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19 SEVERE ACCIDENTS

Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," constitutes the standard design certification (DC) for the U.S. Advanced Boiling Water Reactor (ABWR) design. To document the U.S. Nuclear Regulatory Commission (NRC) staff's review supporting initial certification of the ABWR, the staff issued a final safety evaluation report (FSER) in NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," in July 1994 and NUREG-1503, Supplement 1, in May 1997.

The staff is documenting its review of the GE-Hitachi Nuclear Energy (GEH or the applicant) application for renewal of the ABWR DC in Supplement 2 to NUREG-1503. Chapter 1 of this supplemental FSER describes the staff's review process for the ABWR DC renewal. This supplemental FSER section documents the NRC staff's review specifically related to Chapter 19, "Severe Accidents," Section 19.5, "Aircraft Impact Assessment," of the GEH Design Control Document (DCD), Revision 7. Except as modified by this supplement to the FSER, the findings made in NUREG-1503 and its Supplement 1 remain in full effect.

19.5 19.5(A) Aircraft Impact Assessment

10 CFR 52.59(a), "Criteria for renewal," states, in part, that the first time the Commission issues a rule granting the renewal for a standard DC in effect on July 13, 2009, the Commission shall find that the renewed design complies with the applicable requirements of 10 CFR 50.150, "Aircraft Impact Assessment," the aircraft impact assessment (AIA) rule. The ABWR DC for which GEH is requesting renewal was in effect prior to July 13, 2009. Therefore, the applicant's design changes to address these requirements are reflected in the ABWR DCD, Revision 7.

The impact of a large, commercial aircraft is a beyond-design-basis event (BDBE). Under 10 CFR 50.150 DC renewal applicants for new nuclear power reactors are required to perform a design specific assessment of the effects on the facility of the impact of a large, commercial aircraft. Applicants are required by 10 CFR 50.150(b) to submit a description of the design features and functional capabilities identified as a result of the assessment in its DCD, along with a description of how the identified design features and functional capabilities show that they meet the acceptance criteria in 10 CFR 50.150(a)(1).

The Statement of Considerations for the AIA rule regarding new nuclear power reactors states that: "The NRC's decision on an application subject to 10 CFR 50.150 will be separate from any NRC determination that may be made with respect to the adequacy of the impact assessment which the rule does not require be submitted to the NRC." Since the AIA is not submitted to the NRC for its review, the staff conducts its DC review to determine whether or not descriptions of the design features and functional capabilities are complete enough such that, assuming the design features and functional capabilities perform their intended functions, there is reasonable assurance that the acceptance criteria in 10 CFR 50.150(a)(1) can be met.

This ABWR DC renewal supplemental FSER section describes the staff's evaluation of the applicant's DCD Tier 2, Section 19G, "Aircraft Impact Assessment," and changes to the ABWR DCD, Revision 7.

19.5.1 19.5(B) *Regulatory Criteria*

As described in Section 19.5(A) of this supplemental FSEER Section, 10 CFR 52.59(a) and 10 CFR 50.150 require renewal applicants to perform a design-specific assessment of the effects on the facility resulting from the impact of a large, commercial aircraft for new nuclear power reactors. The applicant has made changes in ABWR DCD, Revision 7, with a description of the design features and functional capabilities identified as a result of the assessment in its ABWR DCD, along with a description of how the identified design features and functional capabilities show that the acceptance criteria in 10 CFR 50.150(a)(1) are met. Therefore, in accordance with 10 CFR 52.59(a), this design change is required by the Commission as discussed in Chapter 1 of this supplemental FSEER and will correspondingly be evaluated using the regulations in effect at renewal.

19.5(B).1 *Applicable Regulations*

The staff used the following relevant regulations and guidance to perform this review:

- 10 CFR 50.150(a)(1), requires that applicants 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 (SFP) integrity is maintained.
- 10 CFR 50.150(a)(3)(iii)(B), states that the requirements of 10 CFR 50.150(a)(1) and (a)(2) shall apply to applicants for renewal of standard DCs in effect on July 13, 2009, that have not been amended to comply with the requirements of 10 CFR 50.150 by the time of application for renewal.
- 10 CFR 50.150(b), requires that the final safety analysis report describe (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).

19.5(B).2 *Review Guidance*

- NRC Regulatory Guide (RG) 1.217, "Guidance for the Assessment of Beyond-Design-Basis Aircraft Impacts," Revision 0, issued August 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML092900004), provides guidance for applicants to demonstrate compliance with NRC regulations with regard to AIA. In particular, this RG endorses the methodologies described in the industry guidance document, Nuclear Energy Institute (NEI) 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," Revision 8, issued April 2011 (ADAMS Accession No. ML111440006).
- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (SRP) Section 19.5, "Adequacy of Design Features and Functional Capabilities Identified and Described for Withstanding Aircraft Impacts,"

Revision 0, issued April 2013, provides guidance for meeting the requirements in 10 CFR 50.150(a).

19.5.2 19.5(C) *Summary of Technical Information*

In DCD Tier 2, Section 19G, the applicant stated that an AIA was performed in accordance with the requirements in 10 CFR 50.150(a)(1) using the methodology described in NEI 07-13, Revision 8, as endorsed by RG 1.217, Revision 0, and SRP Section 19.5, Revision 0. Based on the results of its assessment and staff feedback concerning AIA security-related and proprietary information during a non-public teleconference held on January 19, 2017 (ADAMS Accession No. ML17013A018), the applicant identified a set of key design features to show that the acceptance criteria in 10 CFR 50.150(a)(1) are satisfied. The applicant submitted these key design features in ABWR DCD, Revision 6, and in ABWR DCD, Revision 6, markups, based on information submitted in the applicant's letter dated February 28, 2017 (ADAMS Accession No. ML17059C517). The applicant's letter contains Technical Report (TR) NEDE-33875, Revision 3, issued February 2017 (ADAMS Accession Nos. ML17059C523 (public version) and ML17059C525 (non-public proprietary version)), which is incorporated by reference into the DC renewal application and will be part of the renewed ABWR DC. In addition, the technical report references other sections of the ABWR DCD that provide additional details in support of the ABWR AIA. DCD Tier 2, Section 19G, also describes how the key design features show that the acceptance criteria in 10 CFR 50.150(a)(1) are met.

