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19 PROBABILISTIC RISK ASSESSMENT AND SEVERE ACCIDENT EVALUATION

19.2 Severe Accident Evaluations

19.2.7 Beyond Design Basis Large Commercial Aircraft Impact Assessment

19.2.7.1 Introduction

This section describes the staff's evaluation of the description of design features and functional capabilities credited by the applicant to show that the facility can withstand the effects of the impact of a large commercial aircraft. These design features and functional capabilities are described in Final Safety Analysis Report (FSAR) Tier 2, Revision 5, Section 19.2.7, "Beyond Design Basis Large Commercial Aircraft Impact Assessment."

19.2.7.2 Summary of Technical Information

In FSAR Tier 2, Revision 4, Section 19.2.7, the applicant stated that it performed an aircraft impact assessment (AIA) in accordance with the requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.150(a)(1) using the methodology described in Nuclear Energy Institute (NEI) 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," Revision 7, with no exceptions.

After the original FSAR submittal, the U.S. Nuclear Regulatory Commission (NRC) released Regulatory Guide (RG) 1.217, August 2011, "Guidance for the Assessment of Beyond-Design-Basis Aircraft Impact," which cites NEI 07-13, Revision 8. In Request for Additional Information (RAI) 565, Question 19.357, the staff requested that the applicant confirm that the FSAR cited the correct revision to NEI 07-13 and make applicable changes to FSAR Tier 2, Section 19.2.7.3. In an April 26, 2013, response to RAI 565, Question 19-357, the applicant provided a proposed revision to FSAR Tier 2, Sections 19.2.7.3 and 19.2.8, and AREVA Technical Report (TR) ANP-10317, "Design Requirements for the U.S. EPR Aircraft Hazard Protection Structures," Revision 1, to cite NEI 07-13 Revision 8, which is the latest version of NEI 07-13 and endorsed by RG 1.217 and Standard Review Plan (SRP) Section 19.5, "Adequacy of Design Features and Functional Capabilities Identified and Described for Withstanding Aircraft Impacts," April 2013. The staff confirmed that FSAR Tier 2, Revision 5, dated July 19, 2013, was revised according to the committment made in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 565, Question 19-357 resolved.

Based on the results of the assessment, the applicant identified a set of key design features to show that the acceptance criteria in 10 CFR 50.150(a)(1) are satisfied. These key design features are reported in FSAR Tier 2, Revision 5, Section 19.2.7, and technical reports incorporated by reference therein along with references to other sections of the FSAR that provide additional detail. FSAR Tier 2, Revision 5, Section 19.2.7, also contains descriptions of how the key design features show that the acceptance criteria in 10 CFR 50.150(a)(1) are met.

19.2.7.2.1 Description of Key Design Features

The credited design features, their function(s), and references to sections containing the detailed descriptions are summarized below:

(1) The use of individual hardened and isolated shield structures specific to the Containment, Fuel Building, and Safeguard Buildings 2 and 3

This design feature described in AREVA TR ANP-10317, FSAR Tier 2, Sections 1.2.3.1.2 and 3.8.4, and FSAR Tier 2, Appendix 3B, "Dimensional Arrangement Drawings," and Appendix 3E, "Design Details and Critical Sections for Safety-Related Category I Structures," protects the following credited systems, structures, and components (SSCs) that are housed in these structures.

- The containment vessel, as described in FSAR Tier 2, Revision 5, Section 3.8.2
- Containment isolation system, as described in FSAR Tier 2, Revision 5, Section 6.2.4
- Reactor Coolant System (RCS), as described in FSAR Tier 2, Revision 5, Section 5.0
- Reactor trip breakers, as described in FSAR Tier 2, Revision 5, Section 7.2.1.1
- Emergency core cooling water source, in containment refueling water storage tanks, as described in FSAR Tier 2, Revision 5, and Section 6.3
- Main steam system from the steam generators to the Safeguard Building annulus penetration (trains 1, 2, 3, and 4) as described in FSAR Tier 2, Revision 5, Section 10.3
- Main feedwater system from the steam generators to the Safeguard Building annulus penetration (trains 1, 2, 3, and 4) as described in FSAR Tier 2, Revision 5, Section 10.4.7
- Spent Fuel Pool (SFP) as described in FSAR Tier 2, Revision 5, Section 9.1
- SFP makeup capability, as described in FSAR Tier 2, Revision 5, Section 9.1.3.2.4
- Fuel pool cooling and purification system as described in FSAR Tier 2, Revision 5, Section 9.1.3
- Cask loading pit/transfer compartment, as described in FSAR Tier 2, Revision 5, Section 9.1.4.3.1
- Main Control Room (MCR), as described in FSAR Tier 2, Revision 5, Section 6.4
- MCR Heating, Ventilation, and Air Conditioning (HVAC) as described in FSAR Tier 2, Revision 5, Section 9.4.1
- Safety injections/Residual Heat Removal System (RHRS) (trains 2 and 3) as described in FSAR Tier 2, Revision 5, Section 6.3
- Emergency Feedwater (EFW) system (trains 2 and 3) as described in FSAR Tier 2, Revision 5, Section 10.4.9
- Component Cooling Water System (CCWS) (trains 2 and 3) as described in FSAR Tier 2, Revision 5, Section 9.2.2

- CCWS common header, as described in FSAR Tier 2, Revision 5, Section 9.2.2
- Essential Service Water System (ESWS) (interior portions) (trains 2 and 3) as described in FSAR Tier 2, Revision 5, Section 9.2.1
- Uninterruptible electrical power supply systems (trains 2 and 3) as described in FSAR Tier 2, Revision 5, and Section 8.3.2
- Electrical Power Supply System (EPSS), as described in FSAR Tier 2, Revision 5, Section 8.3.1; portions of trains 2 and 3 in Safeguard Building
- Safety Chilled Water System (SCWS) (trains 2 and 3) as described in FSAR Tier 2, Revision 5, and Section 9.2.8
- Electrical division of Safeguard Building ventilation system (trains 2 and 3), as described in FSAR Tier 2, Revision 5, Section 9.4.6
- Fuel Building ventilation system as described in FSAR Tier 2, Revision 5, Section 9.4.2
- Annulus Ventilation System as described in FSAR Tier 2, Revision 5, Section 6.2.3.2.2
- Extra Boration System (EBS), as described in FSAR Tier 2, Revision 5, Section 6.8
- Instrumentation and Controls (I&C) for the systems and components in this list, as described in FSAR Tier 2, Revision 5, Section 7.0

(2) The use of a hardened building exterior for Safeguard Buildings 1 and 4

This design feature described in AREVA TR ANP-10317; FSAR Tier 2, Sections 1.2.3.1.2 and 3.8.4; and FSAR Tier 2, Appendix 3B protects the following credited SSCs that are housed in these structures.

- Safety Injection/RHRS (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 6.3
- EFW system (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 10.4.9
- CCWS (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 9.2.2
- ESWS (interior portions) (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 9.2.1
- SCWS (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 9.2.8
- Uninterruptible electrical power supply systems (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 8.3.2
- Main Steam Supply System (MSS) from the Safeguard Building annulus penetration to the MSIV (trains 1, 2, 3, and 4), as described in FSAR Tier 2, Revision 5, Section 10.3

- EPSS, as described in FSAR Tier 2, Revision 5, Section 8.3.1 – portions of trains 1 and 4 in Safeguard Building

- Main Feedwater System (MFWS) from the Safeguard Building annulus penetration to the main feedwater isolation valve (MFWIV) (trains 1, 2, 3, and 4), as described in FSAR Tier 2, Revision 5, Section 10.4.7

- Electrical division of Safeguard Building ventilation system (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 9.4.6

- I&C located in Safeguard Buildings 1 and 4 for the systems and components in this list, as described in FSAR Tier 2, Revision 5, Section 7.0

(3) Screening by the site arrangement and plant structural design

The assessment credits the arrangement and design of the following building features to limit the location and effects of potential aircraft strikes on the U.S. EPR structures:

- The location and design of concrete barriers at selected locations along the exterior of the U.S. EPR structures described in AREVA TR ANP-10317, Revision 1, or in FSAR Tier 2, Appendix 3B protects the interior of these structures.

