF DET “LATE CS OPERATION STATUS” for EARLY, LATE, and NOCS operation conditions as 0, 0, and 1, respectively. However, in contrast, page 2 of 2 of the same figure indicates that the sorting of this event branching is based on a set of rules which determine the branch pathway based on the values for key plant damage state attributes and prior event decisions in the CET.

Response

The 0, 0, and 1 shown on the printout are not used. The event was evaluated purely from the set of rules described in the notebook. All of the events that show <R> underneath them at the bottom of the page were evaluated using rules and not split fractions. The CET notebook is revised to remove the numbers in locations that did not use split fractions (see Attachment 1, which is placed in the electronic reading room).

Impact on DCD
This is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model, but the CET notebook (APR1400-K-P-NR-013602-P) will be revised as stated in the response

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-187 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-168 (AI 19-187)

The staff is unsure whether other potential fire-induced ISLOCA scenarios were looked at other than the RCS-SDC interface (fire PRA Vol II notebook).

Response

All containment penetrations identified during the full power internal events (FPIE) analysis (see Table A-1 of Appendix A of APR1400-K-P-NR-013101-P, Initiating Events Notebook) were reviewed to determine if fire impacts would change the outcome of the screening, and subsequent frequency of an ISLOCA in the full power fire PRA (FP-FPRA).

Penetrations screened in the FPIE PRA based on screening criteria 1 (line does not interface with the RCS), 2 (line is < or = 3/8") and 3 (path could not be over-pressurized by introduction of RCS pressure) are deemed directly applicable to the FP-FPRA, and hence all of these lines were screened for the FP-FPRA. Penetrations screened in the FPIE PRA based on screening criteria 4 (paths with low pressure portions which are isolated by four or more normally closed valves or periodically leak-tested check valves in series) were screened from the FP-FPRA if at least 2 of the four isolation valves were any combination of check valves, or normally locked closed manual valves since check valves and manual valves are not impacted by fire. The remaining penetrations include the two SDC pump suction lines (Penetrations PC-125 and PC-215) which are dispositioned in Volume 2 of the FPRA report (APR1400-K-P-NR-013402-P). Volume 2 of the FPRA report is revised to clarify that all potential ISLOCA pathways were reviewed (see Attachment 1, which is placed in the electronic reading room).

[Note that previous discussions on PC-403 were incorrect since there is no locked closed MOV in this line, rather it is a normally locked closed manual valve CV-362 (see DCD Figure 9.3.4-1 “Chemical and Volume Control System Flow Diagram (1 of 7), DCD page 9.3-141. Therefore this penetration has a check valve, CV-363 and a locked closed manual valve, CV-362; neither of these valves are vulnerable to fire-induced spurious operation, and the random impact of failure of these valves is already evaluated in the FPIE model.]

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, Volume 2 of the FPRA report (APR1400-K-P-NR-013402-P) will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-193 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-174 (AI 19-193)

The fire PRA notebook seems to indicate that the "site PRA and fire protection personnel" reviewed Task 1 (Plant Boundary Definition and Partitioning). The staff is unclear what was meant by "site."

Response

The fire PRA notebook is incorrect since there is not a site yet. Section II.3. of Volume I of the Fire PRA Notebook, APR1400-K-P-NR-013401-P, is revised to correct this statement (see Attachment 1, which is placed in the electronic reading room).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, Volume I of the Fire PRA Notebook, APR1400-K-P-NR-013401-P, will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-196 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-177 (AI 19-196)

The second top event of the ISLOCA Containment Event Tree shown on DCD Figure 19.1-44 is given as “INTERFACING SYSTEMS LOCA.” However, this top event does not question “interfacing systems LOCA failure” because PDSs input to this CET consists of such failure. Instead, this top event questions the availability of a water pool outside the containment for scrubbing of fission products.

Response

As stated, the top event really questions the potential for fission product scrubbing. The text description of the top event is changed to "Releases Are Scrubbed". The text description does not alter any of the analyses.

The revised DCD Figure 19.1-44 is shown in Attachment 1. The revised Figure 5.2-2 of notebook APR1400-K-P-NR-013602-P is shown in Attachment 2.

Note: Attachment 2 is placed in the electronic reading room.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model. However, notebook APR1400-K-P-NR-013602-P will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Figure 19.1-44 DCD Markup for Question PRA-177

[Figure 19.1-44, Page 19.1-1413]