19.5(C).1 *Description of Key Design Features*

DCD Tier 2, Section 19G, describes the credited design features, functions, and references to sections containing the detailed descriptions as summarized below:

- DCD Tier 2, Section 19G.4.1, "Primary Containment"
 - (1) The reinforced concrete containment vessel (RCCV) as described in DCD Tier 2, Sections 3.8, "Seismic Category I Structures," and Section 3H.1, "Reactor Building," protects the safety systems located inside primary containment from the impact of a large, commercial aircraft.
- DCD Tier 2, Section 19G.4.2, "Site Arrangement and Plant Structural Design"
 - (1) The location and design of the control building (C/B) structure as described in DCD Tier 2, Section 3.8.4, "Other Seismic Category I Structures," and DCD Tier 2, Section 3H.2 "Control Building," protect portions of the reactor building (R/B) from the impact of a large, commercial aircraft. The C/B location, fixed with respect to other major structures, is defined in GEH TR NEDE-33875P, Revision 3, to ensure that credit of the C/B as an intervening structure is maintained.
 - (2) The location and design of the turbine building (T/B) structure and layout as described in DCD Tier 1, Section 2.15.11, "Turbine Building," and DCD Tier 2, Figures 1.2-24 through 1.2-31, protect the entire north wall of the C/B and portions of the north wall of the R/B from the impact of a large, commercial aircraft. The T/B location, fixed with respect to other major structures, is defined in GEH TR NEDE-33875P, Revision 3 to ensure that credit of the T/B as an intervening structure is maintained.

- (3) The location and design of the R/B structure as described in DCD Tier 2, Sections 3.8.4 and DCD Tier 2, Section 3H.1, "Reactor Building," protect portions of the primary containment and the entire south wall of the C/B from the impact of a large, commercial aircraft. This includes the protection provided by exterior walls, interior walls, intervening structures and barriers on the large openings in the reactor building exterior walls. The reactor well shield plugs protect the drywell head from secondary impacts as identified in DCD Tier 2, Section 3H.1.3, "Structural Description." The R/B location, fixed with respect to other major structures, is defined in GEH TR NEDE-33875P, Revision 3 to ensure that credit of the R/B as an intervening structure is maintained.
- (4) The location and design of the SFP and its supporting structure as described in DCD Tier 2, Section 9.1, "Fuel Storage and Handling," and DCD Tier 2, Figure 1.2-12, "Reactor Building, Arrangement Plan at Elevation 31700/38200 mm," protect the SFP from the impact of a large, commercial aircraft.
- (5) The physical separation of the Class 1E emergency diesel generators prevent the loss of all electrical power to core cooling systems by protecting them from physical damage, fire damage and smoke effects.
- (6) The location and design of the service building (S/B) structure as described in DCD Tier 2, Section 3H.6, "Summary of Key Structural Design Features," and Figures 1.2-20 through 1.2-22 protect the east wall of the C/B from the impact of a large, commercial aircraft. The S/B location, fixed with respect to other major structures, is defined in GEH TR NEDE-33875P, Revision 3 to ensure that credit of the S/B as an intervening structure is maintained.
- (7) The location and design of the C/B annex structure as described in DCD Tier 2, Section 3H.6 and DCD Tier 2, Figures 1.2-20 through 1.2-22, protect the west wall of the C/B from the impact of a large, commercial aircraft. The C/B annex location, fixed with respect to other major structures, is defined in GEH TR NEDE-33875P, Revision 3, to ensure that credit of the C/B annex as an intervening structure is maintained.
- (8) The seismic gap between the R/B and C/B described in DCD Tier 2, Section 3.8.5.1, "Description of the Foundations," protects the C/B from shock effects from strikes on the R/B.
- (9) The R/B heating ventilation and cooling system (HVAC) ducting locations ensure routing maintains separation divisionally through protection or physical separation so that the impact of a large, commercial aircraft strikes do not result in a loss of all divisions of core cooling.
- (10) During normal operating conditions, the R/B crane will be parked at the R/B north wall when not in use.
- (11) Any permanent structure that penetrates the C/B roof is sized to preclude a strike from the east and west directions.

- DCD Tier 2, Section 3H.6, “Summary of Key Design Features”
 - (1) Structural configuration of the SFP within the R/B precludes a direct strike on the SFP. The SFP is a reinforced concrete structure with an American Society for Testing and Materials (ASTM) A-240 Type 304L stainless steel liner. The SFP walls are strengthened as described in TR NEDE-33875P, Revision 3 to ensure that the structural integrity of the SFP is maintained.
 - (2) Structural configuration of the RCCV within the R/B precludes a direct strike on containment, and the structural design of the RCCV ensures that the RCCV is not perforated.
 - (3) Shield blocks over the drywell head are to be configured to fully resist secondary impact from concrete debris, aircraft wreckage, and falling crane components to protect the integrity of drywell head. The reactor cavity shield blocks are shown in DCD Figure 3H.1-23, “Reactor Building Reactor Cavity Shield Blocks.”
 - (4) Interior partition walls are to be thickened and strengthened as shown in TR NEDE-33875P, Revision 3, to limit physical damage to interior partition walls.
 - (5) Reinforced concrete sliding barriers with structural capacity equivalent to the surrounding wall are to be provided for the 6 large openings on 1F (DCD Tier 2, Figure 1.2-8, “Reactor Building, Arrangement Plan”).
 - (6) Protective awnings for the HVAC exhaust openings on 2F (DCD Tier 2, Figure 1.2-9, “Reactor Building, Arrangement Plan,”) are sized to provide structural capacity equivalent to the corresponding exterior wall to prevent unabated wreckage through these openings.
 - (7) Protective awnings for the HVAC intake openings on 3F (DCD Tier 2, Figure 1.2-10, “Reactor Building, Arrangement Plan”) are sized to provide structural capacity equivalent to that provided in Table 3-2 of NEI 07-13, Revision 8 for exterior walls.
 - (8) Deleted.
 - (9) The exterior walls of the C/B annex are to be reinforced concrete.
 - (10) The exterior wall of the S/B is to be reinforced concrete.
 - (11) The exterior wall of the T/B is to be reinforced concrete.
 - (12) The exterior walls of the R/B on the east, west, and south sides are to be strengthened with enhanced reinforcement as described in TR NEDE-33875P, Revision 3.

19.5(C).2 Description of How Regulatory Acceptance Criteria are Met

The acceptance criteria in 10 CFR 50.150(a)(1) require the applicant to perform a design-specific assessment of the impact of a large, commercial aircraft on the facility. 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 SFP integrity is maintained.

In the ABWR DCD, Revision 6, the applicant in DCD Tier 2, Section 19G, and in ABWR DCD, Revision 6, markups as submitted by letter dated September 2, 2016 and November 23, 2016, GEH indicates that it meets the 10 CFR 50.150(a)(1) acceptance criteria by including features in the ABWR design that, following the impact of a large, commercial aircraft, show that the design can:

- Maintain core cooling, and
- Maintain SFP integrity.

The applicant's ABWR AIA, to maintain core cooling and SFP integrity, credits the safety-related systems as described in DCD Tier 2, Section 19G of the ABWR DCD, Revision 7. The ABWR DC renewal AIA design changes ensure that the reactor can be shut down and decay heat can be adequately removed from the reactor core following the impact of a large, commercial aircraft. The key design features and physical separation for assuring core cooling are described in DCD Tier 2, Section 6.3, "Emergency Core Cooling." Some of this equipment is located inside the RCCV and some is located inside the R/B. Locations inside the RCCV are protected from structural, shock, and fire damage by the design of the RCCV structure as well as the R/B structure, which limits the penetration of a large, commercial aircraft such that the RCCV is not perforated. Equipment inside the R/B is protected by structural design features of the R/B itself and by structures adjacent to the R/B, including the T/B, the C/B annex, and the S/B. In addition, fire barriers have been designed and located in the R/B to contain the spread of fire inside the building such that at least one train of safety-related equipment for core cooling is protected for each R/B impact scenario.