- The location and design of the Emergency Power Generating Building structures and layout described in FSAR Tier 2, Revision 5, Section 3.8 and AREVA TR ANP-10317, Revision 1, protects portions of Safeguard Buildings 2 and 3 and Safeguard Building 4.

- The location and design of the Essential Service Water Building structures and layout described in FSAR Tier 2, Revision 5, Section 3.8 and AREVA TR ANP-10317, Revision 1, protects portions of Safeguard Building 1, Safeguard Buildings 2 and 3, and Safeguard Building 4.

- The location and design of the Nuclear Auxiliary Building (NAB) structure and layout described in FSAR Tier 2, Revision 5, Section 1.2.3 and AREVA TR ANP-10317, Revision 1, protects portions of Safeguard Building 4 and the Fuel Building.

- The location and design of the concrete sliding door between the Radioactive Waste Processing Building (RWPB) and NAB at elevation zero feet described in FSAR Tier 2, Revision 5, Section 1.2.3 and AREVA TR ANP-10317, Revision 1, protects portions of the Fuel Building.

(4) Physically separate and redundant trains

This design feature results in the following safety-related and support systems, credited in FSAR Tier 2, Chapter 15 analyses with being physically separated and redundant, remaining functional after the aircraft impact to maintain core and SFP cooling capability.

- Safety Injection/RHRS, as described in FSAR Tier 2, Revision 5, Section 6.3

- EFW System, as described in FSAR Tier 2, Revision 5, Section 10.4.9

- CCWS (trains 1 and 4), as described in FSAR Tier 2, Revision 5, Section 9.2.2

- ESWS (Exterior and buried portions), as described in FSAR Tier 2, Revision 5, Section 9.2.1
- ESW pump building ventilation system, as described in FSAR Tier 2, Revision 5, Section 9.4.11
- Ultimate heat sink, as described in FSAR Tier 2, Revision 5, Section 9.2.5
- Uninterruptible electrical power supply systems, as described in FSAR Tier 2, Revision 5, Section 8.3.2
- EPSS and emergency diesel generator (EDG), as described in FSAR Tier 2, Revision 5, Section 8.3.1
- Emergency power generating building ventilation system, as described in FSAR Tier 2, Revision 5, Section 9.4.9

(5) Fire barriers and fire protection features

Selected fire barriers, fire dampers, fire doors, and penetration seals are 3-hour rated to prevent fire damage in one division from spreading to an adjacent division. Selected structural elements and blast dampers are rated for 5 pounds per square inch differential (psid) to prevent explosion effects from spreading to adjacent areas. The credited fire barriers, fire dampers, fire doors, penetration seals, structural elements, and blast dampers are identified on the fire zone layout figures in FSAR Tier 2, Appendix 9A.

(6) Technical Reports

AREVA Technical Reports ANP-10295, "U.S. EPR Security Features," Revision 4, ANP-10296, "U.S. EPR Design Features that Enhance Security," Revision 1, and ANP-10317, Revision 1 provide additional description of the design features and success criteria credited in the assessment. The staff notes that these technical reports are incorporated by reference in FSAR Tier 2, Revision 5.

19.2.7.2.2 Description of How Regulatory Acceptance Criteria are Met

The acceptance criteria in 10 CFR 50.150(a)(1) is as follows: (1) The reactor core will remain cooled or the containment will remain intact; and (2) spent fuel cooling or SFP integrity is maintained. The staff finds that applicant has met 10 CFR 50.150(a)(1) by including features in the U.S. EPR design that maintain core cooling, an intact containment, spent fuel cooling and SFP integrity following the impact of a large, commercial aircraft. The staff notes that, although the regulations require meeting two of the acceptance criteria as stated above, the applicant states that its AIA meets all four acceptance criteria in the rule.

As indicated in FSAR Tier 2, Revision 5, Section 19.2.7, the applicant proposes to maintain core cooling using the safety-related systems described in FSAR Tier 2, Revision 5, Section 19.2.7 that have been designed specifically to ensure that the reactor can be shut down and decay heat can be removed adequately from the reactor core. Some of this equipment is located inside the Containment, Fuel Building, and Safeguard Buildings 2 and 3, which are protected by a hardened and isolated shield structure. Other equipment is located in Safeguard Buildings 1 and 4, which have hardened exterior walls that protects the equipment from physical damage

resulting from the impact of a large commercial aircraft. In addition, selected fire barriers, fire dampers, fire doors, and penetration seals are three-hour rated to prevent fire damage in one division from spreading to an adjacent division. Selected structural elements and blast dampers are rated for 5 psid to prevent explosion effects from spreading to adjacent areas. The credited fire barriers, fire dampers, fire doors, penetration seals, structural elements, and blast dampers are identified on the fire zone layout figures in FSAR Tier 2, Revision 5, Appendix 9A.

The staff notes that FSAR Tier 2 satisfies the "containment remains intact" acceptance criterion in 10 CFR 50.150(a)(1) by the provision of a hardened and isolated reactor shield structure around the containment structure as a key design feature. In FSAR Tier 2, Section 19.2.7.5.1, the applicant stated that its analyses and assessment concluded that the hardened and isolated containment shield structure would not be perforated, and no significant structural damage would occur, because of either local or global aircraft impacts. The hardened and isolated Fuel Building shield structure, which is a key design feature that is not perforated, also protects the containment equipment hatch. The containment structure inside the shield structures would not be impacted by the aircraft or any associated debris. Therefore, the containment performance, including ultimate pressure capacity, would be unaffected. Under these conditions, no physical damage or fire damage inside containment needs to be considered.

The staff notes that FSAR Tier 2 satisfies the SFP integrity and SFP cooling acceptance criterion in 10 CFR 50.150(a)(1) by the provision of a hardened and isolated external shield structure surrounding the Fuel Handling Building, which houses the SFP, as a key design feature. Further, provision of concrete barriers at selected locations on the exterior of the U.S. EPR Fuel Building and the design of the concrete sliding door in the RWPB at the interface with the NAB protect portions of the Fuel Building. In FSAR Tier 2, Section 19.2.7.5.1, the applicant stated that its analyses demonstrated that no physical damage to the interior of the Fuel Building results from the impact of a large commercial aircraft. The prevention of aircraft perforation of the hardened and isolated shield structure surrounding the Fuel Building ensures that the SFP is not perforated and that SFP integrity is maintained. In FSAR Tier 2, Section 19.2.7.4, the applicant stated that the use of hardened and isolated shield structures protects the Containment and Fuel Building and credited portions of SSCs that provide SFP cooling and SFP makeup.

19.2.7.3 Regulatory Criteria

The impact of a large commercial aircraft is a beyond-design-basis event (BDBE). Under 10 CFR 52.47(a)(28), "Contents of application; technical information," and 10 CFR 50.150, "Aircraft impact assessment," applicants for new nuclear power reactors[1] are required to perform a design-specific assessment of the effects on the facility of the impact of a large commercial aircraft. In the application, the applicant is required to provide a description of the design features and functional capabilities identified in the assessment and how the acceptance criteria of the 10 CFR 50.150 rule was met.