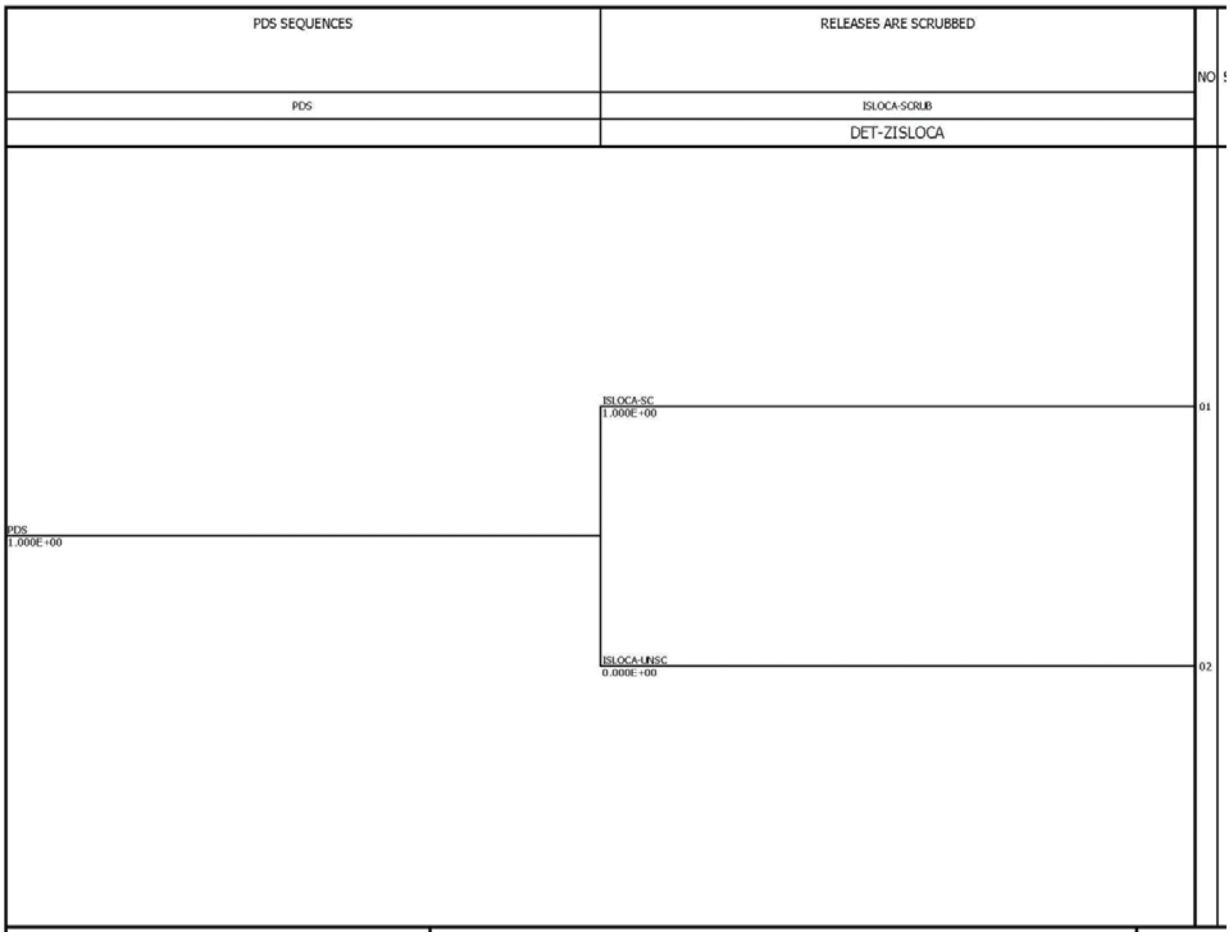

Figure 19.1-44 ISLOCA Containment Event Tree

Response to Action Item 19-197 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-178 (AI 19-197)

The second top event of the Containment Isolation Failure Containment Event Tree shown on DCD Figure 19.1-45 is given as “CONTAINMENT ISOLATION FAILURE.” However, this top event does not question “containment isolation failure” because PDSs input to this CET consists of such failure. Instead, this top event questions the availability of containment spray for scrubbing of fission products.

Response

As stated, the top event really questions the containment spray status. The text description of the top event is changed to "Containment Spray Successful". The text description does not alter any of the analyses.

The revised DCD Figure 19.1-45 is shown in Attachment 1. The revised Figure 5.2-3 of notebook APR1400-K-P-NR-013602-P is shown in Attachment 2.

Note: Attachment 2 is placed in the electronic reading room.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model. However, the PRA notebook APR1400-K-P-NR-013602-P will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Figure 19.1-45 DCD Markup for Question PRA-178

[Figure 19.1-45, Page 19.1-1414]

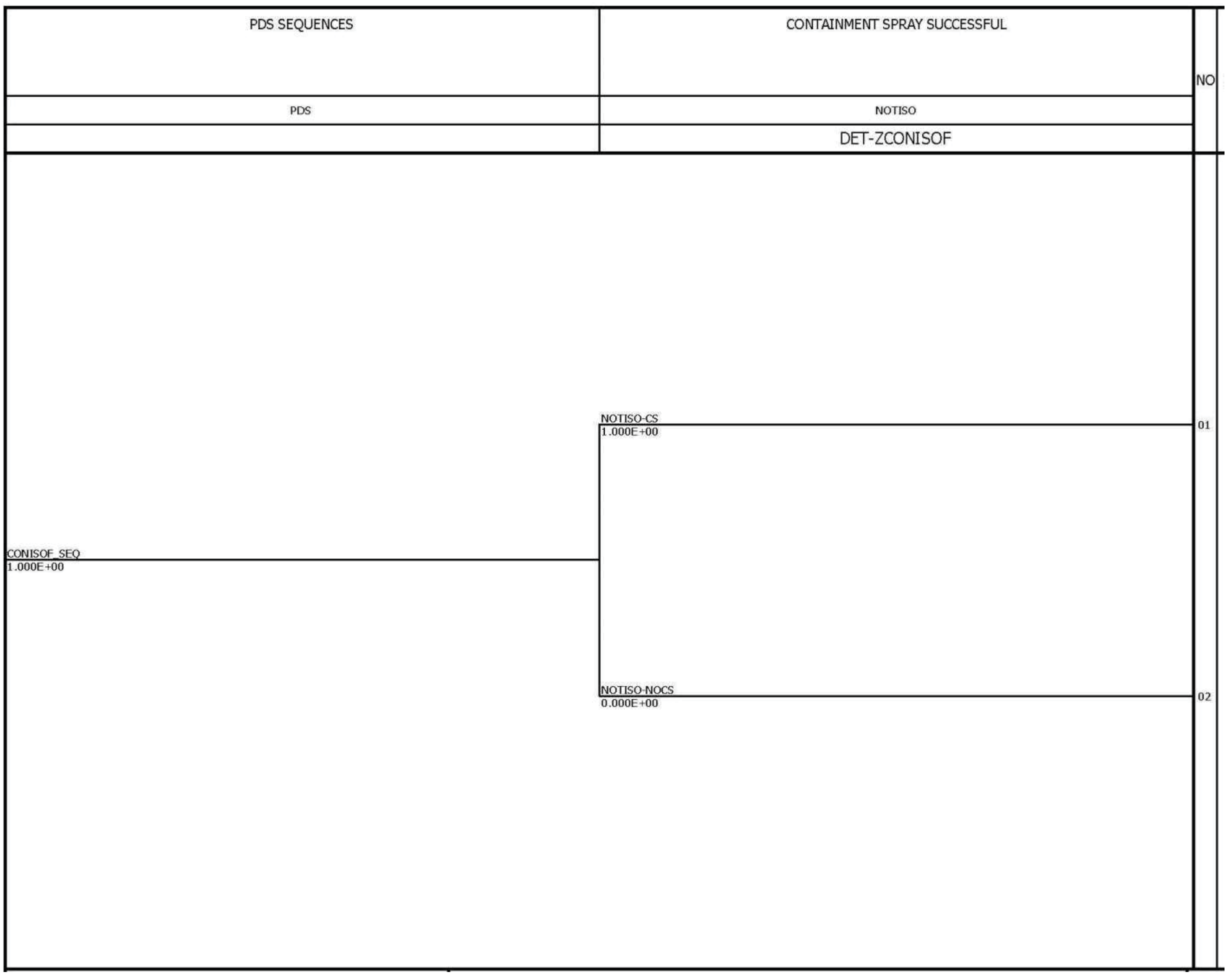

Figure 19.1-45 Containment Isolation Failure Containment Event Tree

Response to Action Item 19-198 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-179 (AI 19-198)

The second top event of the Containment Failure before Vessel Breach Containment Event Tree shown on DCD Figure 19.1-46 is given as “CONTAINMENT FAILURE BEFORE RV BREACH.” However, this top event does not question “containment failure before vessel breach” because PDSs input to this CET consists of such failure. Instead, this top event questions the containment failure mode.