As for maintaining spent fuel integrity, GEH provided design changes in DCD Tier 2, Section 19G.5, which determined that impact from a large, commercial aircraft would not result in perforation of the SFP liner, and no SFP liner leakage, or SFP drain down conditions would occur from piping attachments that would result in leakage below the required minimum SFP water level.

19.5.3 19.5(D) Technical Evaluation

The staff reviewed the AIA information in DCD Tier 2, Section 19G, and the referenced DCD sections and evaluated the following:

19.5 (D).1 Reasonably Formulated Assessment

In DCD Tier 2, Section 19G, the applicant stated, that its AIA is based on the guidance provided by RG 1.217, Revision 0, and NRC endorsed NEI 07-13, Revision 8, with no exceptions. The staff also finds that the applicant's hired contractors used to perform the AIA were well-experienced and have performed the AIA previously for other design centers.

The staff finds that the applicant adequately meets the guidance in SRP Section 19.5, Items III.1 and 2, because the applicant used an assessment methodology that conforms to the guidance

in NEI 07-13, Revision 8, as endorsed by RG 1.217, Revision 0, and the assessment was performed by qualified personnel consistent with the guidance in SRP Section 19.5, Item III.2.

19.5(D).2 Key Design Features for Core Cooling

In DCD Tier 2, Section 19G.4.4, "Core Cooling Features," the applicant described the key design features for assuring core cooling. The staff's evaluation of these key design features is documented in other sections of NUREG-1503 the FSER for the original ABWR DC. For example, FSER Section 9.2.1.5 evaluates the reactor service water system and FSER Section 9.2.11 describes the reactor building cooling water system. These systems are key design features for providing the necessary cooling water for ABWR emergency core cooling system (ECCS) operation. The staff used the information provided by the applicant to confirm that these features are also suitable for maintaining core cooling following the impact of a large, commercial aircraft. During the review, the staff also confirmed that all these design features can be initiated and operated from the control room or an alternate location, and require little, if any, further operator intervention to maintain the core cooling function.

The applicant stated that, following normal power operation, an undamaged ECCS has the capability of maintaining core cooling. In addition to the ECCS, the applicant identified support systems necessary to maintain core cooling. Table 19.5 of this FSER Supplement shows the staff's compiled list of the credited key design features identified in ABWR DCD Tier 2, Section 19G.

The applicant's assessment determined that at least one division of ECCS would be available following the impact of a large, commercial aircraft on the R/B. The applicant credited advance warning, consistent with NEI 07-13, Revision 8, for the operators to take manual action to shutdown the reactor prior to impact. The applicant further described that the hydraulic control units are located below grade, outside of the assessed AIA damage footprint of the ABWR design. The applicant further described that during shutdown conditions (reactor shutdown with the reactor head removed and reactor water level at the level of the vessel flange or higher) administrative controls will be established by the combined license applicant to ensure residual heat removal (RHR) train A and either RHR or high pressure core flooders for train B and C are not out of service for maintenance until the cavity is flooded. This will ensure an adequate water reservoir to provide cooling of the fuel in the vessel for at least 24 hours.

The staff reviewed changes to the ABWR DCD as proposed in a GEH Letter dated September 2, 2016 (ADAMS Accession Nos. ML16258A347), and its supplement dated November 23, 2016 (ADAMS Accession No. ML16334A291). The applicant provided ABWR DCD, Revision 6, markups, drawings, and a TR NEDE- 33875P, Revision 3, necessary to update the ABWR design to the latest AIA. These letters identify additional key design support features for core cooling. For example, the letters state that cabling and ventilation is routed divisionally, and the main control room HVAC mechanical and electrical cross connects are identified as key design features for core cooling. The staff finds the applicant's addition of key design features acceptable because it modifies the ABWR DCD to contain a description of the design features and functional capabilities as required by 10 CFR 50.150(b).

The applicant provided the necessary information from its letters dated September 2, 2016, and November 23, 2016, in the ABWR DCD, Revision 7, which incorporated the changes from the ABWR DCD, Revision 6 markups. Therefore, Confirmatory Item 19.5-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

Based on the staff's review of DCD Tier 2, Section 19G, and the applicant's use of the NRC endorsed guidance document NEI 07-13, Revision 8, the staff finds that the applicant performed a reasonably formulated AIA analysis that identifies key design features necessary for core cooling. Also, based on the above, the staff finds the applicant's description of the key design features for maintaining core cooling to be adequate and acceptable, and therefore meets the requirements of 10 CFR 50.150(b).

Table 19.5 provides a complete list of the ABWR key design features as shown below.

SER Table 19.5 - Key Design Features

Design Feature	DCD Reference Sections	Function
Fire Barriers: 3-hour fire-rated	9.5.1 9A	Protect core cooling equipment from fire damage
Fire Barriers: 3-hour fire-rated, 5-psid rated	9.5.1 9A	Protect core cooling equipment from fire damage
Emergency Core Cooling Systems	6.3	Core cooling
Reactor Service Water System	9.2.15	Core cooling
Reactor Building Cooling Water System	9.2.11	Core cooling
Class 1E ac and dc Power Systems	8.3.1; 8.3.2	Core cooling
Instrumentation System	7.2; 7.3.2.1; 7.3.2.4; 7.3.2.6; 7.3.2.7; 7.3.2.8	Core cooling
AC Independent Water Addition System	5.4.7	Core cooling
Control Rod Drive Hydraulic Control Units	4.6.1	Core cooling
Ultimate Heat Sink	9.2.5	Core cooling
Containment Overpressure Protection System	6.2.5	Core cooling
Reactor Safety Relief Valves	6.2	Core cooling
Main Control Room HVAC	9.4.1.1.4	Core cooling
Reactor Building HVAC	9.4; Appendix 9A	Core cooling
Makeup Water Condensate System	9.2.9	Core cooling
Fire Water Storage System	9.5.1	Core cooling
Suppression Pool	6.2.1	Core cooling
SFP and Support Structures	9.1 and Figure 1.2-12	SFP Integrity
Primary Containment	3.8; 3H.1	Protect core cooling equipment
Control Building	3.8.4; 3H.2	Protect core cooling equipment and provide screening for reactor building

Design Feature	DCD Reference Sections	Function
Turbine Building	Tier 1 2.15.11; Figure 1.2-24 through 1.2-31	Provide screening for control building and reactor building
Control Building Annex	3H.6; Figures 1.2-20 through 1.2-22	Provide screening for control building
Service Building	3H.6; Figures 1.2-20 through 1.2-22	Provide screening for control building
Reactor Building	3.8.4; 3H.1	Protect core cooling equipment and SFP integrity, and provide screening for the control building

19.5(D).3 Key Design Features that Protect Core Cooling Design Features

The key ABWR design features and functional capabilities that protect the core cooling design features are described below. These include: fire barriers and fire protection features, plant arrangement and plant structural design features, ability to survive shock-induced vibrations, and ability to trip the reactor.

