

## 19.0 SEVERE ACCIDENTS

### 19.2.3.3.4 ABWR Containment Vent Design

The DCD identifies the ABWR containment vent system as the containment overpressure protection system (COPS). COPS is a subsystem of the non-safety-related Atmospheric Control System (ACS). COPS is relied upon to function during beyond-design-basis events (e.g., severe accidents). The design basis of the COPS is discussed in Sections 6.2.5.2.6.2, 19.E.2.8.1, and 19K.11.6 of Tier 2 of the ABWR DCD. The staff evaluation documented in Section 19.2.3.3.4 of NUREG-1503 approved the COPS design as a part of the original ABWR DC review. By letter dated January 8, 2016 (ADAMS Accession No. ML16008A079), GEH proposed increasing the COPS pipe diameter and rupture disk in Tier 2 to reflect a correction to an error in the original system flow rate calculations and to conform with the required minimum capacity COPS flow rate in Tier 1.

#### 19.2.3.3.4.1 Regulatory Criteria

As stated above, the changes are proposed to correct an error and to address an inconsistency between Tier 1 and Tier 2. As such, the proposed changes to the COPS are “modifications,” as this term is defined in Chapter 1 of this supplement. As explained in Chapter 1 of this supplement, modifications are evaluated using the regulations applicable and in effect at the initial ABWR certification. However, the COPS was included in the ABWR design to address Commission policy goals related to severe accidents rather than to meet regulations that existed at initial certification. Therefore, the staff reviewed the proposed changes to ensure the ABWR design continues to meet the Commission’s position for inclusion of a dedicated containment vent path in the ABWR, as documented in SECY-90-016 (ADAMS Accession No. ML003707849) and the associated staff requirements memorandum (SRM) (ADAMS Accession No. ML003707885). In the SRM, the Commission approved the use of COPS in the ABWR subject to the results of a comprehensive regulatory review to fully weigh the potential “downside” risks with the mitigation benefits of the system. In addition, the Commission directed the staff to ensure that the design should provide full capability to maintain control over the venting process. This Commission position was used in the review of the COPS for the original ABWR design, as discussed in Section 19.2.3.3.4 of NUREG-1503. Furthermore, the staff reviewed the modifications in order to determine whether there will be any adverse impacts from making the COPS modifications on conclusions reached by the NRC in its review of the original ABWR design certification (NUREG-1503).

#### 19.2.3.3.4.2 Summary of Technical Information

By letter dated January 8, 2016 (ADAMS Accession No. ML16008A079), GEH submitted proposed changes to the COPS. In its letter, GEH stated that during the process of confirming the detailed design of the COPS pipe diameter in an ABWR under construction, the required minimum capacity COPS flow rate of 28 kg/second specified in Tier 1 of the DCD could not be achieved with the current Tier 2 design information since pipe losses were not accounted for in the original system flow rate calculations. To address this issue, GEH proposed Tier 2 changes to the ABWR DCD to maintain the Tier 1 flow rate of 28 kg/second. The design changes increase the diameter of the COPS piping from 250 mm (10 inches) to 350 mm (14 inches), and the rupture disk size from 200 mm (8 inches) to 250 mm (10 inches). GEH states that these Tier 2 changes will achieve the minimum COPS flow rate of 28 kg/second described in Subsection 2.14.6 of Tier 1 of the ABWR DCD.

GEH letters dated February 18, 2016 (ADAMS Accession No. ML16049A044), April 19, 2016 (ADAMS Accession No. ML16110A154), June 16, 2016 (ADAMS Accession No. ML16168A302), and October 11, 2016 (ADAMS Accession No. ML16285A132) provided additional DCD changes and supporting technical information.

#### 19.2.3.3.4.3 Staff Evaluation

The staff approved the COPS design as a part of the original ABWR DC review which is documented in Section 19.2.3.3.4 of NUREG–1503. The staff review of the proposed COPS design changes focused on assessing the potential impacts on the COPS performance analyses performed in support of the originally certified ABWR design and associated staff findings in NUREG–1503.

The staff reviewed the proposed changes in Chapters 6 and 19 of the ABWR DCD Revision 6 to determine if the COPS is able to meet the required minimum flow rate specified in Tier 1 of the DCD. Fluid flow in piping is accompanied by friction and this friction is reflected in the system performance (e.g., flow rate). In a system with a given pressure input (e.g., actuation pressure for a rupture disk), as the system friction decreases (e.g., due to increasing pipe diameter), the flow rate increases. Therefore, GEH's approach to increase the size of piping and components in the COPS flow path is a reasonable approach to reduce friction losses in order to meet the required minimum flow capacity for COPS.