Response

As stated, the top event really questions the containment failure mode. The text description of the top event is changed to "Containment Failure Size". The text description does not alter any of the analyses.

The revised DCD Figure 19.1-46 is shown in Attachment 1. The revised Figure 5.2-4 of notebook APR1400-K-P-NR-013602-P is shown in Attachment 2.

Note: Attachment 2 is placed in the electronic reading room.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model. However, the PRA notebook APR1400-K-P-NR-013602-P will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 –Figure 19.1-45 Markup DCD for Question PRA-179

[Figure 19.1-45, Page 19.1-1415]

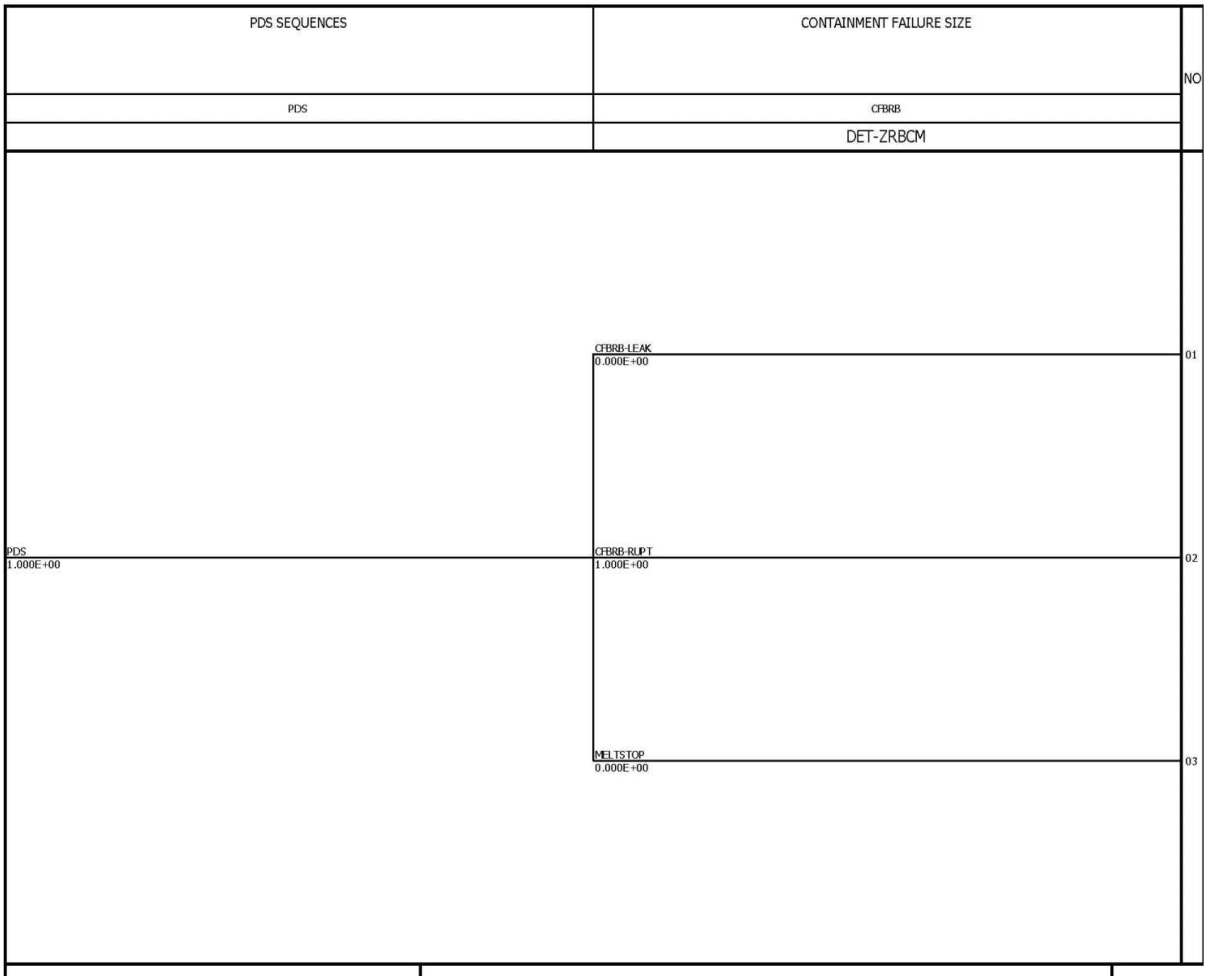

Figure 19.1-46 Containment Failure Before Vessel Breach Containment Event Tree

Response to Action Item 19-200 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-181 (AI 19-200)

Appendix B of the Quantification Notebook discusses the MSPI program in Reference 29 (DC/COL-ISG-018, "Interim Staff Guidance on NUREG-0800 Standard Review Plan; Section 17.4, 'Reliability Assurance Program.'"). Should this be Reference 26 (NEI 99-02, "Regulatory Assessment Performance Indicator Guideline: Rev. 6, October 2009)?

Response

Appendix B of the Level 1 Quantification Notebook (APR1400-K-P-NR-013107-P) will be revised to correct the typing error (see Attachment 1, which is placed in electronic reading room).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model, however, PRA notebook APR1400-K-P-NR-013107-P will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-201 Section 19.2

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.2

Issue # SA-15 (AI 19-201)

DCD Section 19.2.3.2.2 notes that interaction of molten core debris with concrete in the reactor cavity could produce combustible gases such as hydrogen and carbon monoxide. It is not clear whether calculations of maximum containment pressure following the accidents accounted for carbon monoxide burn.

Response

MAAP calculates the energy production rates for the availability of CO and H2 in containment compartment. When there is a burn according to the flammable conditions, CO and H2 could burn at the same time. Therefore, the maximum containment pressure already accounted for the effects of CO burn in Figure 19.2.3-21.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-204 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-182 (AI 19-204)

In the IE Notebook, Page 36, it is unclear why the control room HVAC is screened out when the IE disposition states that the assumption is pending control room heat up analysis.