19.5(D).3.1 *Fire Barriers and Fire Protection Features*

In DCD Tier 2, Section 19G.4.3, “Fire Barrier and Fire Protection Features,” the applicant identified and described the fire protection key design features that protect core cooling equipment. These include the design and location of the 3-hour fire rated fire barriers and the 5 pounds-per-square-inch-differential (psid) (34.5 kilopascal (kPa)), 3-hour fire rated barriers within the R/B. The applicant indicated that the assessment credited the design and location of the R/B fire barriers (including floor assemblies, doors, penetration seals, and dampers) as described in DCD Tier 2, Sections 9.5.1 and 9A.4 (which includes Figures 9A.4-1 through 9A.4-10). These fire barriers limit the effects of internal fires created by the impact of a large commercial aircraft. The applicant clarified that all credited water-tight doors will have a 5 psid (34.5 kPa), 3-hour fire rating. Additionally, all credited penetration seals in 3-hour fire barriers will also be rated for 3-hour, 5-psid. Fire dampers with a 3-hour 5-psid rating will be quick actuating (blast) type.

In addition, the staff reviewed the fire protection related changes to the ABWR DCD, Revision 6. As a result of preparing for the AIA Inspection, GEH determined that the ABWR DCD required additional updating to be consistent with its latest ABWR AIA. Therefore, in the applicant’s letters dated September 2, 2016, and its supplement dated November 23, 2016, GEH provided DCD Revision 6 markups based on information from TR NEDE-33875P, Revision 2 (ADAMS Accession No. ML16334A295) that were necessary to update the ABWR DCD with information included in the latest ABWR AIA. The ABWR DCD, Revision 6 markups based on the update to TR NEDE-33875P, Revision 3, also identified additional editorial changes and additional fire protection key design features that protect the core cooling features. For example, the fire protection related changes include:

- Corrections to room and fire area numbers as well as adjusting rating locations of floor assemblies within DCD Tier 2, Figures 9A.4-3 through 9A.4-8;
- Addition of a new Inspections, tests, analyses, and acceptance criteria in DCD Tier 1, Table 2.15.10, to ensure the R/B steel trusses supporting the roof are encased with 5 psid (34.5 kPa), 3-hour fire rated material;
- Addition of new language under DCD Tier 2, Section 9A.2, to ensure the R/B steel trusses supporting the roof are encased with 5 psid (34.5 kPa), 3-hour fire rated material;
- Addition of a new key design feature stating cabling and ventilation routing is designed divisionally; and
- Addition of new constraint under DCD Tier 2, Section 19G.4.3-1, stating divisional power, instrumentation or control cabling routed through another space must be assessed under 10 CFR 50.150.

These key design features, as described by GEH, ensure at least one complete train of heat removal equipment and necessary support systems (including cooling water, electrical power supply and distribution, and instrument and control) within the R/B are available to provide core cooling following the impact of a large commercial aircraft.

Based on the addition of the fire protection key design features listed above and the staff review of those additional design features, including those identified in the DCD Revision 6 markups, the staff finds the applicant's description of the fire protection key design features for protecting core cooling equipment to be adequate and acceptable in accordance with 10 CFR 50.150(b).

The applicant provided the necessary information from its letters dated September 2, 2016, and November 23, 2016, in the ABWR DCD, Revision 7, which incorporated the changes from the ABWR DCD, Revision 6 markups. Therefore, Confirmatory Item 19.5-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

19.5(D).3.2 Plant Arrangement and Plant Structural Design Features

In the DCD Tier 2, Section 19G.4.2, "Site Arrangement and Plant Structural Design," of the revised ABWR DCD, Revision 6, markups, the applicant stated that the ABWR plant design and arrangement of major structures as described in DCD Tier 2, Section 1.2, "General Plant Description," and Figure 1.2-1, "Site Plan," are key design features. The applicant also described key structural design features for aircraft impact in DCD Tier 2, Section 3H.6, "Summary of Key Structural Design Features," of the revised ABWR DCD, Revision 6, markups.

Specifically, the applicant stated that the AIA credited the arrangement and design of the building features to limit the location and effects of potential aircraft strikes on the R/B, RCCV and C/B. Sections 19.5(D).3.2.1–19.5(D).3.2.7 (below) of this supplemental FSER detail the staff's review of the design features and functional capabilities of those individual buildings to demonstrate that the acceptance criteria of 10 CFR 50.150(a)(1) can be met.

19.5(D).3.2.1 Location and Design of the Control Building

The staff reviewed the ABWR DCD to ensure that the applicant performed a reasonably formulated assessment of the capability of the C/B to protect portions of the north wall of the R/B, and core cooling equipment.

In Item (1) of DCD Tier 2, Section 19G.4.2, of the ABWR DCD, Revision 6, markups, the applicant stated that the location and design of the C/B structure as described in DCD Tier 2, Section 3.8.4 and DCD Tier 2, Section 3H.2 are design features that protect portions of the R/B from the impact of a large commercial aircraft. The staff reviewed general arrangement drawings in DCD Tier 2, Figure 1.2-1, "Site Plan;" Figure 1.2-14 "Control and Service Building, Arrangement;" Figure 1.2-15 "Control and Service Building, Arrangement;" and Figure 1.2-22 "Control and Service Building, Arrangement Plan." The staff also reviewed DCD Tier 2, Section 3.8.4.1.2, "Control Building," and DCD Tier 2, Section 3H.2 "Control Building," and confirmed that the north wall of the R/B is protected by the shear walls of the C/B.

The applicant made additional changes in Item (1) of DCD Tier 2, Section 19G.4.2 to clarify that the C/B location, fixed with respect to other major structures, is defined in the TR NEDE-33875P, Revision 3, to ensure that credit of the C/B as an intervening structure is maintained. The staff reviewed the relevant drawings (DCD Tier 2, Figure 1.2-1; Figure 1.2-20, "Control and Service Building, Arrangement Plan;" Figure 1.2-21 "Control and Service Building, Arrangement Plan;" and Figure 1.2-22 "Control and Service Building, Arrangement Plan"), which show the relative relationship of the building locations among the C/B annex, C/B, and R/B structures. The staff further reviewed DCD Tier 2, Table 3-2, "Intervening Structures Credited in ABWR Aircraft Impact Assessment," and TR NEDE-33875P, Revision 3, Figure 3-1, "ABWR Site Plan - Location of Structures," which show the distance from the intervening structures to the shielded structure. The applicant screened the C/B as an intervening structure based on the criteria set in NEI 07-13, Revision 8 Section 3.2.2, "Screening Based on Intervening Structures." The staff confirmed that the location of the relevant structures is fixed at the original DC stage. On this basis, the staff finds credit of the C/B as an intervening structure acceptable.

