Appendix 19S – Aircraft Impact Assessment

19S.1 Introduction and Background

A design-specific assessment of the effects on the ABWR of the beyond design basis impact of a large, commercial aircraft has been performed in accordance with 10 CFR 50.150(a) to 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. The specific assumptions regarding the aircraft impact were based on guidance provided by the NRC and the Nuclear Energy Institute (NEI 07-13 Rev. 7), including the loading function derived from the aircraft impact characteristics for use in assessments of aircraft impact effects. These guidelines were fully followed with no exceptions taken.

This appendix describes those design features and functional capabilities identified in the assessment, and discusses how the identified design features and functional capabilities show that, with reduced use of operator actions, the reactor core remains cooled or the containment remains intact, and spent fuel cooling or spent fuel pool integrity is maintained. In the following discussion the identified design features are designated as “key design features.”

19S.2 Scope of the Assessment

The evaluation of plant damage caused by the impact of a large, commercial aircraft is a complex analysis problem involving phenomena associated with structural impact, shock-induced vibration, and fire effects. The analysis of the aircraft impact considers structural damage, taking into account:

- An assessment of the effects of aircraft fuselage and wing structure;
- An assessment of the effects of shock-induced vibration on systems, structures, and components;
- An assessment of the penetration of hardened aircraft components, such as engine rotors and landing gear.

The results of the assessment predict that the spent fuel pool and primary containment vessel are not perforated; therefore, further assessment of the damage to internal systems, structures, and components caused by 1) burning aviation fuel and 2) secondary impacts is not required.

The results of the assessment predict that the Reactor Building (R/B) and Control Building (C/B) are perforated; therefore, realistic assessments of the damage to internal systems, structures and components caused by 1) burning aviation fuel and 2) secondary impacts are performed.

19S.3 Assessment Methodology

Methods described in NEI-07-13 were followed to assess the effects on the structural integrity of the primary containment and spent fuel pool, and to assess the physical, fire and vibration effects of the aircraft impact on the core cooling capability of the existing and enhanced design.

19S.4 Results of Assessment

The following key design features and functional capabilities ensure that the ABWR design can maintain core cooling and spent fuel integrity following a strike of a large commercial aircraft.

19S.4.1 Primary Containment

The primary containment, as described in Sections 3.8 and 3H.1, is a key design feature that would protect the safety systems located inside primary containment from the impact of a large commercial aircraft. The assessment concludes that a strike upon the primary containment would not result in the perforation of the primary containment, and would not cause direct damage to the systems within the primary containment or expose them to jet fuel.

The assessment also finds that safety-related components inside primary containment, including the reactor pressure vessel and associated ECCS piping are unaffected by shock-induced vibrations resulting from the impact of a large commercial aircraft.

19S.4.2 Site Arrangement and Plant Structural Design

The design and arrangement of major structures associated with the ABWR design as described in Section 1.2 and Figure 1.2-1 are key design features. Specifically, the assessment credited the arrangement and design of the following building features to limit the location and effects of potential aircraft strikes on the R/B, primary containment and C/B in the following locations:

(1) The location and design of the C/B structure as described in Sections 3.8.4 and 3H.2 are key design features that protect portions of the north wall of the R/B from the impact of a large commercial aircraft.

(2) The location and design of the Turbine Building structure and layout as described in Tier 1 Section 2.15.11 and Tier 2 Figures 1.2-24 through 1.2-31 are key design features that protect portions of the north wall of the C/B and R/B from the impact of a large commercial aircraft.

(3) The location and design of the R/B structure as described in Sections 3.8.4 and 3H.1 are key design features that protect portions of the primary containment and the 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. A detailed structural analysis using the NEI 07-13 methodology was utilized to determine the design of selected internal walls as shown in Figures 1.2-8 and 1.2-9 and external barriers as shown in Figure 1.2-8 that, in combination with the external wall, protects the critical penetrations. That analysis was also used to determine the key design features for the reactor well shield plugs for protecting the drywell head from secondary impacts as identified in Section 3H.1.4.

(4) The location and design of the spent fuel pool and its supporting structure as described in Section 9.1 and Figure 1.2-12 are key design features in protecting the spent fuel pool from the impact of a large commercial aircraft.