Response

The notebook states: "It is assumed that in the event of loss of all cooling, sufficient time is available for operators to take compensatory actions, and failure of control room HVAC is assumed to not result in a plant trip or require a plant shutdown. (PENDING Control Room Heatup Analyses)"

It was screened out based the fact that there has never been any U.S. PRAs which ultimately ended up requiring loss of MCR HVAC as an initiating event. If the MCR heat-up analysis supports this, then the phrase "(PENDING Control Room Heatup Analyses)" will be deleted. If the MCR heat-up analysis provides evidence that loss of MCR HVAC will result in some sort of transient, then the initiator will be modeled.

Hence, at this time, no PRA Notebook or DCD revisions are envisioned.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-205 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-183 (AI 19-205)

In the IE Notebook, Page 61, it is unclear why the reactor vessel rupture data is taken from the 25-year table in NUREG 1829, over the 40-year table.

Response

Per NUREG-1829, the estimates in the analysis were a function of effective break size at three distinct time periods: current-day (25 years fleet average), end-of-plant-license (40 years fleet average), and end-of-plant-license-renewal (60 years fleet average). However, NUREG-1829 does not publish any 60 year final data.

Section 2 of NUREG-1829 goes on to state that "current-day estimates were intended to represent current plant conditions and are therefore equivalent to instantaneous LOCA frequency estimates." Furthermore, the 40 and 60 year estimates were not explicitly defined in the expert elicitation to represent either instantaneous frequencies at 40 and 60 years of operation, or averaged frequencies between 25 - 40 years and 40 - 60 years of plant operation, and the experts were free to choose their own definition.

The 25 year value was chosen as the APR1400 PRA is a current-day PRA, and what was desired equivalent to instantaneous LOCA frequency estimates. During the next update, a sensitivity analysis will be performed using the 40 year LOCA data provided in Table 1 of NUREG-1829.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-206 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-184 (AI 19-206)

In the ASQ Notebook, Page 14, VSLOCA is not modeled but included in SLOCA. It is not clear how the IE frequency for VSLOCA has been included in the SLOCA IE frequency.

Response

The ASQ Notebook is correct. The Initiating Event Notebook is incorrect, and is corrected in the response to PRA-192 (AI 19-214).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-207 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-185 (AI 19-207)

In the ASQ Notebook, Page 21, it is not clear when the 125VDC 'C' and 'D' load shedding needs to occur to extend the battery life (same for buses 'A' and 'B').

Response

There is no load shedding modeled in the APR1400 PRA. This was dated information in the old Accident Sequence Notebook, APR1400-K-P-NR-013102-P, Rev. 0. This old information has been removed in the current version, APR1400-K-P-NR-013102-P, Rev. 0A.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-208 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-186 (AI 19-208)

In the ASQ Notebook, Page 22, the operator action to shed load off the 125VDC bus is not listed with the other key operator actions. It is also not listed in the DCD.

Response

There is no load shedding modeled in the APR1400 PRA. This was dated information in the old Accident Sequence Notebook, APR1400-K-P-NR-013102-P, Rev. 0. This old information has been removed in the current version, APR1400-K-P-NR-013102-P, Rev. 0A.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-209 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-187 (AI 19-209)

In the ASQ Notebook, Pages 25, 34, and 35, the success criteria listed for LLOCA, SLOCA, and SGTR do not match the criteria provided in the DCD, specifically SITs, SIP, and BLEED functions.

Response

The Success Criteria Notebook (APR1400-K-P-NR-013103-P, Rev. 0) is the official repository for the success criteria used in the APR1400. For convenience to the reader, these criteria are copied into the accident sequence notebook; however, on some occasions, it was incorrectly copied over.

The LLOCA success criteria on page 25 of Rev. 0 of the Accident Sequence Notebook has already been corrected in the current revision, APR1400-K-P-NR-013102-P, Rev. 0A (now on page 20 in Rev. 0A). Hence, the SIT and SIP success criteria for LLOCA are now the same in the Success Criteria Notebook, the Accident Sequence Notebook, DCD Table 19.1-8 and the PRA model.

The SLOCA success criteria for the number of SITs needed for aggressive secondary cooling (ASC) is incorrect in the Accident Sequence Notebook (page 34 in Rev. 0.; page 29 in Rev. 0A.) The Small LOCA Top Events Table on Page 29 of APR1400-K-P-NR-013102-P, Rev. 0A is revised to match the success criteria in the Success Criteria Notebook, DCD Table 19.1-8 and the PRA model (see Attachment 1, which is placed in the electronic reading room).

The SLOCA success criteria for the BLEED function on page 35 of Rev. 0 of the Accident Sequence Notebook has already been corrected in the current revision, APR1400-K-P-NR-013102-P, Rev. 0A (now on page 30 in Rev. 0A). Hence, the BLEED success criteria for SLOCA is now the same in the Success Criteria Notebook, the Accident Sequence Notebook, DCD Table 19.1-8 and the PRA model.

The SGTR success criteria for the BLEED function is incorrect in the Accident Sequence Notebook (page 42 in Rev. 0.; page 36 in Rev. 0A.) The SGTR Top Events Table on Page 36 of APR1400-K-P-NR-013102-P, Rev. 0A is revised to match the success criteria in the Success Criteria Notebook, DCD Table 19.1-8 and the PRA model (see Attachment 2, which is placed in the electronic reading room).

The SGTR success criteria for ASC on page 42 of Rev. 0 of the Accident Sequence Notebook has already been corrected in the current revision, APR1400-K-P-NR-013102-P, Rev. 0A (now on page 37 in Rev. 0A). Hence, the ASC success criteria for SGTR is now the same in the Success Criteria Notebook, the Accident Sequence Notebook, DCD Table 19.1-8 and the PRA model.

Response to Action Item 19-209 Section 19.1

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA model. However, the Accident Sequence Notebook (APR1400-K-P-NR-013102-P, Rev. 0A) will be revised as stated in the response.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-210 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-188 (AI 19-210)

In the ASQ Notebook, Pages 25, 31, the LOCA break sizes, LLOCA and SLOCA are different from the break sizes discussed in the IE Notebook.