The applicant further added new Item (11) to the DCD Tier 2, Section 19G.4.2 clarifying that any permanent structure that penetrates the C/B roof will be sized to preclude a strike from the east and west direction. The applicant described in TR NEDE-33875P, Revision 3, that penetrations are not installed on the C/B roof without an AIA cognizant engineer review. The staff reviewed the DCD Tier 2, Figure 1.2-22, "Control and Service Building, Arrangement Plan," and TR NEDE-33875P, Revision 3, Section 3.5, "Functional Success Criteria," and found that permanent structure penetrations on the C/B roof in certain areas depend on AIA strike angles and roof penetration sizes. Therefore, the staff finds the design features and the controls established regarding permanent structure penetrations on the C/B roof acceptable.

Based on the above review, the staff finds that the applicant's description of the C/B location, design, and its AIA analysis, as described in NEDE- 33875P, Revision 3, protects portions of the R/B from the impact of a large, commercial aircraft in accordance with the requirements of 10 CFR 50.150(b). The staff also finds the applicant's description of the design features and controls for permanent structure penetrations of the C/B roof to be acceptable and in accordance with the requirements of 10 CFR 50.150(b).

The applicant provided the necessary information from its letters dated September 2, 2016, and November 23, 2016, in the ABWR DCD, Revision 7, which incorporated the changes from the

ABWR DCD, Revision 6 markups. Therefore, Confirmatory Item 19.5-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

19.5(D).3.2.2 Location and Design of the Turbine Building

The staff reviewed the ABWR DCD to ensure that the applicant performed a reasonably formulated assessment of the capability of the T/B to protect the entire north wall of the C/B, portions of the north wall of the R/B, and core cooling equipment from the impact of a large, commercial aircraft.

In Item (2) of DCD Tier 2, Section 19G.4.2, of the revised ABWR DCD, Revision 6 markups, the applicant stated that the location and design of the T/B structure and layout as described in DCD Tier 1, Section 2.15.11 and Tier 2, Figures 1.2-24 through 1.2-31 are key design features that protect the entire north wall of the C/B and portions of the north wall of the R/B from the impact of a large, commercial aircraft. The staff reviewed general arrangement drawings in DCD Tier 2, Figures 1.2-1, and 1.2-24 through 1.2-31. The staff also reviewed DCD Tier 1, Section 2.15.11, "Turbine Building," and finds that the T/B is designed such that damage to safety-related functions does not occur under seismic loads corresponding to the safe-shutdown ground acceleration. Review of these general arrangement drawings shows that entire north wall of the C/B and portions of the north wall of the R/B are protected by the T/B structure.

The applicant made additional changes in Item (2) to the DCD Tier 2, Section 19G.4.2, to clarify that the T/B location, fixed with respect to other major structures, is defined in TR NEDE-33875P, Revision 3, to ensure that credit of the T/B as an intervening structure is maintained. The staff reviewed the relevant drawings (DCD Tier 2, Figures 1.2-1, and 1.2-24 through 1.2-31), which show the relative relationship of the building locations among the T/B, C/B, and R/B structures. The staff further reviewed TR NEDE-33875P, Revision 3, Table 3-2, "Intervening Structures Credited in ABWR Aircraft Impact Assessment," and Figure 3-1, "ABWR Site Plan-Location of Structures," which show the distance from the intervening structures to shielded structure. The applicant screened the T/B as an intervening structure based on the criteria set in NEI 07-13, Revision 8, Section 3.2.2 as endorsed by RG 1.217, Revision 0. The staff confirmed that the location of the relevant structures is fixed at the original DC stage. On this basis, the staff finds the credit of the T/B as an intervening structure acceptable.

The applicant further added new Item (11) to DCD Tier 2, Section 3H.6 that included details of the T/B reinforced concrete exterior wall adjacent to the C/B. In TR NEDE-33875P, Revision 3, Table 5-1, "Key Structural Design Features in DCD Appendix 3H.6," the applicant described that this is an input to allow credit of the S/B wall as an intervening structure. The staff reviewed DCD Tier 2, Figures 1.2-1 and 1.2-25, "Turbine Building General Arrangement," and TR NEDE-33875P, Revision 3, Table 5-1, and finds them acceptable because the staff agreed with the applicant regarding how they screened the T/B as an intervening structure based on the criteria set in NEI 07-13, Revision 8, Section 3.2.2, as endorsed by RG 1.217, Revision 0.

Based on the above review, the staff finds the applicant's description, including location and design of the T/B structure and layout, as a key design feature for protecting the entire north wall of the C/B and portions of the north wall of the R/B from the impact of a large, commercial aircraft to be acceptable, because the applicant adequately described the above design features and functional capabilities in accordance with 10 CFR 50.150(b).

The applicant provided the necessary information from its letters dated September 2, 2016, and November 23, 2016, in the ABWR DCD, Revision 7, which incorporated the changes from the ABWR DCD, Revision 6 markups. Therefore, Confirmatory Item 19.5-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

19.5(D).3.2.3 Location and Design of Reinforced Concrete Containment Vessel and Reactor Building Structure

The staff reviewed the ABWR DCD to ensure that the applicant performed a reasonably formulated assessment of the capability of the RCCV and R/B structures to protect the safety systems located inside primary containment and the entire south wall of the C/B from the impact of a large, commercial aircraft. The applicant used the guidance provided in NEI 07-13, Revision 8, as endorsed by RG 1.217, Revision 0, to perform detail structural analyses to determine the design of selected structures providing protections from the impact of a large commercial aircraft.

In Item (3) of DCD Tier 2, Section 19G.4.2, as revised in the ABWR DCD, Revision 6 markups, the applicant stated that the location and design of the R/B structure as described in DCD Tier 2, Sections 3.8.4, "Other Seismic Category I Structures," and DCD Tier 2, Section 3.H1, "Reactor Building," are the key design features protecting portions of the primary containment and the entire south wall of the C/B from the impact of a large, commercial aircraft. The applicant further described the protection provided from exterior walls, interior walls, intervening structures, and barriers on the large openings in the R/B exterior walls.