Applicants subject to 10 CFR 50.150 are not required to submit the assessment to the U.S. Nuclear Regulatory Commission (NRC) in their applications, but must make the complete AIA available for NRC inspection, at the applicants' offices or their contractors' offices, upon

[1] "Applicants for new nuclear power reactors" is defined in the Statement of Considerations for the Aircraft Impact Rule (74 *Federal Register*(*FR)* 28112, June 12, 2009)

NRC request in accordance with 10 CFR 50.70, “Inspections”; 10 CFR 50.71, “Maintenance of Records, Making of Reports”; and Section 161.c of the Atomic Energy Act of 1954, as amended. The outcome of the NRC inspection is not part of this report. The staff used the following relevant regulations and guidance to perform this review.

19.2.7.3.1 Applicable Regulations

- 10 CFR 52.47(a)(28), as it relates to the requirement that applications for standard design certifications that are subject to 10 CFR 50.150(a) must contain the information required by 10 CFR 50.150(b).

- 10 CFR 50.150(a)(1), as it relates to the requirement that each applicant perform a design-specific assessment of the effects on the facility of the impact of a large commercial aircraft. Using realistic analyses, the applicant shall identify and incorporate into the design those design features and functional capabilities to show that, with reduced use of operator actions: (i) The reactor core remains cooled, or the containment remains intact; and (ii) spent fuel cooling or spent fuel pool integrity is maintained.

- 10 CFR 50.150(b), as it relates to the requirement that the final safety analysis report must include a description of: (1) The design features and functional capabilities that the applicant has identified for inclusion in the design to show that the facility can withstand the effects of a large commercial aircraft impact in accordance with 10 CFR 50.150(a)(1); and (2) how those design features and functional capabilities meet the assessment requirements of 10 CFR 50.150(a)(1).

- 10 CFR 52.47(b)(1), as it relates to the requirement that a standard design certification application contain the proposed inspections, tests, and analysis the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that if the inspections, tests and analyses are performed and the acceptance criteria met, a plant that incorporates the standard design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act of 1954 as amended, and NRC regulations.

19.2.7.3.2 Review Guidance

- RG 1.217, “Guidance for the Assessment of Beyond-Design-Basis Aircraft Impacts,” August 2011, provides guidance for applicants to demonstrate compliance with NRC regulations with regard to AIA. The regulatory position in this RG considers conformance to the guidance in NEI 07-13, “Methodology for Performing Aircraft Impact Assessments for New Plant Designs,” Revision 8, as an acceptable method for use in satisfying the requirements in 10 CFR 50.150(a) regarding the assessment of aircraft impacts for new nuclear power reactors.

- NUREG-0800, SRP Section 19.5, “Adequacy of Design Features and Functional Capabilities Identified and Described for Withstanding Aircraft Impacts,” April 2013, provides review guidance to staff for performing safety evaluations of AIA in applications, including standard design certification, to meet the requirements in 10 CFR 50.150. The staff notes that although SRP Section 19.5 was issued in April 2013 and did not exist at the time of the U.S. EPR design certification application submittal, it is being used in the

staff's review since the interim staff guidelines were incorporated into SRP Section 19.5. The following staff interim review guidelines have now been incorporated in SRP Section 19.5.

(a) "Reasonably Formulated Assessment" Guideline

The staff considers an AIA performed by qualified personnel using a method that conforms to the guidance in NEI 07-13, Revision 8, to be a method that is reasonably formulated to meet the requirements of 10 CFR 50.150(a). The staff considers qualified personnel to be: (1) The designer of the facility for which the AIA applies; and/or (2) an applicant's primary contractor for the AIA who has also designed a nuclear power reactor facility either already licensed or certified by the NRC or currently under review by the staff.

(b) "Reactor Core Remains Cooled" and "Spent Fuel Pool (SFP) Cooling Maintained" Guideline

The "reactor core remains cooled" criterion or "spent fuel pool cooling maintained" criterion in 10 CFR 50.150(a)(1) is satisfied if design features or functional capabilities have been included in the design of the plant to specifically perform that cooling function with reduced use of operator action.

(c) "Intact Containment Structure" Guideline

The "intact containment structure" criterion in 10 CFR 50.150(a)(1) is satisfied if the containment: (1) Will not be perforated by the impact of a large commercial aircraft; and (2) will maintain ultimate pressure capability, given a core damage event, until effective mitigation strategies can be implemented. Effective mitigation strategies are those that provide, for an indefinite period of time, sufficient cooling to the damaged core or containment to limit temperature and pressure challenges to less than the ultimate pressure capability of the containment as defined in FSAR Tier 2, Chapter 19.

(d) "Spent Fuel Pool Integrity Maintained" Guideline

The "spent fuel pool integrity maintained" criterion in 10 CFR 50.150(a)(1) is satisfied if the impact of a large commercial aircraft on the SFP wall or support structures does not result in leakage through the SFP liner below the required minimum water level of the pool.

(e) "Reduced Operator Action" Guideline

The staff considers use of operator action reduced when: (1) All necessary actions to control the nuclear facility can be performed in the control room or at an alternate station containing equipment specifically designed for control purposes; and (2) a reduced amount of active operator intervention, if any, is required to meet the acceptance criteria in 10 CFR 50.150(a)(1). Reduction in the use of operator action is measured relative to the actions required to address aircraft impact without the AIA rule in place (e.g., similar actions contained in operational programs in place at current operating reactor sites).

- Statements of Consideration for the AIA rule (74 *FR* 28112, June 12, 2009), which indicate, among other things, that for the staff to conclude that the rule has been met, it

must find that the applicant has performed an AIA reasonably formulated to identify design features and functional capabilities to show, with reduced use of operator action, that the acceptance criteria in 10 CFR 50.150(a)(1) are met.

19.2.7.4 Staff Evaluation

The staff reviewed the description of key design features provided by the applicant and the description of how the key design features show that the acceptance criteria in 10 CFR 50.150(a)(1) are met. The staff's evaluation is provided below.

19.2.7.4.1 Reasonably Formulated Assessment

In FSAR Tier 2, Revision 4, Section 19.2.7, the applicant stated that their AIA is based on the guidance of NEI 07-13, Revision 7.

Since the original FSAR submittal, RG 1.217, August 2011, cites NEI 07-13, Revision 8, in RAI 565, Question 19-357, the staff requested that the applicant confirm the correct revision to NEI 07-13 and provide applicable changes to FSAR Tier 2, Section 19.2.7.3. In an April 26, 2013, response to RAI 565, Question 19-357, the applicant confirmed that its AIA meets the guidance in NEI 07-13, Revision 8, which is endorsed in RG 1.217. Based on the applicant's use of NRC-endorsed guidance document NEI 07-13, Revision 8, the staff finds that the applicant has performed a reasonably formulated assessment.

19.2.7.4.2 Key Design Features for Core Cooling

The staff reviewed the AIA application and determined it incomplete regarding key design features for core cooling. FSAR Tier 2, Revision 2, Section 19.2.7.4 identifies design features credited for meeting the acceptance criteria of 10 CFR 50.150(a)(1). To assist the staff's review, cross-references to respective sections of the FSAR regarding the description of the credited design features should have been provided in FSAR Tier 2, Section 19.2.7.4, and identifying design features used to meet the acceptance criteria of 10 CFR 50.150(a)(1). Therefore, in RAI 449, Question 19-339, the staff requested that the applicant address the following two issues:

1. Include in FSAR Tier 2, Section 19.2.7.4 references to other FSAR sections where the design features credited for meeting the acceptance criteria of 10 CFR 50.150(a)(1) are described.

2. Describe in the FSAR how each of the identified design features was used to meet the acceptance criteria of 10 CFR 50.150(a)(1).