Response

The LOCA break sizes in the Accident Sequence Notebook, APR1400-K-P-NR-013102-P, Rev. 0A, are correct. Some of the sizes in the Initiating Event Notebook, APR1400-K-P-NR-013101-P, Rev. 0A are incorrect; however, these are addressed in PRA-193 (Action Item 19-215).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-211 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-189 (AI 19-211)

In the ASQ Notebook, Page 34, it is unclear whether there is any operator action identified for the manual alignment of the SCS pumps to IRWST during the Shutdown Cooling System Injection (SCSI Top Event).

Response

The documentation for SCSI on page 34 of the AS Notebook states: "In order to establish SCS injection following a successful aggressive cooldown, the SCS pumps must be manually aligned to the IRWST, the suction and discharge valves must be opened, and the pumps must be manually started."

Note that while systemic operator actions may be mentioned in other PRA notebooks, the operator action is always described in the associated system notebook, and the details of the HEP calculation for the operator action are contained in the HRA notebook. This is consistently applied throughout the PRA notebooks.

For this particular case, Section 5.7 (Human Actions) of the Shutdown Cooling system notebook (APR1400-K-P-NR-013202-P) describes the operator action to perform the action of manually aligning and starting the SC pumps (SIOPH-S-INJ). Details of the HEP associated with SIOPH-S-INJ are contained in the HRA Notebook (APR1400-K-P-NR-013105-P). Hence, at this time, no PRA Notebook or DCD revisions are envisioned.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-213 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-191 (AI 19-213)

In the IE Notebook, Page 17, it is unclear why "Steam Generator Level Control" is determined to cause at most a loss of main feed water, however it is assigned to the IE Group - Transients.

Response

The probable impacts of a Steam Generator Level Control event are similar to those of a Feedwater Flow Instability event. In the worst case, the Feedwater flow control valves go wide open to completely closed. If the valves go wide open it is similar to the Increase in Feedwater Flow event (see line above Steam Generator Level Control in Table 1) which results in a transient with feedwater available. If they go fully closed, it is a loss of feedwater event.

Table 1 of the IE NB, APR1400-K-P-NR-013101-P, Rev. 0A is revised to clarify this issue (see Attachment 1, which is placed in the electronic reading room).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the Initiating Event Notebook (APR1400-K-P-NR-013101-P, Rev. 0A) will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-214 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-192 (AI 19-214)

In the IE Notebook, Page 52, it is not clear how a very small LOCA event (VSLOCA) is modeled in the PRA.

Response

The VSLOCA event initiator is included in the SLOCA event; however the IEF for the VSLOCA was not added to the SLOCA IEF. Table 19.1-6 of the DCD is revised to reflect the updated IEF (see Attachment 1). The Initiating Event Notebook, APR1400-K-P-NR-013101-P, Rev. 0A, is also revised as needed to reflect that VSLOCA is modeled as part of SLOCA (see Attachments 2, 3 and 4).

Note that the impact of this error is a non-conservative estimate for the SLOCA IEF. Incorporating the VSLOCA IEF into the SLOCA IEF increases the SLOCA IEF from 1.99E-03/rcy to 2.40E-03/rcy (Note: rcy = reactor calendar year).

The impact on of this change on both CDF and LRF is small. The CDF increased from 1.2954E-06/yr to 1.3055E-06/yr resulting in an increase of about 0.8%. Note that the precision quoted in the DCD is 1.3E-06/yr; hence, the CDF quoted in the DCD does not change as a result of this change in the SLOCA IEF. This small CDF impact is consistent with the small SLOCA CDF contribution of 3.8% (DCD Table 19.1-17).

The LRF increased from 1.1070E-07/yr to 1.1119E-07/yr resulting in an increase of about 0.5%. Note that the precision quoted in the DCD is 1.1E-07/yr; hence, the LRF quoted in the DCD does not change as a result of this change in the SLOCA IEF. This small LRF impact is consistent with the small SLOCA LRF contribution of 2.3% (DCD Table 19.1-32).

Given the small impact on both CDF and LRF, it is anticipated that there will not be any significant impact on the risk ranking results. During next PRA update, KHNP will reconsider the treatment of VSLOCA. The DCD will then be revised, as necessary.

Note: Attachments 2, 3, and 4 are placed in the electronic reading room.

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
The treatment of VSLOCA will be reconsidered during next PRA update.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Table 19.1-6 DCD Markup for Question PRA-192

[Table 19.1-6, Page 19.1-286]

Table 19.1-6 (1 of 2)

Internal Events PRA Initiating Event Frequencies

Designator	Initiating Event Description	Mean Frequency (Per Rx Critical Year)(1)	Mean Frequency (Per Rx Calendar Year)(2)	Error Factor
LLOCA(3)	Large LOCA (Rupture greater than 15.24 cm dia.)	1.33E-06	1.26E-06	10.7
MLOCA(3)	Medium LOCA (Rupture of 5.08 cm to 15.24 cm dia.)	5.10E-04	4.85E-04	10.0
SLOCA(3)	Small LOCA (Rupture of 5.08 cm dia. or less) (Total of SLOCA + VSLOCA + RCP Seal LOCA + IOSRV Frequencies)	~~2.09~~2.53E-03	~~1.99~~2.40E-03	8.4
SGTR	Steam Generator Leakage/Tube Rupture	2.07E-03	1.97E-03	2.5
LSSB-U	Large Secondary Side Breaks Upstream of MSIV	3.67E-04	3.49E-04	8.4
LSSB-D	Large Secondary Side Breaks downstream of MSIV	7.70E-03	7.32E-03	1.6

Response to Action Item 19-215 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-193 (AI 19-215)

In the IE Notebook, Page 52, LLOCA is given to be 0.50ft2 but later defined as LOCAs greater than 6 inches in size. It is not clear which LOCA size is used for LLOCA analysis.

Response

The original version of the Initiating Event Notebook (APR1400-K-P-NR-013101-P, Rev. 0) had incorrect LOCA sizes in several places throughout the document. The latest version, APR1400-K-P-NR-013101-P, Rev. 0A, corrected these errors in all places except Section 7 and Table 4. Therefore, Section 7 of APR1400-K-P-NR-013101-P, Rev. 0A is revised to correct the LOCA sizes to be consistent with the Accident Sequence Notebook APR1400-K-P-NR-013102-P, Rev. 0A and the DCD Table 19.1-6 (see Attachment 1, which is placed in the electronic reading room).

The LOCA size errors in Table 4 were already addressed in the response to PRA-192 (AI 19-214).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the Initiating Event Notebook (APR1400-K-P-NR-013101-P, Rev. 0A) will be revised as stated in this response, and in the response to PRA-192 (AI 19-214).