The staff reviewed DCD Tier 2, Section 3.8.4 and DCD Tier 2 Section 3.H1 and finds that the R/B and RCCV are reinforced concrete structures, below grade. Review of these general arrangement drawings (DCD Tier 2, Figures 1.2-1, and 1.2-4 through 1.2-12) shows that the entire south wall of the C/B is protected by the concrete shear walls of the R/B. Further, in DCD Tier 2, Section 19G.2, "Scope of Assessment," of the revised ABWR DCD, Revision 6, markups, the applicant stated that the SFP and RCCV are not perforated in the event of an aircraft impact based on the assessment results; therefore, assessment of the damage to RCCV internal structures, systems and components (SSCs) and secondary impact is not required. In addition, the staff reviewed TR NEDE-33875P, Revision 3, Section 2.0, "Analysis Inputs," Section 4.3, "Structural Assessment," Table 4-2, "Summary of Material Specifications," and Table 4-4, "Summary of Strengthening Measures. The staff finds that the applicant performed the assessment for the AIA using the methodology in NEI 07-13, Revision 8, as endorsed by RG 1.217, Revision 0, strengthened measures for the interior and exterior walls based on results of the assessment; and designed external barriers as shown in DCD Tier 2, Figure 1.2-8, "Reactor Building, Arrangement Plan," and DCD Tier 2, Figure 1.2-9, "Reactor Building, Arrangement Plan," in combination with the external wall to protect the critical penetrations. Section 19.5(D).3.2.7 (below) of this supplemental FSER provides the technical evaluation of the adequacy of the reactor cavity shield blocks for protecting the drywell head from secondary impacts.

The applicant made additional changes in Item (3) to the DCD Tier 2, Section 19G.4.2 clarifying that TR NEDE-33875P, Revision 3, defines the R/B location, as fixed with respect to other major structures to ensure that credit of the R/B as an intervening structure is maintained. The staff reviewed the relevant drawings (DCD Tier 2, Figures 1.2-1, and 1.2-4 through 1.2-12), which show the relative relationship of the building locations among the T/B, C/B, and R/B structures. The staff further reviewed TR NEDE-33875P, Revision 3, Table 3-2 and Figure 3-1, which show

the distance from the intervening structures to shielded structure. The applicant screened the R/B as an intervening structure based on the criteria set in NEI 07-13, Revision 8, Section 3.2.2 of, as endorsed by RG 1.217, Revision 0. The staff confirmed that the location of the relevant structures is fixed at the original DC stage. On these bases, the staff finds that crediting the R/B as an intervening structure is acceptable.

The applicant added new Item (10) to the DCD Tier 2, Section 19G.4.2 clarifying that the R/B crane will be parked at the north wall of the R/B when it is not used because doing so would significantly reduce the probability of the effect of secondary impact from falling crane components on the shield blocks that protects the drywell head from the impact of a large, commercial aircraft.

In Item (2) in DCD Tier 2, Sections 3H.6, of the revised ABWR DCD, Revision 6, markups, the applicant stated that the structural configuration of the RCCV within the R/B precludes direct strike on containment, and structural design of the RCCV ensures that the RCCV is not perforated. In addition, In DCD Tier 2, Section 19G.4.1, of the revised ABWR DCD, Revision 6, markups, the applicant described the RCCV as a key design feature that would protect the safety systems located inside primary containment from the impact of a large, commercial aircraft. The staff reviewed the description of key design features of RCCV in DCD Tier 2, Section 3.8 and DCD Tier 2, Section 3.H1. The staff also reviewed the description of RCCV material specifications in TR NEDE-33875P, Revision 3, Table 4-2, "Summary of Material Specifications," and Section 4.3, "Structural Assessment." The staff finds that the RCCV is not perforated in the event of an aircraft impact based on the assessment results; therefore, assessment of the damage to RCCV internal SSCs and secondary impact is not required. In Section 19.5(D).3.2.7 (below) of this supplemental FSER, provides the staff's independent review and assessment of the shield blocks protecting integrity of the drywall head from the secondary impacts.

The applicant made additional changes in Item (4) DCD Tier 2, Section 3H.6, of the revised ABWR DCD, Revision 6, markups clarifying that the interior partition walls are thickened and strengthened as shown in TR NEDE-33875P, Revision 3, to limit physical damage to interior partition walls from the impact of a large, commercial aircraft. The staff reviewed general arrangement drawings for the interior partition walls in DCD Tier 2, Figures 1.2-8 and 1.2-9. The staff also reviewed the description of thickened and strengthened internal partition walls in TR NEDE-33875P, Revision 3, Table 4-4. The staff finds that the interior partition walls are appropriately thickened and strengthened based on the results of the assessment in TR NEDE-33875P, Revision 3, and are therefore acceptable.

In Item (5) of DCD Tier 2, Sections 3H.6, of the revised ABWR DCD, Revision 6, markups, the applicant stated that the reinforced concrete sliding barriers with structural capacity equivalent to the surrounding wall are provided for the 6 large openings on 1F, as shown in DCD Tier 2, Figure 1.2-8, to limit physical damage to exterior walls. The staff reviewed DCD Tier 2, Figure 1.2-8 and TR NEDE-33875P, Revision 3, and finds that reinforced concrete sliding barriers in combination with the external wall are provided to protect the critical penetrations from the impact of a large, commercial aircraft and are therefore acceptable.

The applicant added new Item (12) to the DCD Tier 2, Section 3H.6 which clarifies that the R/B exterior walls on the east, west, and south sides are strengthened with enhanced reinforcement as described in TR NEDE-33875P, Revision 3. The staff reviewed the description of the enhanced reinforcement of the exterior wall on the east, west and south of the R/B in TR

NEDE-33875P, Revision 3, Table 4-4. The staff finds that the east, west, and south sides are adequately strengthened with enhanced reinforcement based on the results of the assessment in TR NEDE-33875P, Revision 3, and are therefore acceptable.

Based on the above review, the staff finds the applicant's description of the location and design of the R/B and RCCV as the key structural design features for providing protection for maintaining core cooling to be adequate and acceptable, because the applicant described the physical protections and intervening structures to protect the primary containment (RCCV and drywell head) and the entire south wall of the C/B using the guidance of NEI 07-13, Revision 8, as endorsed by RG 1.217, Revision 0, to perform detail structural analyses, and to determine the design of selected structures providing protections in accordance with 10 CFR 50.150(b).

The applicant provided the necessary information from its letters dated September 2, 2016, and November 23, 2016, in the ABWR DCD, Revision 7, which incorporated the appropriate changes from the ABWR DCD, Revision 6 markups. Therefore, Confirmatory Item 19.5-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

19.5(D).3.2.4 Location and Design of Service Building Structure

The staff reviewed the ABWR DCD to ensure that the applicant performed a reasonably formulated assessment of the capability of the S/B to protect the east wall of the C/B, and core cooling equipment.

In Item (6) of DCD Tier 2, Section 19G.4.2, of the revised ABWR DCD, Revision 6, markups, the applicant stated that the location and design of the S/B structure as described in DCD Tier 2, Section 3H.6 and Figures 1.2-20 through 1.2-22 are key design features that protect the east wall of the C/B from the impact of a large commercial aircraft. The staff reviewed general arrangement drawings in DCD Tier 2, Figures 1.2-1, and 1.2-14 through 1.2-22. The staff also reviewed DCD Tier 1, Section 2.15.14, "Service Building," and finds that the S/B is located adjacent to the C/B. Review of these general arrangement drawings show that the east wall of the C/B is protected by concrete shear wall of S/B.