In a July 6, 2011, response to RAI 449, Question 19-339, the applicant stated:

> U.S. EPR FSAR, Tier 2, Section 19.2.7.4 was revised in Revision 3 to include an additional description and cross-references to the respective U.S. EPR FSAR sections that describe the design features credited for conformance with 10 CFR 50.150. In addition, U.S. EPR FSAR Tier 2, Section 19.2.7.4 was revised, in Revision 3, to describe how each of the identified design features meets the acceptance criteria of 10 CFR 50.150.

New Technical Report ANP-10317, "Design Requirements for the U.S. EPR Aircraft Hazard Protection Structures," documents design requirements that were credited for conformance with 10 CFR 50.150. U.S. EPR FSAR Tier 2, Section 19.2.8 was revised in Revision 3 to add a reference to ANP-10317. This report was also added to the list of reports referenced in U.S. EPR FSAR Tier 2, Table 1.6-1.

The staff reviewed the applicant's July 6, 2011, response to RAI 449, Question 19-339 and finds the response and the proposed FSAR changes acceptable because the applicant provided clarification that they would include an FSAR discussion related to cross-references to the respective FSAR sections that describe the design features credited for conformance to 10 CFR 50.150, and describe how each of the identified design features meets the acceptance criteria of 10 CFR 50.150. The staff notes that the applicant also cited and added the new TR ANP-10317, in FSAR Tier 2, Section 19.2.8 and in FSAR Tier 2, Revision 3, Table 1.6-1. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised according to the commitment in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 449, Question 19-339 resolved.

The staff reviewed the AIA application and determined that FSAR Tier 2, Revision 2, Section 19.2.7.5, "Evaluation of U.S. EPR Performance," was unclear. The staff notes that FSAR Tier 2, Revision 2, Section 19.2.7.5, under "physical damage," indicates that analyses were performed for the Containment, Safeguard, and Fuel Buildings, and that the physical separation and redundant train design allows supporting functions such as power and the ultimate heat sink to survive. However, these analyses did not address the protection of all design features as provided in FSAR Tier 2, Revision 2, Section 19.2.7.4. Therefore, in RAI 449, Question 19-340, the staff requested that the applicant clarify and revise the FSAR as to how the analyses of physical perforation of structures by aircraft components address the protection of all design features as provided in FSAR Tier 2, Revision 2, Section 19.2.7.4, such as: ECCS; decay heat removal systems; emergency feedwater tanks; and emergency core cooling water.

In a July 6, 2011, response to RAI 449, Question 19-340, the applicant stated that FSAR Tier 2, Section 19.2.7.5 provides a statement that the Finite Element Analyses indicated that interior areas of the four Safeguard Buildings, Fuel Building, and the Containment Building are not susceptible to damage due to physical perforation from aircraft components. Therefore, components housed in these structures, such as the emergency core cooling system components, decay heat removal systems, emergency feedwater tanks, and emergency core cooling water, are not susceptible to damage resulting from physical perforation of the structures by aircraft components. The applicant also stated that FSAR Tier 2, Section 19.2.7.4 and Section 19.2.7.5 were revised, in Revision 3, to clarify that the systems and components listed in FSAR Tier 2, Section 19.2.7.4, are housed in the Safeguard, Fuel, and Containment Buildings.

The staff reviewed the applicant's July 6, 2011, response to RAI 449, Question 19-340 and finds the response and the proposed FSAR changes acceptable because the applicant included a discussion in the FSAR to clarify that the systems and components listed in FSAR Tier 2, Section 19.2.7.4, which are housed in the Safeguard, Fuel, and Containment Buildings, are not susceptible to damage resulting from physical perforation by aircraft components as described in FSAR Tier 2, Revision 3, Sections 19.2.7.4 and 19.2.7.5. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised according to the commitment made in

the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 449, Question 19-340 resolved.

The staff reviewed the AIA application and determined it to be incomplete in regard to key design features for core cooling. FSAR Tier 2, Revision 3, Section 19.2.7.4, "Design Features Credited for Conformance with 10 CFR 50.150," states that the location and design of the concrete sliding door in the RWPB at elevation zero feet described in FSAR Tier 2, Section1.2.3 and ANP-10317, Revision 1, protects portions of the Fuel Building. The staff notes that, contrary to the requirements of 10 CFR 50.150(b)(1), FSAR Tier 2, Revision 3, Section 19.2.7.4 does not contain a description of design features nor of functional capabilities relied on for the concrete sliding door to ensure that the assessment requirements in 10 CFR 50.150(a)(1) are met. Therefore, in RAI 565, Question 19-358, the staff requested that the applicant address the following four issues.

1. The normal position of this concrete sliding door during power operations and at shutdown conditions

2. Controls in place that allow the door to be open/closed

3. The time it would take to close this concrete door

4. Key design features that would potentially be affected or lost in the Fuel Building by a large commercial aircraft impact with the concrete door open, and the effects on the SFP, SFP cooling, or SFP liner

In an April 26, 2013, response to RAI 565, Question 19-358, the applicant stated the following:

> The criteria for the design feature located at the interface of the RWPB and NAB are shown in Figure 2-9 of AREVA TR ANP-10317. U.S. EPR FSAR, Tier 2, Section 19.2.7.4, Item 3, Bullet 5 will be revised as follows:
>
> The location and design of the (RWPB) is described in Section 1.2.3. The design features for the RWPB concrete sliding door located between the RWPB and NAB at Elevation 0 feet that are relied upon to meet the requirements of paragraph (a) (1) of 10 CFR 50.150 are described in Reference 24.
>
> The concrete sliding door is maintained closed during operations and shutdown conditions. The door is periodically opened to the size of a typical personnel door for personnel access. Per NEI 07-13, Revision 8, Section 3.2.2, Damage Rule Sets for Reinforced Concrete Buildings, "the assessment should extend the physical damage through any opening greater than the area of a typical single personnel access door." Doors not greater than a typical single personnel door, "is not considered to provide a substantial debris pathway and need not be considered in the assessment." Therefore, the combined license (COL) applicant may maintain the normal position of the concrete sliding door as partially open (not to exceed the size of a typical personnel door) without invalidating the assessment conducted in support of U.S. EPR FSAR Tier 2, Section 19.2.7.
>
> Further, since the concrete sliding door is only infrequently opened in excess of the size of a typical personnel door for equipment transit, this concrete sliding door requires no further analysis be performed. While the concrete sliding door

may be temporarily opened for the transit of equipment, the concrete sliding door may not be maintained open in excess of the size of a typical personnel door.

TR ANP-10317 (U.S. EPR FSAR Tier 2, Chapter 19, and Reference 24) will be revised to clarify that:

- The normal position of this concrete sliding door is closed during power operations.
- The normal position of this concrete sliding door is closed during shutdown conditions.
- Due to the weight of the concrete sliding door, electrical power, hydraulic controls, or other controls or devices are required to open and close the concrete sliding door located in the hallway between the RWPB and the NAB.

U.S. EPR FSAR, Tier 2, Section 1.2.3.1.2, will be revised to add the following sentence to the end of the RWPB section - The design of the concrete sliding door located in the hallway between the RWPB and the NAB is described in Section 19.2.7.4.3.

The staff reviewed the applicant's April 26, 2013, response to RAI 565, Question 19-358 and finds the response and the proposed FSAR changes acceptable. The staff notes that the concrete sliding door to the RWPB at the NAB protects portions of the Fuel Building. The door's normal position is closed. The staff also notes that the opening and closing of the RWPB-to-NAB concrete sliding door will be controlled by site administrative procedures, which are the responsibility of the COL applicant. The COL applicant may keep the normal position of the concrete sliding door as partially open (with the opening not to exceed the size of a typical personnel doorway) without invalidating the assessment conducted. The staff confirmed that FSAR Tier 2, Revision 5, dated July 19, 2013, was revised according to the commitment made in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 565, Question 19-358 resolved.