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-216 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-194 (AI 19-216)

In the IE Notebook, Page 63, it is not clear why the very small LOCA (VSLOCA), which was identified as an industry initiating event category, is assigned with an n/a under the APR1400 initiator table.

Response

Table 5 in the Initiating Event Notebook incorrectly states that the very small LOCA is “n/a” in for the APR1400; this should be “SLOCA.” Table 5 of the Initiating Event Notebook, APR1400-K-P-NR-013101-P, Rev. 0A is revised to clarify this issue (see Attachment 1, which is placed in the electronic reading room).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the Initiating Event Notebook (APR1400-K-P-NR-013101-P, Rev. 0A) will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-217 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-195 (AI 19-217)

In the ASQ Notebook, Page 14 mentions the loss of nuclear cooling water. It is unclear whether this is a plant system, since the staff could not find any discussion about this system.

Response

There is no nuclear cooling water system in the APR1400. This was incorrect information in the old Accident Sequence Notebook, APR1400-K-P-NR-013102-P, Rev. 0. This incorrect information has been removed in the current version, APR1400-K-P-NR-013102-P, Rev. 0A.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-218 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-196 (AI 19-218)

In the ASQ Notebook, Page 18, the SIT and SI pump success criteria do not match the information in the DCD, i.e., 3/4 SITs and 2/4 SIPs must inject during a LLOCA against 2/4 SITs and 3/4 SIPs in the DCD.

Response

This was dated information in the old Accident Sequence Notebook, APR1400-K-P-NR-013102-P, Rev. 0. This old information has been removed in the current version, APR1400-K-P-NR-013102-P, Rev. 0A.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-219 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-197 (AI 19-219)

In the ASQ Notebook, Page 21, it is unclear whether the time to start and load AAC generator (within ten minutes) has been evaluated to be feasible or not.

Response

Per the Auxiliary Power System Notebook (APR1400-K-P-NR-013211), the AAC will be available to accept supply power within 10 minutes of the SBO event with the basis being a reference to the AAC System Functional Description (1-591-M403-001). In addition, the same 10 minute time is mentioned in several places within Chapter 8 (Electrical Systems) of the DCD. For example from DCD Section 8.3.1.2.2, page 8.3-34, "The AAC power source is designed to be available to power the shutdown buses within 10 minutes of the onset of an SBO." Also, Section 8.4.1.6, page 8.4-6 states, "The AAC GTG is started once every refueling outage to verify its availability within 10 minutes and the rated load capacity test is performed."

So, the feasibility of the 10 minutes start time used in the PRA is based on the AAC design, and the testing verifies the viability. Hence, at this time, no PRA Notebook or DCD revisions are envisioned.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report

Response to Action Item 19-220 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-198 (AI 19-220)

In the IE Notebook, Page 63, it is unclear whether "2 or more stuck open safety/relief valves" event has been considered as SLOCA.

Response

Only 1 POSRV is required to result in a SLOCA; therefore, opening of 2 POSRVs is non-minimal.

Table 5 of the IE NB, APR1400-K-P-NR-013101-P, Rev. 0A is revised to clarify this issue (see Attachment 1, which is placed in the electronic reading room).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the Initiating Event Notebook (APR1400-K-P-NR-013101-P, Rev. 0A) will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-223 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-200 (AI 19-223)

In the Success Criteria Notebook, Page 48, Section 5.5.3.1 states that there is a potential that the RCP seal remains intact. The staff could not find any discussion of the basis for this statement and how long the seals would stay intact for. This statement should be considered for inclusion in the key assumptions table.

Response

Recall that the RCP seal testing for the APR1400 is not yet complete (see response to PRA-10 (AI 19-010)). Hence, the initial information for the APR1400 RCP seals is based on other RCP seal LOCA models. Other industry RCP seal LOCA models include the potential for the high temperature seals to remain intact given loss of all RCP seal cooling as long as the RCPs are tripped. The APR1400 seal are high temperature seals, and therefore the model includes this assumption. The seals remain intact for the duration of the event, and as the RCS cools down, they continue to remain intact.

The RCP seal testing is expected to conclude sometime this fall with the RCP seal LOCA report to be completed a couple months after the testing is complete. The RCP seal model will be incorporated in the PRA update. Any key assumptions or risk insights gained after incorporation of the APR1400 RCP seal LOCA model will be included in the key assumptions table in the DCD at that time.

It is suggested that this be combined with PRA-10.

Impact on DCD
There is no impact on the DCD at this time.

Impact on PRA
The PRA model will be updated to include the APR1400 RCP seal cooling model after it becomes available.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-225 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-202 (AI 19-225)

In the Success Criteria Notebook, Page 55, Section 5.5.6.6, the staff found no basis for the assumption that "1 out of 2 Safety Injection Trains" is adequate for LLOCA hot leg injection, since for LLOCA, it states that "3 out of 4 Safety Injection Pumps" are needed for adequate cooling. It is not clear whether the requirement of 1 out of 2 SI train includes SI pumps and tanks.

Response

Note that only 2 SIPs are piped for hot leg injection (HLI). From the SI System Notebook, APR1400-K-P-NR-013201-P, "SI lines 1 & 2 inject the borated water to the RCS only through DVI nozzles while SI lines 3 & 4 can inject through either a DVI nozzle line, or a hot leg injection line which is used during the long term cooling mode." This information is also found in the Safety Injection Pumps description in Section 6.3.2.5.2 of the DCD.

So, when the Success Criteria Notebook, Page 55, Section 5.5.6.6 states, "the success criterion for this function is successful manual re-alignment of one of two SI trains for hot leg injection within 3 hours" it is referring to SIPs 3 and 4 (SI-PP02C and SI-PP02D). Furthermore, this statement should read "one of two SI pumps." Section 5.5.6.6 of the Success Criteria Notebook is revised to state this (see Attachment 1, which is placed in the electronic reading room).

Additionally, note that Success Criteria Notebook, Page 55, Section 5.5.6.6 references DCD Section 15.6.5.3.3, this is changed to 15.6.5 (see Attachment 1) as there is information in various Section 15.6.5 subsections (not just 15.6.5.3.3) which support the success criteria.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the Success Criteria Notebook (APR1400-K-P-NR-013103-P, Rev. 0) will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-227 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-204 (AI 19-227)

The staff is not clear if the large fuel oil storage tanks in the auxiliary building have been evaluated as potential combustible sources that can significantly exacerbate a potential fire scenario occurring in their vicinity.