The applicant made additional changes in Item (6) to the DCD Tier 2, Section 19G.4.2 that clarify that the S/B location, fixed with respect to other major structures, is defined in TR NEDE-33875P, Revision 3, to ensure that credit of the S/B as an intervening structure is maintained. The staff reviewed the relevant drawings (DCD Tier 2, Figures 1.2-1 and 1.2-24 through 1.2-22), which show relative relationship of the building locations among the S/B, C/B, and R/B structures. The staff further reviewed TR NEDE-33875P, Revision 3, Table 3-2, "Intervening Structures Credited in ABWR Aircraft Impact Assessment," and Figure 3-1, "ABWR Site Plan – Location of Structures," which show the distance from the intervening structures to shielded structure. The applicant screened the S/B as an intervening structure based on the criteria set in NEI 07-13, Revision 8, Section 3.2.2, of as endorsed by RG 1.217, Revision 0. The staff confirmed that the location of the relevant structures is fixed at the original DC stage. On these bases, the staff finds credit of the S/B as an intervening structure acceptable.

The applicant further added new Item (10) to DCD Tier 2, Section 3H.6 stating that the S/B exterior wall adjacent to the C/B is a reinforced concrete wall. In TR NEDE-33875P, Revision 3, Table 5-1 the applicant describes the S/B as an intervening structure. The staff reviewed DCD Tier 2, Figures 1.2-1 and 1.2-15, and TR NEDE-33875P, Revision 3, Table 5-1 and finds it

acceptable, because the applicant screened the S/B as intervening structure based on the criteria set in NEI 07-13, Revision 8, Section 3.2.2 of as endorsed by RG 1.217, Revision 0.

Based on the above review, the staff finds the applicant's description, including location and design, of the S/B structure as key design features for protecting the east wall of the C/B from the impact of a large, commercial aircraft to be adequate and acceptable, because the applicant adequately described the above design features and functional capabilities in accordance with 10 CFR 50.150(b).

The applicant provided the necessary information from its letters dated September 2, 2016, and November 23, 2016, in the ABWR DCD, Revision 7, which incorporated the changes from the ABWR DCD, Revision 6 markups. Therefore, Confirmatory Item 19.5-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

19.5(D).3.2.5 Location and Design of Control Building Annex Structure

The staff reviewed the ABWR DCD to ensure that the applicant performed a reasonably formulated assessment of the capability of the C/B annex building to protect the west wall of the C/B, and core cooling equipment.

In Item (7) of DCD Tier 2, Section 19G.4.2, of the revised ABWR DCD, Revision 6, markups, the applicant stated that the location and design of the C/B annex building structure as described in DCD Tier 2, Section 3H.6 and Figures 1.2-20 through 1.2-22 are key design features that protect the west wall of the C/B from the impact of a large, commercial aircraft. The staff reviewed general arrangement drawings in DCD Tier 2, Section 3H.6, Figures 1.2-1, and 1.2-20 through 1.2-22. The staff also reviewed DCD R Tier 1, Section 2.15.15, "Control Building Annex," and finds that the C/B annex is located adjacent to the C/B. Review of these general arrangement drawings show that west wall of the C/B is protected by the concrete shear walls of the C/B annex.

The applicant made additional changes in Item (7) to the DCD Tier 2, Section 19G.4.2 that clarify that the C/B annex location, fixed with respect to other major structures, is defined in the TR NEDE-33875P, Revision 3 to ensure that credit of the C/B Annex as an intervening structure is maintained. The staff reviewed the relevant drawings (DCD Figures 1.2-1, and 1.2-24 through 1.2-31), which show the relative relationship of the building locations among the C/B annex, C/B, and R/B structures. The staff further reviewed TR NEDE-33875P, Revision 3, Table 3-2 and Figure 3-1 which show the distance from the intervening structures to shielded structure. The applicant screened the C/B annex as an intervening structure based on the criteria set in NEI 07-13, Revision 8, Section 3.2.2, as endorsed by RG 1.217, Revision 0. The staff confirmed that the location of the relevant structures were fixed at the original DC stage. On these bases, the staff finds credit of the C/B annex as an intervening structure acceptable.

The applicant made additional changes in Item (9) of DCD Tier 2, Section 3H.6 that state that the C/B annex building exterior walls are made of reinforced concrete. The staff reviewed Figures 1.2-1 and 1.2-15 in DCD Tier 2, Revision 6, and TR NEDE-33875P, Revision 3, Table 5-1, and finds it acceptable, because the applicant screened the S/B as an intervening structure based on the criteria set in NEI 07-13, Revision 8, Section 3.2.2 of, as endorsed by RG 1.217, Revision 0.

Based on the above review, the staff finds the applicant's description, including location and design, of the C/B annex structure as key design features for protecting the west wall of the C/B from the impact of a large, commercial aircraft to be acceptable, because the applicant adequately described the above design features and functional capabilities in accordance with 10 CFR 50.150(b).

The applicant provided the necessary information from its letters dated September 2, 2016, and November 23, 2016, in the ABWR DCD, Revision 7, which incorporated the changes from the ABWR DCD, Revision 6 markups. Therefore, Confirmatory Item 19.5-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

19.5(D).3.2.6 The Seismic Gap between Reactor Building and Control Building

The staff reviewed the ABWR DCD to ensure that the applicant performed a reasonably formulated assessment of the seismic gap between the R/B and C/B in protecting the C/B from shock effects from strikes on the R/B.

In Item (8) of DCD Tier 2, Section 19G.4.2 of the revised ABWR DCD, Revision 6, markups, the applicant stated that the seismic gap between the R/B and C/B described in DCD Section 3.8.5 is a key design feature in protecting the C/B from shock effects from strikes on the R/B. The staff reviewed DCD Tier 2, Section 3.8.5.1, and found that both R/B and C/B are supported by the reinforced concrete mat foundations, which are separated from each other by a gap of 2 meters (6 feet-6-3/4 inches) to minimize the structural interaction between the buildings. The staff also reviewed TR NEDE-33875P, Revision 3, Table 3-2 and Figure 3-1, which show the distance from the intervening structures to shielded structure. The staff confirmed that the seismic gap between R/B and C/B provided in the report is greater than 2 meters (6 feet-6-3/4 inches) and is therefore acceptable.

Based on the above review, the staff finds the applicant's description, including the seismic gap between the R/B and C/B as a key design feature for protecting the C/B from shock effects from strikes on the R/B to be acceptable, because the applicant adequately described the above design features and functional capabilities in accordance with 10 CFR 50.150(b).

19.5(D).3.2.7 Shield Blocks Over Drywell Head

The staff reviewed the ABWR DCD to ensure that the applicant performed a reasonably formulated assessment of the capability of the shield blocks to protect the integrity of the drywell head from the secondary impact of concrete debris, aircraft wreckage, and falling crane components resulting from the impact of a large commercial aircraft on the R/B.