(5) The physical separation of the Class 1E emergency diesel generators and an independent power supply as described in Section 9.5.14 is a key design feature that prevents the loss of all electrical power to core cooling systems.

19S.4.3 Fire Barriers and Fire Protection Features

The design and location of 3-hour fire barriers, including floor plugs (see Figure 1.2-8), fire doors and watertight fire doors that separate the safety divisions within the R/B and C/B are key design features for the protection of core cooling equipment within these buildings from the impact of a large commercial aircraft. The assessment credited the design and location of fire barriers (including doors) as described in Sections 9.5.1 and 9A.4 for the R/B and the C/B to limit the effects of internal fires created by the impact of a large commercial aircraft. All credited watertight doors have a 5 psid rating.

19S.4.4 Core Cooling Features

The design and physical separation of the emergency core cooling systems described in Section 6.3, the SRVs described in Section 5.2.2, the alternate feedwater injection system described in Section 9.5.14, the suppression pool described in Section 6.2.1, and the containment overpressure protection system described in Section 6.2.5 are key design features for assuring core cooling.

The ABWR design for aircraft impact is in full compliance with the guidance of NEI 07-13, "Methodology for Performing Aircraft Assessments for New Plant Designs". In the event of a threatened aircraft impact while the reactor is at power operation, the guidelines in NEI 07-13 allow the assumption that the operators will have advance warning to take manual action to shutdown the reactor prior to impact unless the hydraulic control units (HCUs) are in the physical damage footprint. For the ABWR design, the HCU's are located below grade, outside of the damage footprint. As a result, such advance warning to shutdown the RPV can be credited.

Following shutdown from 100% power operation, any undamaged Emergency Core Cooling (ECC) system has the capability of maintaining core cooling. Should all ECC systems be rendered inoperable as a result of the aircraft impact, the Alternate Feedwater Injection (AFI) system has the capability to provide sufficient core cooling by maintaining the water level above the top of the active fuel. In this scenario, the SRV will cycle as reactor pressure increases to the SRV lift setpoint, and this will relieve energy from the RPV to the suppression pool. After an extended period of time, as the suppression pool heats up, pressure in the containment will increase. This will eventually result in the Containment Overpressure Protection System (COPS) rupture disc opening, which will relieve containment pressure to atmosphere. This is the ultimate heat removal path.

For an aircraft impact during shutdown with the reactor head removed and reactor water level above the flange, the existing RHR system will provide sufficient decay heat removal. If the RHR system is unavailable as a result of the aircraft impact, decay heat removal will be accomplished by evaporation, with makeup to the RPV provided by the AFI system.

As noted in the discussion above, the primary systems for heat removal following a postulated aircraft impact that render all ECC systems inoperable are the AFI system, the SRV's, the suppression pool and the COPS. The SRV's and the suppression pool are housed within and protected by the primary containment which is not perforated by the aircraft impact. The COPS is sufficiently protected from aircraft impact such that it will perform its intended function as described above. The AFI system is housed in a structure that is at least 300 feet from the strike location which is an area not affected by the same impact that would disable the ECCS and/or emergency power supplies. The necessary controls and support equipment for the AFI is either in the AFI Pump House or protected from aircraft impact. The water supply for the AFI is located near the AFI Pump House in an area that is not affected by the same impact that would disable the ECCS and/or emergency power supplies. The power supply for the AFI equipment is also located in an area that is not affected by the same impact that would disable the ECCS and/or emergency power supplies.

19S.5 Conclusions of Assessment

This assessment based upon NEI 07-13, concludes that the ABWR can continue to provide adequate protection of the public health and safety in the event of an impact of a large, commercial aircraft, as defined by the NRC. The aircraft impact would not inhibit the ABWR's core cooling capability and spent fuel pool integrity based on best estimate calculations. There are no AIA scenarios that would result in leakage from the spent fuel pool below the required minimum water level. The pool liner is not perforated and all piping attachments are configured such that they will not allow drain down below the minimum water level. The assessment resulted in the identification of the key design features and functional capabilities described in Section 19.S.4, changes to which are required to be controlled in accordance with 10 CFR 50.150(c).