A staff analysis confirmed that the applicant's original system flow rate calculations did not properly account for pipe losses. In a public phone call held on September 22, 2016 (ADAMS Accession No. ML17004A315), the staff requested information on how GEH accounted for piping losses. In a letter dated October 11, 2016 (ADAMS Accession No. ML16285A132), the applicant provided the requested information (e.g., overall system resistance coefficient). The staff review and analysis confirmed that the applicant's revised COPS design and analysis properly account for pipe losses and provide reasonable assurance that the DCD Tier 1 COPS flow requirement is met. In addition, ITAAC 2.14.6-04, requires a combined license holder to confirm that the design meets the Tier 1 COPS flow rate based on the as-built plant layout and the as-built system loss coefficients. Therefore, staff finds the applicant's proposed Tier 2 changes provide reasonable assurance of meeting the Tier 1 COPS flowrate acceptance criterion.

In a supplemental letter dated April 19, 2016 (ADAMS Accession No. ML16110A154), GEH stated that they reviewed the various severe accident analyses and evaluations performed for the ABWR DC and identified those affected by the proposed COPS design changes. Based on the review, GEH identified the impact of flashing during venting to be the only analysis affected by the change, particularly related to the suppression pool surface response to a decompression wave. Since the proposed increase in the COPS sizing maintains the original COPS performance characteristics (e.g., rupture disk setpoint of 0.72 MPa, minimum COPS flow rate of 28 kg per second), the staff agrees that most of the original analyses remain valid, including the thermal-hydraulic accident sequence and core melt progression analyses.

The staff evaluated the proposed changes to the DCD regarding the suppression pool surface response to a decompression wave. DCD Revision 5, Tier 2, Section 19E.2.3.5.1 described the evaluation of the response of the suppression pool surface to a decompression wave. DCD Section 19E.2.3.5.1 stated that the decompression resulting from the COPS rupture disc opening during an accident is not large enough to cause pool pressure to drop below its saturation pressure of 330 kPa at its initial temperature of 410 K, or 137°C (738 R or 278°F) and

that the pool surface would move upward at only a negligible velocity for the transmitted decompression. GEH re-evaluated the response of the suppression pool surface to a decompression wave for the new COPS piping and the rupture disk sizes to confirm that the conclusions in the certified ABWR DCD are unchanged and provided proposed changes to DCD Section 19E.2.3.5.1.

The staff review identified errors in three equations in the approved ABWR DCD, Equations 19E.2-41a, 19E.2-41d, and 19E.2-41k. The  $(k + 1)$  term in the denominator of the exponential term in Equations 19E.2-41a and 19E.2-41d should be corrected as  $(k - 1)$ . In these equations,  $k$  represents the specific heat ratio for an ideal gas because the applicant assumed that the nitrogen and steam mixture in the COPS piping would behave as an ideal gas. To check the validity of this assumption the staff calculated the suppression pool surface response to a decompression wave using thermodynamic properties of a mixture of nitrogen and saturated steam instead. The magnitude of the decompression wave transmitted into the water pool and the resulting pool rise velocity, as presented in ABWR DCD Section 19E.2.3.5.1.6, did not change (up to two significant figures). Therefore, the applicant's assumption is acceptable. The  $Ct/r$  in the exponential term in Equation 19E.2-41k should be corrected as  $Ct/R$ . In this equation,  $C$ ,  $t$ ,  $r$ , and  $R$  represent the acoustic speed, time, distance from the center of COPS piping at the entrance to the suppression pool, and radius of COPS piping at the entrance to the suppression pool, respectively. The staff found that these errors did not affect the results provided in the approved ABWR DCD or in the DC renewal application. The calculations have used the corrected form of Equations 19E.2-41a and 19E.2-41d and a conservatively simplified version of Equation 19E.2-41k that did not contain the erroneous term.

The staff discussed the above errors during public teleconferences with GEH on February 5 (ADAMS Accession No. ML16050A486) and April 6, 2016 (ADAMS Accession No. ML16111A557). In letters dated February 19 (ADAMS Accession No. ML16049A043) and June 16, 2016 (ADAMS Accession No. ML16168A301), GEH stated that after its review GEH agreed with the staff on these errors, corrected the equations, and provided proposed DCD changes.

The staff's review of GEH's submittals confirms that the increase in COPS piping and the rupture disk sizes did not affect the conclusions in the certified ABWR DCD that the decompression resulting from the COPS rupture disc opening during an accident is not large enough to cause pool pressure to drop below its saturation pressure of 330 kPa at its initial temperature of 410 K or 137°C (738 R or 278°F) and that the pool surface would move upward at only a negligible velocity for the transmitted decompression. The staff's review also finds GEH's proposed changes to ABWR DCD Tier 2, Section 19E.2.3.5.1 to be acceptable.

Based on above, the staff finds that the proposed changes to the COPS are acceptable. The proposed DCD markups are treated as a **Confirmatory Item 19.02-1**, pending their incorporation into a revision of the DCD.

#### 19.2.3.3.4.4 Conclusion

Based on the evaluation provided in this SER section, the staff concludes that the proposed changes do not alter the safety findings made in NUREG-1503 and remain consistent with the Commission's position for inclusion of a dedicated containment vent path in the ABWR, as documented in in SECY-90-016 and the associated SRM. Therefore, the staff finds that the design, as modified, satisfies the NRC's regulations applicable and in effect at initial certification. Inclusion of the proposed changes in the DCD is being tracked by the Confirmatory Item discussed above.