Attachment 6

PSAT Calculation 04011H.04

"Suppression Pool Scrubbing Efficiency (Including Pool Bypass)"

CALCULATION TITLE PAGE

CALCULATION NUMBER: PSAT 04011H.04

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REASON FOR REVISION: Nonconformance Rpt

0 - Initial Issue — N/A

1 - Change of Reference 2 — N/A
Addition of References 5 and 6
Addition of pool DF calculation in accordance with References 2 and 5

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Purpose

The purpose of this calculation is to determine the maximum removal efficiency that can be credited for the passage of particulates and of elemental iodine (including Te-132 which is being treated as elemental I-132 except for half-life) through (and around) the Browns Ferry suppression pool for the purpose of applying the revised DBA source term of Reference 1.

Methodology

The overall methodology is that of Reference 2 except for timing (which is specified in Reference 1) and the suppression pool DF which is explicitly calculated below (see Calculation section) in lieu of using the minimum value of 10 given as a "default" in Reference 2. (Per Reference 2, "in the absence of detailed analysis, a [suppression pool decontamination] factor of 10 [may be] used, although this is likely to be significantly lower than what would be calculated"). To account for pool bypass, a steam mass flow corresponding to 10 times the drywell-to-torus vacuum breaker surveillance test acceptance value is used. It is compared to the mass flow out of the drywell during and immediately after the source term release (referred to as the slow drywell sweep and the fast drywell sweep, respectively) to determine the bypass fraction. No removal credit is taken for the fraction of the drywell sweep-out flow which bypasses the suppression pool. The overall pool DF (expressed as a "filter efficiency") is calculated accordingly.

Assumptions

Assumption 1: There is no dynamic pressure drop through the vent system during either the slow sweep or fast sweep of the drywell.

Justification: The fast sweep-out of the drywell occurs with a vent flow of about 32 lbm/sec (Reference 3). As was discussed in Reference 3, during the blowdown of the reactor vessel for a DBA recirc suction LOCA all coolant is released except for a portion in the lower reactor vessel. If it is estimated that: (1) the total coolant released is of the order of 400000 lbm, (2) about 40% of that flashes to steam (Reference 3 calculates 38%), and (3) the blowdown requires not more than 30 seconds (the start of the gap release in Reference 1). Thus, the average steam flow through the vent system is about 5300 lbm/sec. Considering that the vent system differential pressure would not be expected to exceed 30 psid for such an event, and further that pressure drop would be, at worst, linear with flow (and at best, proportional to flow velocity squared), the differential pressure for a flow of only 32 lbm/sec would be expected to be in the range of 0.001 to 0.2 psid. For a vent submergence of 3.5 ft (Reference 4, Item 8.14) the static differential pressure (to clear the vents) would be about 1.5 psid. Therefore, at worst, the dynamic pressure drop, even for the fast sweep-out flow of 32 lbm/sec, would be of the order of 10 percent of the static pressure difference and can therefore be neglected.

References

Reference 1: Soffer, L., et al., "Accident Source Terms for Light-Water Nuclear Power Plants", NUREG-1465, February 1995

Reference 2: Leaver, D. E., et al., "Licensing Design Basis Source Term Update for the Evolutionary Advanced Light Water Reactor", DOE/ID-10298, September, 1990

Reference 3: PSAT 04011H.01, "Volumetric Flowrate as a Function of Time from Drywell to Torus (and Return)", Revision 0

Reference 4: PSAT 04000U.03, "Design Data Base for Application of the Revised DBA Source Term to the TVA Browns Ferry Nuclear Power Plant", Revision 0

Reference 5: Powers, D. A., and Sprung, J. L., "A Simplified Model of Aerosol Scrubbing by a Water Pool Overlying Core Debris Interacting With Concrete", NUREG/CR-5901, November, 1993

Reference 6: PSAT 04002H.09, "Elemental Iodine Filter Efficiency in Main Steam Lines",

Calculation

Proprietary to Polestar Applied Technology, Inc.

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Results

The overall efficiency of the suppression pool as a filter for removing particulate and elemental iodine is 0.72 during the slow sweep-out (prior to 7230 seconds) and 0.95 during the fast sweep-out (from 7230 seconds to 7890 seconds).

Conclusions

Because of the relatively low flowrate corresponding to the slow sweep of the drywell, the pool bypass (which is not sensitive to flowrate since it depends only on the hydrostatic pressure difference needed to clear the vents) is relatively large during that period leading to a relatively low overall efficiency. During the high flow of the fast sweep the pool bypass is correspondingly smaller and the efficiency correspondingly greater.