The staff reviewed the AIA application and determined it to be incomplete in regard to key design features for core cooling. The staff notes that FSAR Tier 2, Revision 3, Section 19.2.7 submittal should accurately reflect the results of the AIA performed by the applicant as required by 10 CFR 50.150. The staff also notes that the submittal should include all key design features and functional capabilities credited in the AIA with helping to meet the acceptance criteria.

FSAR Tier 2, Section 19.2.7.5.2, "RCS Heat Removal Capability," states that the analyses performed demonstrated the ability of the U.S. EPR design, after impact by a large commercial aircraft, to maintain functionality of one or more divisions of systems credited in FSAR Tier 2, Chapter 15 with providing reactor core cooling under accident conditions. The U.S. EPR design has features such as hardened and isolated shield structures, a strategic site arrangement and plant structural design, fire barriers, and physically separate and redundant trains. These features contribute to the success of one or more divisions of systems credited in FSAR Tier 2, Chapter 15 with continuing to function and provide reactor core cooling after the impact of a large commercial aircraft.

The staff notes that the applicant's submittal should include all key design features for RCS heat-removal capability and functional capabilities credited in the AIA with meeting the acceptance criteria, and not just cite SSCs credited in FSAR Tier 2, Chapter 15. Support systems such as the ultimate heat sink (UHS), component cooling water system, and essential service water systems are not described in FSAR Tier 2, Chapter 15.

As such, in RAI 565, Question 19-359, the staff requested that the applicant verify that the submittal fully identifies and describes all key design features and functional capabilities credited in the AIA for RCS heat-removal capability. The staff requested that the applicant revise the submittal if it is noted that key design features and functional capabilities credited in the AIA are not clearly identified or described in the FSAR Tier 2, Section 19.2.7.

In an April 26, 2013, response to RAI 565 Question 19-359, the applicant stated:

> The front-line systems, used in the AIA analysis for determining if adequate core cooling could be provided after an aircraft impact, are those systems credited in the U.S. EPR FSAR Tier 2, Chapter 15, accident analyses and also those systems credited in the PRA-based success sets. The AIA analysis also considered the impact on the front-line systems from damage to supporting systems and dependencies. The front-line systems, support systems, and dependencies are included in the list of protected systems listed in U.S. EPR FSAR Tier 2, Section 19.2.7.4.
>
> U.S. EPR FSAR Tier 2, Section 19.2.7.5, will be revised to indicate that supporting systems necessary for the front-line systems to be able perform their intended functions are protected from damage (e.g., UHS, CCWS, ESWS, HVAC).
>
> The following items will be added to the list of protected equipment in U.S. EPR FSAR Tier 2, Section 19.2.7.4:
>
> - CCWS Common Headers (Section 9.2.2)
> - SFP Makeup Capability (Section 9.1.3.2.4)
> - EPSS (Section 8.3.1 - Portions of trains 2 and 3 in Safeguard Buildings)
> - EPSS (Section 8.3.1 - Portions of trains 1 and 4 in Safeguard Buildings)
>
> The following clarification will be added to U.S. EPR FSAR Tier 2, Section 19.2.7.4, and sub part (1):
>
> > The use of hardened and isolated shield structures provides protection for the Containment, Fuel Building, and Safeguard Buildings 2 and 3 structures and the credited portions of following SSCs that are housed in these structures.
>
> The following clarification will be added to U.S. EPR FSAR Tier 2, Section 19.2.7.4, and sub part (1):

> The structural isolation of the shield structures provides protection against shock induced vibration from the impact of a large commercial aircraft so that the credited portions of the SSCs housed in these structures are not damaged.

The following clarification will be added to U.S. EPR FSAR Tier 2, Section 19.2.7.4, and sub part (2):

> The hardened building exterior provides protection for the credited portions of the following SSCs housed in Safeguard Buildings 1 and 4 from physical damage resulting from the impact of a large commercial aircraft.

The staff reviewed the applicant's April 26, 2013, response to RAI 565, Question 19-359 and finds the response and the proposed FSAR changes acceptable because the applicant provided clarification in the application that support systems such as UHS, CCWS, ESWS, SFP, EPSS and HVAC that are necessary for the front-line systems are on the list of protected equipment. In addition, the applicant clarified that structures protect the credited portions of the SSCs. The staff confirmed that FSAR Tier 2, Revision 5, dated July 19, 2013, was revised according to the commitment made in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 565, Question 19-359 resolved.

The staff reviewed the AIA application and determined it to be unclear with regard to key design features for core cooling. FSAR Tier 2, Revision 3, Section 19.2.7.4, "Design Features Credited for Conformance with 10 CFR 50.150," states that the use of hardened and isolated shield structures protects the Containment, Fuel Building, and Safeguard Buildings 2 and 3 structures and that the CCWS, trains 2 and 3 is one of the systems for which protection is provided.

FSAR Tier 2, Section 19.2.7.5, "Evaluation of U.S. EPR Performance," states that the physically separate and redundant train design of the U.S. EPR allows supporting functions such as emergency power and ultimate heat sink capability to survive.

FSAR Tier 2, Section 9.2.2, "Component Cooling Water System," states that the CCWS divisions are cross-connected between various headers for example, header 1A, 1B, 2A, and 2B. Cross-connected trains also exist for the safety chilled water system. The safety chilled water system is further discussed in FSAR Tier 2, Section 9.2.8.

In RAI 565, Question 19-361, the staff requested that the applicant describe in FSAR Tier 2, Section 19.2.7 the key design features that are credited with, and have cross-connections between division/trains for, surviving aircraft impact in accordance with 10 CFR 50.150(b)(1). Specifically, the staff requested that the applicant discuss in the FSAR that key design features that may physically be located in multiple structures, but are able to be cross-connected with motor-operated, automatic, hydraulic, or manual valves will be able to perform their intended function for core cooling or SFP cooling after the impact of a large commercial aircraft.

In an April 26, 2013, response to RAI 565, Question 19-361, the applicant stated:

> The AIA evaluated multi-divisional effects for normally cross-tied divisional systems (e.g., CCWS, SCWS). The AIA evaluated the system response of the cross-tied system to determine if damage in one division will affect the

functionality of the second division. A summary of the evaluation is included in AREVA TR ANP-10296.

The following sentence will be added to U.S. EPR FSAR Tier 2, Section 19.2.7.5.2:

> The assessment evaluated multi-divisional effects for normally cross-tied divisional systems (e.g., Component Cooling Water System and Safety Chilled Water System). The assessment evaluated the system response of the cross-tied system to determine if damage in one division will affect the functionality of the second division.

The staff reviewed the applicant's April 26, 2013, response to RAI 565, Question 19-361, and finds the response and the proposed FSAR changes acceptable because the applicant provided an FSAR discussion related to the two cross-tied systems, CCWS and SCW. The assessment evaluated the response of the cross-tied system to determine whether damage in one division will affect the functionality of the second division. The staff confirmed that the FSAR Tier 2, Revision 5, dated July 19, 2013, was revised according to the commitment made in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 565, Question 19-361 resolved.