Response

Oil tanks are not considered as ignition sources in NUREG/CR-6850. The only ignition sources in these room (F065-A01C and F065-A01D) include one (1) ventilation fan in each room (which by examination of plant general arrangement drawings are about 10-15 feet from the tank), and transient sources. There is a pre-action sprinkler system in these rooms (which is not credited in the FPRA due to low screening CDF). The vent lines of the fuel oil storage tanks (and day tanks) are fitted with a flame arrester to protect the tanks from an external open fire (DCD Section 9.5.4). Regardless, since a full room burnout scenario is assumed for these rooms, all ignition sources in these rooms are assumed to fail all equipment and cables in the rooms regardless of the oil in the tanks.

All flammable liquid tanks in buildings containing safe shutdown equipment were considered as potential ignition sources in the seismic-fire interaction assessment, APR1400-K-P-NR-013455-P (to be loaded in the ERR) which was developed in response to Issue PRA-116. The tanks and their associated piping were all deemed seismically rugged based on their seismic Category, and therefore deemed unlikely to fail and release their contents during a seismic event. Based on this they were judged to be not significant to seismic-fire risk.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-228 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-205 (AI 19-228)

The LPSD fire PRA notebook includes the following statement, "The intent of the development of the APR1400 LPSD FPRA model is mainly to support design certification (DC) by demonstrating that the risk impact of fires during LPSD conditions is small. Therefore, the implications of using conservative assumptions is not as great for risk models which are used in risk-informed applications such as the maintenance rule, etc. where overly conservative assumptions can lead to incorrect conclusions. Although the result of this model will be used to populate risk ranking tables in the DC document, it is done with the understanding that the results were developed in a conservative manner."

Based on the above statement, the staff is unclear if the impact of overly conservative assumptions on risk insights were assessed (e.g., use of sensitivity studies) and whether the risk insights supporting the D-RAP are valid. D-RAP SSCs may be considered for the eventual maintenance rule implementation.

Response

In general, when conservative assumptions are used in the DC stage PRA, the assumptions are related to information that is not available during the DC stage. The statement in the notebook is actually applicable to all conservative assumptions made in the DC PRA. It is understood that these assumption may impact initial risk ranking; however it is also understood that when this information becomes available, it will be incorporated into the PRA removing the conservatism. Any impact on the RAP list based on updated risk ranking can then be made, which is required by procedure.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-232 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-209 (AI 19-232)

The probability of IRWST suction strainer plugging is not increased relative to the power operation PRA model. The IRWST design characteristics (e.g., large, separation between suction lines, debris filtering capability) and plant procedures (e.g., foreign material control) are expected to provide reasonable assurance that this probability is low. This PRA assumption should be a key risk insight.

Response

Agreed, this item will be added in the risk insight Table 19.1-4 (See Attachment 1).

Impact on DCD
The DCD will be revised as stated in the response.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DCD TIER 2

Attachment 1 – Table 19.1-4 DCD Markup for Question PRA-209

[Table 19.1-4, page 19.1-283]

Table 19.1-4

Relation of the Plant Safety Functions and the Initiating Events

No.	Insight	Disposition
Risk Insights from PRA Models		
58	The fire PRA assumes that the fire barrier management procedures used during LPSD will include directions to provide reasonable assurance that breached risk-significant fire barriers can be closed in sufficient time to prevent the spread of fire across the barrier. The procedural direction is to include the use of a fire watch whose duties are commensurate with the risk associated with the barrier. For example, for fire barriers that separate two fire compartments that both contain no equipment or cables necessary to prevent core damage or large early release during LPSD conditions, or have been demonstrated to have low risk significance, there will at least be a roving fire watch to check the barrier during rounds. For fire barriers separating fire compartments that contain equipment or cables necessary to prevent core damage or large early release during LPSD conditions, and have been demonstrated to be risk significant with respect to fire, a permanent fire watch will be established until the barrier is reclosed. In the latter case, the fire barrier management procedure is to direct that hoses or cables that pass through a fire barrier use isolation devices on both sides of a quick-disconnect mechanism that allow for reclosure of the barrier in a timely fashion to re-establish the barrier prior to fire spread across the barrier.	Subsection 19.1.6.3.1.2 COL 19.1(11)
##	The probability of IRWST suction strainer plugging is not increased relative to the power operation PRA model. The IRWST design characteristics (e.g., large, separation between suction lines, debris filtering capability) and plant procedures (e.g., foreign material control) are expected to provide reasonable assurance that this probability is low.	Subsection 19.1.6.1.2.5

Response to Action Item 19-234 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-211 (AI 19-234)

In the Success Criteria Notebook, Page 41, it states that the Class 1E, C and D batteries would last up to 16 hours with no load shedding. However, the staff found no information regarding the 16-hour design duration of C and D batteries in DCD Chapter 8.

Response

The notes in Table 8.3.2-1 (page 8.3-80 through page 8.3-83) identify the duty cycle for each 1E battery train. This table consists of 4 pages, each page is for a single 1E DC train. Note (5) in pages 1 and 2 of Table 8.3.2-1 identifies the duty cycle of the train A and B battery to be 8 hours. Note (8) in pages 3 and 4 of Table 8.3.2-1 identifies the duty cycle of the train C and D battery to be 16 hours.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-235 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-212 (AI 19-235)

In the Success Criteria Notebook, Page 42, it states that during feed and bleed, the operator manually opens the POSRV pilot valve. It is unclear whether the manually opening of the valve is done at the valve itself or from the control room.

Response

The POSRV pilot valves are in the reactor containment building. Hence, manual operation of the POSRVs is mainly from the main control room (MCR). Note that one of the two POSRV pilot valves for each POSRV is disconnected (key locked power off) outside the control room; this needs to be keyed back in before operation from the control room. The operator action for feed and bleed considers the step required to re-power the key locked power off pilot valves.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-236 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-213 (AI 19-236)

In the Success Criteria Notebook, Page 47, Section 5.5.2.8 states that if automatic throttling of AFW fails, then early cooldown has to be completed in less time. The staff is unclear how the cooldown would be completed in the case when automatic throttling of AFW fails, as it is not discussed in this section.

Response

This question concerns SGTR event tree top event ECLDN (Early Cooldown during SGTR). The operator action for this event is HR-RCSCD1-ISOL. ECLDN includes this operator action as well as equipment necessary to perform the RCS cooldown function including the auxiliary pressurizer spray or the reactor coolant gas vent system for RCS pressure control, continued control of AF throttling to maintain SG level, and opening of the main steam atmospheric dump valves for SG cooldown.

