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CEB92-60

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Fro . Carol E. Buchholz CEB

Subject: Response to Remaining Currently Open Items

I believe the following issues cover almost all of the remaining questions you have raised. The only issues we have not responded to are those related to the corium protection for the sump. As John and I discussed, we will wait until next week before finalizing our response to that question. Hopefully, Tony will be better by that time, and we can discuss the questions he raised on the phone before we submit the final response.

I hope this information is useful in resolving any questions you may have as you write the SER. Please let me know as soon as possible if you are aware of any other areas where I owe you a response.

Item 1: Detailed chronology of "FS" cases

Provide a detailed chronology of the "FS" cases which are identified in Table 19E.2-16 but not discussed in the text. Along with other events of significance, please include the time to: suppression pool overflow, lower drywell dryout, passive flooder opening, drywell spray start and stop, and firewater start and stop. (Note: this is further discussion of question "Revised MAAP calculations 3-2" in a previous NRC transmittal). (Open Issue 8-2 in the PRA status of November 30, 1992)

Response 1:

The attached pages from the current draft of the SSAR material indicate the changes requested for the discussion of the firewater spray cases. The affected pages are 19E.2-13, -13.1, -14, -15, -15.1, -19, -19.1, -21, -21.1 and -52.

Item 2:

Look at the potential for water to be present in the lower drywell of the ABWR during SBRC sequences. Consider the possibility of delayed vessel failure. Determine the impact of these sequences on the probability repc-ted in the steam explosion analysis.

Response 2:

The SBRC and NSRC sequences were reexamined to determine if water is present in the lower drywell before vessel failure. It was determined that water can be present before vessel failure for these sequences. A revision to the SSAR text is included on pages 19E.2-16, -16.1 and -55 in the enclosed package of SSAR material. The NSRC cases are similarly affected. The amended SSAR text for these sequences is given on pages 19E.2-21 and -61.

As a result of the above examination, the probability of a pre-flooded lower drywell was re-examined. The emendation to the SSAR draft is provided on Page 19EB.6-3 of the enclosed documentation. This section was originally submitted in CEB92-X as X.2.7.6.2.2. Also, the section will be moved to 19EB.1.1 in order to increase the visibility of the very low probability of occurrence for a large scale FCI event.

Item 3:

Provide information indicating how the leak rate testing for the vacuum breakers is performed. Indicate why the values used in the Decomposition Event Trees for bypass are appropriate.

Response 3:

This following response will be incorporated into the SSAR text regarding suppression pool bypass in Chapter 19. This discussion replaces all previous discussions of the probability of a stuck open vacuum breaker and the probability of vacuum breaker leakage. The probability of a stuck open vacuum breaker remains unchanged from previous submittals. The probability of leakage decreased from 0.18 failures per demand to 0.17 failures per demand. The decomposition event trees will not be requantified since this difference is negligible.

19EE.2.1 Vacuum Breaker Stuck Open (VB)

When a vacuum breaker (V/B) sticks open or catastrophically fails, a large pathway is established between the drywell and wetwell. The deterministic analysis described in Section 19EE.3 demonstrates that pathway areas

greater than 41 cm^2 (opening widths greater than 0.9 cm) can significantly effect accident consequences.

The suppression pool bypass scoping analysis presented in Section 19E.2.3.3 assumed a failure probability for V/B full reverse flow of 6.7E-2/demand based on pre-1970 U.S. BWR operating history of general check valves. This failure rate is highly conservative because:

(1) The ABWR V/B design is based on current knowledge which is substantially improved over earlier check valve designs.

(2) The ABWR V/B environment is significantly less severe than general check valves - the working fluid is gas rather than liquid and the ABWR V/B's will not experience chugging loads.

The failure probability used in this analysis was based on BWR operating experience from April 1981 to March 1991 as contained in a database of Licensing Event Reports. The database was queried for abnormal wetwell-to-drywell vacuum breaker (V/B) operation. Information about the valves connecting the containment and reactor building were not included because some of these valves are not swing, check valves. The database query provided a short narrative of each abnormal operation as well as the total component operating time.

The database query included BWR Mark I, II and III containments. The V/B's in these containments are similar in design to the ABWR V/B's - passive, flapper-type valves attached to horizontal piping. The ABWR V/B's will be slightly different in size than some of those currently in operation, but this does not undermine the applicability of the data.

The failures were culled to exclude failures other than those that could lead to a V/B sticking open or catastrophically failing. Failures to open were excluded because mechanical binding was never the root cause. Most failures to open (10 out of 12) were attributed to either the setpoint drift or worn retaining magnets. Neither of these conditions would prevent the V/B from closing once it had open, albeit at a differential pressure outside the normal range. The remaining failures were due to: 1) a loose set screw on the flapper pivot pin and 2) excessive clearance between the valve shaft and disk. Both of these conditions led to opening forces greater than technical specification limits and greater than the forces required to open the other V/B's tested in the same sequence. In the ABWR design, the depressurization transients which lead to opening of the V/B's are very mild. Therefore, if either of the these two failure conditions existed during an accident, the affected valves would probably not open because the other vacuum breakers would open and relieve high differential wetwell pressure before the force required to open the affected valves was achieved.