In Item (3) of DCD Tier 2, Section 3H.6, from the revised ABWR DCD, Revision 6, markups, the applicant stated that the shield blocks are configured to fully resist secondary impacts from concrete debris, aircraft wreckage and falling crane components to protect the integrity of drywell head. The applicant further stated that the shield blocks are placed over the drywell head in the reactor cavity between the pool girders as shown in DCD Tier 2, Figure 3H.1-23. The staff reviewed DCD Tier 2, Section 3H.1.3, "Description of the Containment and the Reactor Building," DCD Tier 2, Figure 3H.1-23, DCD Tier 2, Section 3H.6, and TR NEDE-33875P, Revision 3. As described in the ABWR DCD sections and in the TR NEDE-33875P, Revision 3, the shield blocks are configured to fully resist secondary impacts from concrete debris, aircraft wreckage and falling crane components to protect the integrity of drywell head.

Based on the above review, the staff finds the applicant's description of the shield blocks as the key structural design feature for providing physical protection of the integrity of the drywell head to be acceptable because the applicant adequately described the above design features and functional capabilities in accordance with 10 CFR 50.150(b).

19.5(D).4 Shock Damage

In DCD Tier 2, Section 19G.2, the applicant stated that the analysis of aircraft impacts considers the effects of shock-induced vibrations on SSCs. In DCD Tier 2, Section 19G.4.1, "Primary Containment," the applicant stated that safety-related components inside primary containment, including the reactor pressure vessel and associated ECCS piping are not adversely affected by shock-induced vibrations resulting from the impact of a large, commercial aircraft. In addition, DCD Tier 2, Section 19G.4.4, the applicant stated that all support systems were assessed for shock damage.

Based on the applicant's use of NEI 07-13, Revision 8, as endorsed by RG 1.217, Revision 0, for its assessment scope that included shock-induced vibration, the staff finds that the applicant has performed a reasonably formulated shock analysis within the ABWR AIA.

19.5(D).5 Spent Fuel Pool Integrity

In DCD Tier 2, Section 19G.2, "Scope of Assessment," of the revised ABWR DCD, Revision 6, markups, the applicant stated that the SFP and RCCV are not perforated, based on the assessment results, in the case of an aircraft impact; therefore, assessment of the damage to RCCV internal SSCs and secondary impact is not required. In Item (4) of DCD Tier 2, Section 19G.4.2, in the revised ABWR DCD, Revision 6, markups, the applicant stated the location and design, and its supporting structures as described in DCD Tier 2, Section 9.1 and Figure 1.2-12 are the key design features in protecting the SFP from the impact of a large commercial aircraft. However, the applicant did not describe whether an assessment was performed to ensure that required minimum water level in the SFP is maintained in the case of an aircraft impact. Therefore, on April 20, 2015, the staff issued a Request for Additional Information (RAI) 19-6 (ADAMS Accession No. ML15110A122), requesting the applicant to confirm if an assessment was performed to ensure there is no leakage through the SFP liner below the required minimum technical specification water level of the pool. The applicant responded in a letter dated September 17, 2015 (ADAMS Accession No. ML15264A003), and submitted clarification in the DCD Tier 2, Section 19G.5, "Conclusions of Assessment," "that the aircraft impact would not inhibit the ABWR's core cooling capacity and SFP integrity based on the best estimate calculations." Previously, as part of the DCD Revision 6, the applicant stated the following:

[T]here are no AIA scenarios that would result in leakage from the SFP below the required minimum water level. The location and design of the SFP and its supporting structure preclude a direct hit from aircraft impact, therefore the pool liner is not perforated, and all piping attachments are configured such that they would not allow drain down below the minimum water level described in DCD Tier 2, Section 9.1.3.3, Safety Evaluation

The staff assessed the response and finds that the applicant adequately addressed this question since the aircraft impact would not inhibit the ABWR's core cooling capability and spent SFP pool integrity based on best estimate calculations performed in accordance with NEI 07-13,

Revision 8, as endorsed by RG 1.217, Revision 0. Therefore, the staff considers RAI 19-6 to be resolved and closed.

The applicant made additional changes to Item (1) in DCD Tier 2, Section 3H.6, of the revised ABWR DCD, Revision 6, markups. The applicant stated that (1) the structural configuration of the SFP within the R/B precludes a direct strike on the SFP, (2) the SFP is a reinforced concrete structure with a specified minimum thick ASTM A-240 Type 304L stainless steel liner, and (3) the SFP walls are strengthened as described in TR NEDE-33875P, Revision 3, to ensure the integrity of the SFP is maintained. The staff reviewed DCD Tier 2, Sections 9.1.2, "Spent-Fuel Storage," and TR NEDE-33875P, Revision 3, and the staff confirmed that the SFP is a reinforced structure with a specified minimum thick stainless-steel liner and the SFP walls are strengthened.

Based on the above review, the staff finds the description of the key design features for ensuring SFP integrity to be acceptable, because the applicant adequately described the above design features and functional capabilities in accordance with 10 CFR 50.150(b).

The applicant provided the necessary information from its RAI response dated September 17, 2015, in the ABWR DCD, Revision 7, which incorporated the changes from the ABWR DCD, Revision 6, markups. Therefore, Confirmatory Item 19.5-2 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

19.5.4 19.5(E) Conclusion

The staff finds that the applicant has performed an AIA in ABWR DCD, Revision 7, 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 52.59(a) and 10 CFR 50.150(a)(1) are met.

The staff also finds that the applicant adequately described the key design features and functional capabilities identified and credited to meet 10 CFR 50.150(b), including descriptions of how the key design features meet the acceptance criteria in 10 CFR 50.150(a)(1); namely the facility can withstand the effects of a large commercial aircraft impact such that the reactor core remains cooled and SFP integrity is maintained. Therefore, the staff finds that the applicant meets the applicable requirements of 10 CFR 50.150(b).

References

1. 10 CFR 50.150, "Aircraft Impact Assessment."
2. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."
3. 10 CFR Part 52, Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor."
4. 10 CFR 52.47, "Contents of Applications; Technical Information."
5. 10 CFR 52.59, "Criteria for Renewal."
6. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 19.5, "Adequacy of Design Features and Functional Capabilities Identified and Described for Withstanding Aircraft Impacts," Revision 0, April 2013 (ADAMS Accession No. ML12276A112).
7. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," July 1994 (ADAMS Accession No. ML080670592).
8. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," Supplement 1, May 1997 (ADAMS Accession No. ML080710134).
9. NRC, RG 1.217, "Guidance for the Assessment of Beyond-Design-Basis Aircraft Impacts," Revision 0, August 2011 (ADAMS Accession No. ML092900004).
10. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, December 2010 (ADAMS Accession No. ML110040323).
11. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 6, Tier 1 and Tier 2, February 2016 (ADAMS Accession No. ML16214A015).
12. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 7, Tier 1 and Tier 2, December 2019 (ADAMS Accession No. ML20007E371).
13. NEI 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," Revision 8, April 2011 (ADAMS Accession No. ML111440006).