Review of the SGTR event tree (DCD Figure 19.1-19) shows that ECLDN is only applicable for scenarios with prior success of reactor trip, safety injection and secondary side heat removal. If AF flow control fails low (i.e., loss of AF), then secondary side heat removal fails, and top event ECLDN is not considered as a different event tree path is followed. Therefore, AF flow control failure for this top event is failing high resulting in SG overfill prior to the RCS being lowered below the MSSV lift pressure.

Although the Success Criteria Notebook states that a faster cooldown (46 minutes) could be performed if AF flow control is lost, it is not credited in the PRA since the AF flow control could be lost sometime after the 46 minute time window, and therefore the faster RCS cooldown could not be accomplished in time. Since the information on the faster cooldown is not included in the model, it is removed to avoid confusion (see Attachment 1).

Note: Attachment 1 is placed in the electronic reading room.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the Success Criteria Notebook (APR1400-K-P-NR-013103-P, Rev. 0) will be revised as stated in this response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-237 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-214 (AI 19-237)

In the Success Criteria Notebook, Page 49, it is not clear how Section 5.5.4.2 applies to LLOCA, since the title of the section doesn't seem to include it.

Response

The title of section is incorrect, and will be changed to include LLOCA (see Attachment 1).

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model. However, the Success Criteria Notebook (APR1400-K-P-NR-013103-P, Rev. 0) will be revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Attachment 1 – Section 5.5.4.2 of APR1400-K-P-NR-013103-P Markup for Question PRA-214

[Section 5.5.4.2, page 49]

5.5.4 RCS Inventory Success Criteria

5.5.4.1 SIT – Safety Injection Tanks (in LLOCA)

There are four passive Safety Injection Tanks (SITs). Each is connected to a direct vessel injection (DVI) line and will discharge when RCS pressure drops below 632 psig (Reference 5 Table 6.2.1-21). This inventory provides immediate inventory makeup before the Safety Injection pumps can start and provide a significant flow rate into the reactor core during a large LOCA event.

The success criterion for this function in Large LOCA, based on the RELAP analyses in Table 5-1, case 0, is that two of the four SITs must inject.

5.5.4.2 SIS – Safety Injection System (in LLOCA, MLOCA, SLOCA, SGTR, LSSB-U, LSSB-D, FWLB, PLOCCW, PLOESW and PR-SL)

The Safety Injection system has four high pressure, low capacity pumps that automatically start on a Safety Injection Actuation System (SIAS) signal. According to the RELAP analysis for large LOCA cases summarized in Table 5-1, the case 1 where three SI pumps with two SITs are available is the most bounding case to prevent core damage for all the cases of large LOCA. Thus, the success criterion for a large LOCA is to inject safety injection flow using three or more SI pumps.

Response to Action Item 19-238 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-215 (AI 19-238)

In the Success Criteria Notebook, Page 54, Section 5.5.6.2, it is unclear how long the RCP seals would remain intact after an SBO.

Response

This is the basically the same issue as identified in PRA-200 (AI 19-222). Please see the response to PRA-200. Like PRA-200, it is suggested that this be combined with PRA-10.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

Response to Action Item 19-240 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-217 (AI 19-240)

Section 6.2.1 of APR1400-K-P-NR-013602-P, “APR1400 Design Certification Probabilistic Risk Assessment: Full Power Level 2 PRA: CET DET Analysis,” Revision 0, July 2013, notes the following: “A MSSV has a certain failure probability to close (or reclose) given that it has opened. Following the APR1400 DC Analysis notebook (Reference 39), the fail-close probability of one MSSV, [designated] as PFTC, is assigned to be 1.69E-04/demand.”

However, Reference 39 is APR1400-K-P-NR-013222-P, “Full Power Level 1 PRA: Containment Isolation System Notebook” but not “APR1400 DC Analysis notebook.”

Response

The correct reference should be Reference 34. Section 6.2.1 of APR1400-K-P-NR-013602-P is revised to reflect the correct reference (See Attachment 1).

Note: Attachment 1 is placed in the electronic reading room.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA. However, Section 6.2.1 of APR1400-K-P-NR-013602-P, Revision 0 is revised as stated in the response.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.

APR1400 DC PRA NOTEBOOK

Attachment 1 – APR1400-K-P-NR-013602-P Markup for Question PRA-217

[Section 6.2.1, page 77]

- NO-DEPRESS : P(NO-PRESS) = 0.9
- ALL-DEPRESS : P(ALLDEPRESS) = 0.1

Event 5 SGSORV : No stuck open of MSSVs at the time of core damage ?

This event is similar with event 2. This event considers the probability that a main steam safety valves (MSSVs) will fail to reclose early at the time of core damage. If the MSSVs fail to reclose, the secondary side is depressurized unintentionally and it can increase the potential for both PI-SGTR and TI-SGTR. In this analysis, the probability that MSSVs fail to reclose are estimated by considering its failure rate (fail to reclose) and the number of MSSV's cycles.

A MSSV has a certain failure probability to close (or reclose) given that it has opened. Following the APR1400 DC Data Analysis notebook (Reference ~~39~~34), the fail-to-reclose probability of one MSSV, designed as P_{FTC}, is assigned to be 1.69E-04/demand. The probability P_n for a single valve after any given number (n) of cycles is~~-~~:

Response to Action Item 19-251 Section 19.1

PRA Issue List Regarding APR-1400, DCD Tier 2, SECTION 19.1

Issue # PRA-228 (AI 19-251)

Table 19.1-96 (1 of 24) "LPSD Internal Events PRA Top 100 CDF Cutsets - All POS," the basic events identified in this table should include their assigned probabilities.

Response

Note that all other internal and external events PRA CDF and LRF cutset Tables in the DCD (except Table 19.1-19) do not contain the basic event probabilities. All BE probabilities used in the APR1400 internal and external events PRAs are based off of the information in DCD Table 19.1-14. The LPSD initiating event frequencies are contained in DCD Tables 19.1-82 through 19.1-87. Finally, the LPSD human error probabilities and their dependency values are contained in APR1400-K-P-NR-013705-P, “Low Power and Shutdown PRA Human Reliability Analysis,” Tables 7-1 through 7-8.

For convenience, KHNP will consider adding this information in the next PRA update.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA model.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Reports.