The staff reviewed the AIA application and determined it to be unclear with respect to descriptions for support systems related to key design features. Detailed descriptions for support systems related to key design features appear to be missing from FSAR Tier 2, Section 19.2.7, and the AIA including the following items:

- the essential service water pump building ventilation system as described in FSAR Tier 2, Revision 4, Section 9.4.11
- the nuclear auxiliary building ventilation system as described in FSAR Tier 2, Revision 4, Section 9.4.3
- the safeguard building controlled-area ventilation system as described in FSAR Tier 2, Revision 4, Section 9.4.5
- the containment building ventilation system as described in FSAR Tier 2, Revision 4, Section 9.4.7
- the emergency power generating building ventilation system as described in FSAR Tier 2, Revision 4, Section 9.4.9
- the containment isolation system as described in FSAR Tier 2, Revision 4, Section 6.2.4
- the cask loading pit/transfer compartment as described in FSAR Tier 2, Revision 4, Section 9.1.3.2.4
- alternating current power as described in FSAR Tier 2, Revision 4, Section 8.3

The FSAR Tier 2, Revision 4, Section 19.2.7 applicant submittal reviewed by the staff should accurately reflect the results of the AIA performed by the applicant as required by

10 CFR 50.150. The submittal should include all key design features and functional capabilities credited in the AIA with helping to meet the acceptance criteria. Therefore, in RAI 565, Question 19-363, the staff requested that the applicant verify that the submittal fully identified and described all key design features and functional capabilities credited in the AIA.

In an April 26, 2013, response to RAI 565, Question 19-363, the applicant stated:

> The AIA analysis considered the impact on the front line systems from damage to supporting systems and dependencies. The front line systems, support systems, and dependencies were evaluated against the list of protected systems listed in U.S. EPR FSAR Tier 2, Section 19.2.7.4. As noted in the response to Question 19-359, U.S. EPR FSAR Tier 2, Section 19.2.7.5 will be revised to indicate that supporting systems necessary for the front line systems to be able perform their intended functions, are protected from damage. However, not all the systems included in Question 19-363 were identified in the AIA as having a direct support role for the emergency equipment including:
>
> - NAB Ventilation (U.S. EPR FSAR Tier 2, Section 9.4.3) – No dependencies on this system were identified.
> - Containment Building Ventilation System (U.S. EPR FSAR Tier 2, Section 9.4.7) – No dependencies on this system were identified.
> - Alternating Current Power (U.S. EPR FSAR Tier 2, Section 8.3) – (Analysis credits the EPSS instead).
> - Safeguard Building Controlled-Area Ventilation System (U.S. EPR FSAR Tier 2, Section 9.4.5) – (Analysis credits SBVSE instead).
>
> The following sentence will be added to U.S. EPR FSAR Tier 2, Sections 19.2.7.5.2 and 19.2.7.5.4:
>
> > Maintaining front-line system functionality includes availability of sufficient supporting systems (e.g.; cooling, makeup water supply, power, heat sink systems as identified in Section 19.2.7.4) to allow the front-line system to perform its intended function.
>
> The following items will be added to the list of protected equipment for U.S. EPR FSAR Tier 2, Section 19.2.7.4:
>
> - Containment Isolation System (Section 6.2.4)
> - Cask loading pit/transfer compartment (Section 9.1.3.2.4)
> - Essential Service Water Pump Building Ventilation (Section 9.4.11)
> - Emergency Power Generating Building Ventilation System (Section 9.4.9)

The staff reviewed the applicant's April 26, 2013, response to RAI 565, Question 19-363 and finds the response and the proposed FSAR changes acceptable because the front-line systems,

support systems, and dependencies were evaluated against the list of protected systems listed in FSAR Tier 2, Section 19.2.7.4. The protected equipment list was expanded to include the containment isolation system, cask loading pit/transfer compartment, ESW pump building ventilation and emergency power generating building ventilation. The staff confirmed that FSAR Tier 2, Revision 5, dated July 19, 2013, was revised according to the commitment made in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 565, Question 19-363 resolved.

The key design features listed in FSAR Tier 2, Revision 5, Section 19.2.7 that perform a function related to core cooling are all safety-related design features that have been designed specifically to perform the core cooling functions during normal power operation and following design-basis events initiated during power operation. The staff considered the descriptions and abilities of these features to perform their design-basis safety functions, in order to confirm that they are suitable for maintaining core cooling following the impact of a large commercial aircraft. During its review, the staff confirmed and finds that all of these design features can be initiated and operated from the control room and require little, if any, further operator intervention to maintain the core cooling function, which satisfies the requirements of 10 CFR 50.150(a)(1).

The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of the key design features for core cooling, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.3 Key Design Features that Protect Core Cooling Design Features

19.2.7.4.3.1 *Fire Protection*

The applicant stated that the heat-removal evaluation considered the physical, shock, and fire effects of a large commercial aircraft impact that can cause damage to systems needed to maintain cooling of fuel in the vessel and the SFP.

The fire protection key design features that protect core cooling and SFP cooling key design features include specific fire-rated barriers identified in FSAR Tier 2, Revision 5, Section 9.5.1, Appendix 9A, Figures 9A-1 through 9A-106 (fire zone layout figures). The applicant stated that selected fire barriers, fire dampers, fire doors, and penetration seals are 3-hour-rated to prevent fire damage in one division from spreading to an adjacent division. Selected structural elements and blast dampers are rated for 5 psid to prevent explosion effects from spreading to adjacent areas. The applicant also stated that the analysis indicates that perforation and entry of aircraft fuel are prevented or controlled, and areas within the protected perimeter are not susceptible to damage caused by accelerant-fed fires. The fire damage footprint includes effects from exterior fires that may damage areas within the air intake and exhaust ducts up to the first 3-hour fire-rated and 5-psid-rated barrier.

The staff noted during its initial review of the descriptions of key design features provided by the applicant that a clarification was required concerning locations of the credited fire-protection features. Therefore, in RAI 456, Question 19-346, the staff requested that the applicant identify and describe the specific fire barriers credited for the "one barrier" option as described in NEI 07-13. Fire barriers credited for the "one barrier" option should have both a 3-hour fire rating and be able to withstand 5-psid overpressure to prevent fire spread. In a July 6, 2011, response to RAI 456, Question 19-346, the applicant stated that FSAR Tier 2, Revision 3,

Section 19.2.7.5 will be modified to identify and describe the fire barriers credited for preventing fire damage caused by an impact of a large commercial aircraft from spreading in accordance with NEI 07-13. Additionally, figures in FSAR Tier 2, Appendix 9A will be revised to identify the fire barriers credited for the "one barrier" option. The staff finds this response acceptable because the fire-protection key design features needed to protect the credited core cooling and SFP cooling design features were adequately described. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011 was revised according to the commitment made in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 456, Question 19-346 resolved.

Based on the above, the staff finds the applicant's description of the fire protection key design features for maintaining core cooling and SFP cooling to be adequate. The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of the fire protection, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.3.2 *Hardened and Isolated Shield Structures Specific to the Containment, Fuel Building, and Safeguard Buildings 2 and 3*

In FSAR Tier 2, Revision 5, Section 19.2.7.4, the applicant stated that the use of individual hardened and isolated shield structures is a key design feature that physically protects the safety systems located inside the Containment, Fuel Building, and Safeguard Buildings 2 and 3. The staff reviewed FSAR Tier 2, Revision 5, including Sections 1.2.3.1.2 and 3.8.4, Appendix 3B, and Appendix 3E.1.7, and AREVA TR ANP-10317, Revision 1. Based on its review, the staff finds the applicant's description of the hardened and isolated shield structures (as a key design feature for protecting safety systems inside the Containment, Fuel Building, and Safeguard Buildings 2 and 3 in order to maintain core cooling) to be adequate.

