GE Nuclear Energy

ABWR

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Subject DSER Open Item 21,
PRA punch list items: 021A, 021B
Reliability Assumptions - Outside Certification Scope

Message
The following 5 pages
provide the material
to address the open item

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19.10 Design and Reliability Assumptions and Insights Related to Systems Outside of ABWR Design Certification

The systems for which credit was taken which are outside of the ABWR design certification are those portions of the Reactor Service Water (RWS) System outside of the control building including the safety related ultimate heat sink (UHS), the power cycle heat sink, parts of the offsite power system and the fire truck which supplies the ac independent water addition system.

Reactor Service Water (RSW) System and Safety Related Ultimate Heat Sink (UHS) Assumptions

The configurations of the RSW System and UHS as defined by ABWR system drawings and design performance specifications provided the bases for PRA fault tree modeling and evaluation. The total heat removal capacity of these configurations is sufficient to remove heat loads associated with emergency shutdown and post-LOCA core and containment cooling.

The design features and capacities of these systems are such that any one division can provide sufficient cooling capacity to remove decay heat (provide containment cooling) provided that both pumps and all three heat exchangers in that division are in operation. In addition, one reactor building cooling water (RCW) and one RSW pump in each loop in each division and two RCW heat exchangers in each division provide sufficient cooling capacity to support the core cooling (injection) function for ECCS equipment in that division. These assumptions were made in both internal event and seismic analyses. Developing a plan and implementing procedures for validating these capabilities is a COL interface item.

An RSW isolation valve at the discharge of each pump and in the common header line on the discharge from both pumps are assumed to automatically close on a high water level (0.8 meter) in the control building RSW/RCW rooms. In addition, anti-siphon valves are located in the system to ensure that RSW flow will stop when the RSW pumps are tripped and the isolation valves remain open. The combined reliability of either one of the valves closing (one of two in series) or the pump trip/anti-siphon valve actuation should be less than $1x10^{-5}$ per demand (i.e., essentially three devices in series where only one must work for successful termination of the flood).

<u>Reactor Service Water (RSW) System and Safety Related Ultimate Heat Sink (UHS) Insights</u>

The design features and capabilities of the RSW System and UHS contribute to the reliability of decay heat removal. If a transient is initiated by an internal event or a seismic event while the plant is at power, loss of heat removal is one potential threat which must be considered. However, since the overpressure protection system rupture disk provides a very simple and highly reliable means of removing decay heat, the numerical reliability of the ultimate heat sink for removing decay heat (from an internal event perspective or from a seismic event perspective) is not particularly significant.

While the plant is shutdown and the containment is open, shutdown cooling provides decay heat removal and the rupture disk affords no protection. Insights from the shutdown risk study in Appendix 19Q indicate that there are multiple means of r..moving decay heat during shutdown. Even if all decay heat removal systems fail, the core can be kept covered by injecting water to the reactor vessel using any of several systems and allowing the water to boil. Appendix 19Q provides guidelines on what systems may be maintained during shutdown while still maintaining a high decay heat removal reliability.

The configuration and capabilities of the RWS System and UHS also contribute to the reliability of emergency core cooling system performance by removing heat from the Reactor Building Cooling Water (RCW) System as described in the preceding section.

In the event of an RSW line leak in the control building RSW/RCW room, floor water level detectors alert the operator, trip the RSW pumps and close the isolation valves in the affected division. Insights from the flooding probabilistic risk assessment indicate that either the pump trip or isolation valve closure features must be successful in terminating the flood in order to reduce the risk from control building flooding. For pump tripping to result in termination of the flood, anti-siphon valve(s) should be included in the RSW system design.

Power Cycle Heat Sink Assumptions

These assumptions are noted in Table 19D.4-2. They relate to the ability to recover the heat sink given that it has been lost.

Power Cycle Heat Sink Insights

The circulating water pumps are tripped in the event of a turbine building flood. This trip is expected to be sufficiently reliable to assure a negligibly small addition to the inadvertent plant trip frequency. Beyond this observation, no special attention to the power cycle heat sink is needed from a PRA perspective.

Off-Site Power Assumptions

These assumptions are noted in Subsection 19D.3.1.2.4. A value of 0.1 loss of offsite power events per year was assumed, representing a 90% confidence value. Credit is also taken for offsite power recovery and diesel generator recovery, based on operating experience. Most of these assumptions are more reflective of the offsite power grid than equipment at the plant. However, Subsection 8.2.3, paragraph (4) is an interface requirement to analyze the site specific incoming power line configuration relative to the PRA assumption. Switchyard equipment inspections are included in the PRA input to reliability assurance program (Appendix 19K).

Off-Site Power Insights

With 3 separate safety grade divisions including RCIC which does not require ac-power, the combustion turbine generator and the ac-independent water addition system provided in ABWR, off-site power assumptions are not particularly significant for ABWR from an internal event or seismic event perspective.

Fire Truck Assumption

The fire truck provides a backup water source for the ac-independent water addition system. As noted in Subsection 19.3.1.5.2 an overall reliability for fire water injection was taken as 0.9 for transients. This reliability is controlled by operator error rather than equipment availability. It is judged that the following reliability targets (availability on demand), if satisfied will support the injection function assumed in the PRA:

fire truck: 0.9

diesel driven fire water pump: 0.9

These values should be achieved if the actions noted in the PRA input to reliability assurance (Appendix 19K) are included in the reliability assurance program.

Fire Truck Insights

The ac-independent water addition system was added to the original ABWR design to provide a diverse and seismically rugged means of adding water to the reactor vessel and spraying the drywell. Because of its importance, it is included in the tier 1 design description, in the PRA input to the reliability assurance program (Appendix 19K) and its use should be included in the applicants training program. The later is included as an action item in Section 19.9.

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