Failures to pass leak rate tests during refueling and maintenance outages when the V/B proximity switch indicated "closed" were also excluded because this represents small leakage paths. These failures were included

in the probability for VB_LEAK as described in 19EE.2.2 A "closed" indication will be given only when the V/B disk is seated or very nearly so. Failures to close were included, as were cases in which excessive force was required to cycle a V/B during stroke capability testing.

The database query provided the following results:

Abnormal operation which could lead to failure to close: 18 (N_{close})

Cumulative V/B operating time: 2.66E7 hours (T_{close}).

The ability of V/B's to open and close is demonstrated monthly during stroke capability tests (T_{stroke} = 720 hours). Therefore, the probability that one of the eight ABWR V/B's will fail to close on demand and a large leakage path will be established between the wetwell and drywell can be approximated by

$$P(VB) = \frac{8N_{close}T_{stroke}}{T_{close}} \qquad (19EE\text{-}1)$$

$$= 3.9E\text{-}3/\text{demand}.$$

This failure probability conservatively over-estimates the probability that one of the ABWR V/B's will fail to close during accident conditions because the closure forces during an accident will be at least an order of magnitude greater than those present during testing and normal operation. Additional closure force will enhance sealing and overcome some, if not all closing resistance.

The vacuum breakers in the ABWR will not be stroke tested every month as are those in current operation. This is expected to improve V/B reliability because the monthly stroking increase wear, increase galling potential, imparts impact loads to the valve components, loads the valves in a non-uniform manner, and decreases the sealing ability of the soft seats. Reliability will also be increased by improvements made possible by the operational experience of vacuum breakers currently in BWRs with Mark I, II and III containments. These improvements will include material selection, valve assembly techniques and maintenance procedures. Corrosion on ABWR V/B components will be negligible because of material selection and operating environment (nearly pure nitrogen). Since reliability is improved and corrosion will be negligible, the failure probability determined during monthly testing of current vacuum breakers provides a conservative over-estimation of ABWR vacuum breaker reliability.

19EE.2.2 Vacuum Breaker Leaks (VB_LEAK)

The consequences of small leakage paths between the drywell and wetwell are less severe than those for a V/B sticking open. The small leakage area cutoff was determined to be 41 cm^2 in the sensitivity study contained in

Section 19EE.3. The BWR operating history described in the previous section (19EE.2.1) was also used to determine the probability of small leakage.

BWRs with Mark I containments have a single passive, flapper-type valve attached to the end of each vacuum breaker line. Mark II containments have two passive, flapper-type valves in series in each vacuum breaker line. Mark III containments have a single, flapper-type valve in series with a motor operated valve (MOV) in each line. All of the valves are attached to horizontal piping in the wetwell airspace. Since the ABWR has a single, flapper-type valve on the end of each line in the wetwell airspace, the operating experience of BWRs with Mark I containments provides the best indication of ABWR V/B leakage. Actual ABWR V/B's will perform better than those in Mark I containments because: 1) the ABWR V/B materials - especially those of the seating surfaces - will be improved because they will be based on the many years accumulated vacuum breaker experience of current BWRs, 2) the ABWR V/B's will not experience chugging loads and 3) the ABWR V/B's will not be cycled every month.

The ability of V/B's to remain leak tight is demonstrated during wetwell-to-drywell leakage tests performed as part of each refueling and maintenance outage. During these tests, the drywell is pressurized with respect to the wetwell and the pressure decay rate measured. If the pressure differential decreases too rapidly indicating excessive leakage, the root cause is found and corrected. The instances when a vacuum breaker was found to be the leakage pathway are reported in Licensing Event Reports and included in the operating experience database. The pressurization rate used in the leakage tests are generally slower than those experienced during accident conditions. Increased pressurization rates improve the sealing capability of soft seats and reduce leakage.

All failures reported in the selected operating history of wetwell-to-drywell vacuum breakers in Mark I containments except failures to open and those used to determine V/B stuck open were included in the determination of small leakage probability. The database query provided the following results:

Number of Mark I wetwell-to-drywell vacuum breaker abnormal operations which could lead to small leakage: 42 (N_{leak})

Cumulative Mark I V/B operating time: 2.37E7 hours (T_{leak}).

The actual amount of leakage was not reported in the database and is generally not available. However, the vacuum breaker leakage area can be roughly characterized. Currently, wetwell-to-drywell vacuum breakers are verified closed by indication lights in the control room every seven days. Position is determined by proximity switches which are generally accurate to within the 0.9 cm disk opening which corresponds to the 41 cm^2 cutoff area. The proximity switches used in conjunction with the ABWR vacuum breakers will have even closer tolerances because of the increased