The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of the hardened and isolated shield structures specific to the containment, fuel building, and safeguard buildings 2 and 3, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.3.3 *Hardened Building Exterior for Safeguard Buildings 1 and 4*

In FSAR Tier 2, Revision 5, Section 19.2.7.4, the applicant stated that the hardened building exterior for Safeguard Buildings 1 and 4 is a key design feature that protects the safety systems located inside Safeguard Buildings 1 and 4. The staff reviewed FSAR Tier 2, Revision 5, Sections 1.2.3.1.2 and 3.8.4, FSAR Tier 2, Appendix 3B, and AREVA TR ANP-10317 Revision 1. Based on its review, the staff finds the applicant's description of the hardened building exterior of Safeguard Buildings 1 and 4 (as a key design feature for protecting safety systems inside these buildings in order to maintain core cooling) to be adequate.

The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of the

hardened building exterior for safeguard buildings 1 and 4, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.3.4 *Site Arrangement and Plant Structure Design*

In FSAR Tier 2, Revision 5, Section 19.2.7.4, the applicant stated that the site arrangement and structural design of major structures are key design features credited for compliance with 10 CFR 50.150. The characteristics of the structures credited for compliance with 10 CFR 50.150 are described in AREVA TR ANP-10317 Revision 1; the descriptions are supplemented by information in the FSAR. The assessment credits the arrangement and design of the following building features with limiting the location and effects of potential aircraft strikes on the U.S. EPR structures:

- The location and design of concrete barriers at selected locations along the exterior of the U.S. EPR structures protects the interior of these structures
- The location and design of the Emergency Power Generating Building structures and layout protects portions of Safeguard Buildings 2 and 3 and Safeguard Building 4
- The location and design of the Essential Service Water Building structures and layout protects portions of Safeguard Building 1, Safeguard Buildings 2 and 3, and Safeguard Building 4
- The location and design of the NAB structure and layout protects portions of Safeguard Building 4 and the Fuel Building

The staff finds the applicant's description of the site arrangement and plant structural design to be adequate. The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of the site arrangement and plant structure design, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.3.5 *Physically Separate and Redundant trains*

In FSAR Tier 2, Revision 5, Section 19.2.7.4, the applicant stated that physically separate and redundant trains, as described in Section 1.2.3.1, are a key design feature credited for compliance with 10 CFR 50.150. The following U.S. EPR safety-related and support systems credited in Chapter 15 are physically separated and redundant:

- Safety Injection/RHRS as described in FSAR Tier 2, Revision 5, Section 6.3
- EFW System as described in FSAR Tier 2, Revision 5, Section 10.4.9
- CCWS as described in FSAR Tier 2, Revision 5, Section 9.2.2
- ESWS (exterior and buried portions) as described in FSAR Tier 2, Revision 5, Section 9.2.1
- Ultimate heat sink as described in FSAR Tier 2, Revision 5, Section 9.2.5

- Uninterruptible electrical power supply systems as described in FSAR Tier 2, Revision 5, Section 8.3.2

- EPSS and EDG as described in FSAR Tier 2, Revision 5, Section 8.3.1

The staff finds the applicant's description of the key design features for providing physical protection to the systems that maintain core cooling to be adequate. The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of the physically separate and redundant trains, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.3.6 *Vibration and Shock*

In FSAR Tier 2, Revision 3, Section 19.2.7.5, the applicant stated that an analysis was performed of the linear distance from the impact point to each elevation of each structure. This analysis resulted in specific zones at each elevation to account for the damage footprint for the most sensitive equipment. Analyses were performed based on shock-induced vibration from an exterior wall strike and a strike on the adjacent Containment Shield Structure.

The staff reviewed the AIA application and determined it to be incomplete regarding an AIA event during fuel-handling activities. FSAR Tier 2, Revision 3, Section 9.1.4, "Fuel Handling System," describes a spent fuel cask transfer system that is connected to the underside of the spent fuel loading pit. One of the structures of concern in NEI 07-13, is the fuel-handling building.

In RAI 565, Question 19-362, the staff requested that the applicant describe in FSAR Section 19.2.7 the key design features for an AIA postulating an impact of a large commercial aircraft during the offloading of spent fuel assemblies from the SFP into a spent fuel cask. The staff also requested that the applicant describe whether, as a result of an aircraft impact during the offloading of spent fuel assemblies from the SFP, there is a leakage path below the minimum water level due to related vibrations/shock damage.

In an April 26, 2013, response to RAI 565, Question 19-362, the applicant stated:

> No additional key design features beyond those already listed in U.S. EPR FSAR Tier 2, Section 19.2.7.4 are required for the protection of the cask loading system. The location of the connection between the cask and the cask loading pit/transfer compartment and the location of the transport vehicle supporting the cask were evaluated for vibration effects in the AIA. No damage resulting in a leakage path below the minimum water level due to related vibrations/shock damage was predicted.

The staff reviewed the applicant's April 26, 2013, response to RAI 565, Question 19-362, and finds the response acceptable because the applicant provided clarification that postulating an AIA event related to the cask loading system will not cause any damage to the cask connection to the cask loading pit that results in a leakage path below the minimum water level. Therefore, the staff considers RAI 565, Question 19-362 resolved.

The staff finds the applicant's description of vibration and shock to be adequately described. The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of vibration and shock, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.4 Keeping the Containment Structure Intact

The key design feature credited for keeping the containment intact is the provision of an exterior hardened and isolated reinforced concrete reactor (or containment) shield structure around the containment structure and a hardened isolated shield structure around the Fuel Building as described in FSAR Tier 2, Revision 5, Section 19.2.7.4 and AREVA TR ANP-10317. In FSAR Tier 2, Revision 5, Section 19.2.7.5, the applicant stated that its local and global aircraft impact assessment of the shield structure concluded that the Containment and Fuel Building shield structures would not be perforated, and that no significant structural damage would occur because of either local or global impacts. The portion of the Fuel Building shield structure across the equipment hatch protects the containment equipment hatch. The Containment structure inside the Containment Shield Structure would not be impacted by the aircraft or associated debris because of the provision of these intervening shield structures. Therefore, the containment performance, including the ultimate pressure capacity of the structure, is unaffected by the impact of a large commercial aircraft. The applicant concluded that under these conditions, no physical damage or fire damage inside containment caused by the impact of a large commercial aircraft needs to be considered.

The staff finds that the applicant has described design features in the form of protective hardened and isolated reinforced concrete containment shield structure and Fuel Building shield structure whose assessment indicated that it would not be perforated under both local and global impact. The applicant's descriptions of the design features indicate that the shield structures would protect and prevent the containment structure located inside the shield structures from being directly struck or perforated by the impact of a large commercial aircraft and also ensure that the ultimate pressure capacity of the containment structure remains unaffected. Therefore, the staff finds that the applicant's description of design features for keeping the containment structure intact to be adequate.

The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of keeping the containment structure intact, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.5 Maintaining the Integrity of the Spent Fuel Pool

The key design feature credited to maintain the integrity of the SFP is the provision of a protective hardened and isolated reinforced concrete external shield structure around the Fuel Building, which houses the SFP, as described in FSAR Tier 2, Revision 5, Sections 19.2.7.4 and 19.2.7.5.3, and in AREVA TR ANP-10317. Further, based on the description in FSAR Tier 2, Section 19.2.7.4 and AREVA TR ANP-10317, the location and design of concrete barriers at selected locations on the exterior of the U.S. EPR structures, including the Fuel Building and the location and design of the concrete sliding door in the RWPB at the interface

with the NAB, are credited with providing protection to portions of the Fuel Building. The applicant stated that its analyses demonstrate that no physical damage to the interior of the Fuel Building results from the impact of a large commercial aircraft and that the prevention of aircraft perforation of the hardened and isolated shield structure surrounding the Fuel Building ensures that the SFP is not perforated and that SFP integrity is maintained. Further, in its April 26, 2013, response to RAI 565, Question 19-358, the applicant clarified the normal position in which the concrete sliding door is kept during operating and shutdown conditions and documented the design requirements as well as the normal position in which the concrete sliding door is to be maintained in AREVA TR ANP-10317, Revision 1. The response to RAI 565, Question 19-358, is discussed and resolved in the staff evaluation in Section 19.2.7.4.2 of this report.

Further, in TR ANP-10317, Revision 3, the applicant included additional design criteria (in the form of shock spectra caused by aircraft impact as a design feature for cask loading operations) to be incorporated into the design of safety-related components of the spent fuel cask transfer facility (SFCTF). However, TR ANP-10317, Revision 3, was not incorporated by reference (IBR) in FSAR Tier 2, Revision 5, but will be IBR in Revision 6. Based on Revision 6 of the application, the staff has verified that the applicant has incorporated by reference TR ANP-10317, Revision 3 accordingly.

Based on the above, the staff finds that the applicant has described key design features and intervening structures that would provide enough protection to the Fuel Building housing the SFP that an aircraft impact does not result in leakage through the SFP liner below the required minimum water level. Therefore, the staff finds the description of the key design features for ensuring that SFP integrity is maintained to be adequate.

The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of maintaining the integrity of the spent fuel pool, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.6 Spent Fuel Pool Cooling

FSAR Tier 2, Section 19.2.7.5.4, "SFP Heat Removal Capability," states that with the SFP integrity maintained, SFP cooling is provided in a way that is consistent with the probabilistic risk assessment (PRA). The availability of the makeup systems is assured because of the integrity of the hardened and isolated shield structure surrounding the Fuel Building. The shield structure provides physical and fire-damage protection against the impact of a large commercial aircraft. The isolation of this structure allows SFP makeup to continue to function and protects against shock-induced vibrations. Maintaining front-line system functionality includes availability of sufficient supporting systems (e.g., cooling, makeup water supply, power, and heat sink systems as identified in FSAR Tier 2, Section 19.2.7.4 to allow the front-line system to perform its intended function. The fire protection system provides the capability to fill the SFP.

Based on the above, the staff finds that the applicant has described sufficient key design features that would provide SPF cooling. The SFP cooling system is protected by the shield structure. The support systems for SFP cooling (UHS, CCWS, Seismic Category I makeup water from the cask loading pit or the transfer compartment and electrical) are protected by the shield structure and/or are physically separate and have redundant trains. Additional SFP

makeup is available from the fire protection system. Therefore, the staff finds the description of the key design features for ensuring that SFP cooling is maintained to be adequate.

The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of spent fuel pool cooling, which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.4.7 Ability to Trip the Reactor (Reactor Scram)

The staff reviewed the AIA application and determined it to be unclear with respect to the ability to trip the reactor. FSAR Tier 2, Revision 3, Section 19.2.7.3, "Methodology," states that the methodology used to demonstrate compliance with 10 CFR 50.150 is NEI 07-13, Revision 7.

FSAR Tier 2, Section 19.2.7.4, "Design Features Credited for Conformance with 10 CFR 50.150," states that because the systems necessary to scram the reactor are housed in the hardened and isolated Shield Building structures, there is no potential for impact damage that would prevent a scram. Following shutdown, one or more trains of the safety-related and support systems in this section are available to maintain core cooling and SFP cooling.

NEI 07-13, Tables 3-4, "Approach to Key Issues in Scenario Development," and 3-5, "Key Assumptions to be Used in Damage Footprint Assessment," provide the guidance for treating reactor scram in the assessment. NEI 07-13, Table 3-4, Item 3, states, in part, "However, in reviewing damage footprints in areas with equipment essential to reactor scram an assessment will be made of the potential for damage to prevent a scram should it have not occurred."

In RAI 565, Question 19-360, the staff requested that the applicant describe those design features that assure that the reactor will be shut down following the impact of a large commercial aircraft, including any features that protect equipment in the reactor trip system (refer to FSAR Tier 2, Section 7.2, "Reactor Trip System"). The staff requested that the applicant include in its discussion the necessary key design features needed for any core boration (refer to FSAR Tier 2, Section 6.8, "Extra Borating System") to keep the core subcritical during cooldown of the reactor coolant in FSAR Tier 2, Section 19.2.7.5.2, "RCS Heat Removal Capability."

The staff requested that the applicant provide the staff with proposed changes to FSAR Tier 2, Section 19.2.7, which show the required descriptions and include the descriptions in the next revision of the FSAR. If detailed descriptions of the subject design features are described in sections of the FSAR other than FSAR Tier 2, Section 19.2.7, identify the features and the sections of the FSAR containing the descriptions in FSAR Tier 2, Section 19.2.7. Include descriptions of any success criteria in the U.S. EPR PRA that are associated with the key design features.

In an April 26, 2013, response to RAI 565, Question 19-360, the applicant stated:

> The assessment evaluated the location of equipment essential to reactor scram to determine if a potential exists for damage to prevent a scram should it have not occurred. The reactor trip components will be added to the list of protected equipment in U.S. EPR FSAR Tier 2, Section 19.2.7.4. The assessment

evaluated the location of equipment essential to core boration to determine if a potential exists for returning to criticality during cooldown after an impact by a commercial airliner. The Extra Borating System (U.S. EPR FSAR Tier 2, Section 6.8) is listed as protected equipment in U.S. EPR FSAR Tier 2, Section 19.2.7.4. U.S. EPR FSAR Tier 2, Section 19.2.7 and AREVA Technical Reports ANP-10295, ANP-10296, and ANP-10317 provide a description of the design features and success criteria credited in the assessment. The success sets are consistent with the PRA success criteria. FSAR Section 19.2.7.4 will be revised to reflect that supplemental details on credited features are found in AREVA Technical Reports ANP-10295, ANP-10296, and ANP-10317. U.S. EPR Tier 2, Section 19.2.8 and U.S. EPR FSAR Tier 2, Table 1.6-1 will be revised to reflect the addition (and revisions) of AREVA Technical Reports ANP-10295, ANP-10296, and ANP-10317.

Reactor Trip Breakers (Section 7.2.1.1) will be added to the list of protected equipment under U.S. EPR FSAR Tier 2, Section 19.2.7.4:

The staff reviewed the applicant's April 26, 2013, response to RAI 565, Question 19-360, and finds the response and the proposed FSAR changes acceptable because the applicant will add the reactor trip components to the list of protected equipment in FSAR Tier 2, Section 19.2.7.4. In addition, the assessment evaluated the location of equipment essential to core boration to determine whether a potential exists for returning to criticality during cooldown after an impact by a large commercial aircraft. The extra borating system is listed as protected equipment. The staff confirmed that the FSAR Tier 2, Revision 5, dated July 19, 2013, was revised according to the commitment in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 565, Question 19-360 resolved.

The staff finds that the applicant's description of the ability to trip the reactor is adequately described. The scope of the NRC finding is limited to the applicant's description of the key design features and functional capabilities. This description is sufficient since the applicant has cross referenced to specific FSAR subsection/s which provide additional details and description of the ability to trip the reactor (reactor scram) which supports the key design features to function in accordance with 10 CFR 50.150 and guidance found in NEI 07-13.

19.2.7.5 Combined License Information Item

There is no combined license information item for this section.

19.2.7.6 Conclusions

The staff finds that the applicant has performed an AIA that is reasonably formulated to identify design features and functional capabilities that show, with reduced use of operator action, that the acceptance criteria in 10 CFR 52.47(a)(28) and 10 CFR 50.150(a)(1) are met. The staff finds that the applicant adequately described the key design features credited to meet 10 CFR 50.150, including descriptions of how the key design features show that the acceptance criteria in 10 CFR 50.150(a)(1) are met. Therefore, the staff finds that the applicant meets the applicable requirements of 10 CFR 50.150(b).