ENCLOSURE 1

EVALUATION OF THE RADIOLOGICAL CONSEQUENCES FOR ACCIDENTAL RELEASES THROUGH BWR 2-INCH VENT AND PURGE LINES

INTRODUCTION

NUREG-0737, Item II.E.4.2(7) required that the containment purge and vent isolation valves must close on a high radiation signal. This position was added to the original NUREG-0578 requirements of Recommendation 2.1.4 as a result of further staff evaluation of features needed to improve containment isolation dependability.

One basis for the implementation of II.E.4.2(7) was the additional protection it would provide against low rates of reactor coolant leakage and releases to the environment which would not initiate the other automatic isolation signals of reactor low water level and high drywell pressure. The BWR Owners Group (BWROG) previously transmitted an evaluation of offsite radiological consequences for accidental releases through BWR vent and purge lines which do not meet the requirement of NUREG-0737, Item II.E.4.2(7) in a letter from T. J. Dente of the BWROG to D. G. Eisenhut of the NRC, dated June 14, 1982. In a June 20, 1985 meeting, the BWROG requested that the staff review its evaluation for small (2-inch diameter) vent and purge lines.

DISCUSSION

The staff has reviewed the BWROG evaluation which provides calculations of the radiological consequences of the limiting reactor coolant system break which would not initiate automatic isolation with the current design. The limiting event was conservatively modeled as a reactor coolant system break such that the drywell atmosphere would contain saturated steam at a pressure just below the containment isolation setpoint. Steam release through one vent or purge line was assumed to pass directly to the environment with no credit given for holdup or dilution, or for filtering by the standby gas treatment system. The fraction of the iodine postulated to become airborne and available for release to the atmosphere, without credit for plateout, was assumed to equal the fraction of the coolant flashing to steam. The BWROG evaluation provided calculations for a typical plant as well as a generic analytical procedure.

Independent calculations of the radiological consequences of the limiting reactor coolant system break were performed by the staff. The staff conservatively estimated a mass release value of 492 cubic feet per minute of saturated steam at 2 psig over a 30 minute duration until the one purge and vent line would be isolated by other actions.

The assumptions used in this staff analysis were as follows:

1. Drywell atmosphere is saturated steam and at a pressure equal to the containment isolation setpoint (psig).

2. Operator action time to close the purge or vent valve is assumed to be 30 minutes.

3. Vent pipe length is conservatively assumed to be 10 ft. for purposes of flow calculations.

4. Elevation changes have been neglected.

The BWR Owners Group analysis used formulas described in NEDM-10363-13, "Hydraulic Analyses Procedure for BWR Piping Systems." The staff used similar formulas, which are described in the Crane Flow of Fluid Manual and the above assumptions, and obtained similar results to those provided by the BWR Owners Group.

The staff, using the above release rate, performed plant specific calculations of the radiological consequences for Pilgrim Unit 1, Hatch Units 1 and 2, Peach Bottom Units 2 and 3, and Limerick Unit 1. The staff's calculation of offsite doses differed from the procedure outlined in the BWROG's evaluation in two respects. First, the staff used short term diffusion estimates typical of other conservative regulatory evaluations of accidents; the BWROG used annual average relative concentrations typical of a realistic evaluation of doses from routine releases. Second, the staff used conservative reactor coolant iodine concentrations assuming a pre-accident iodine spike for those plants with a technical specification iodine spiking limit. For Pilgrim Unit 1, which has no technical specification iodine spiking limit, the staff used the maximum technical specification equilibrium concentration with an accident-initiated spike, modeled by increasing the equilibrium fission product activity release rate from the fuel by a factor of 500. The staff's iodine spiking model is typical of regulatory analyses involving accidental releases of primary coolant, as outlined in Section 15.6.2 of the Standard Review Plan (NUREG-0800). The BWROG's evaluation assumed equilibrium iodine concentrations with an accident-initiated spike using a 95% cumulative probability iodine spiking model.

RESULTS

The staff estimates of the thyroid and whole body doses at the exclusion area and low population zone outer boundaries for the 6 units are presented in Table I (attached). Although specific acceptance criteria do not exist for this postulated accident, the radiological consequences and frequency of occurrence for this accident would tend to be similar to that of the failure of small lines carrying primary coolant outside containment. The staff concluded that the use of the acceptance criteria for the failure of small lines, which appear in Section 15.6.2 of the Standard Review Plan, would be appropriate for use in this evaluation. Thus, the radiological consequences of this postulated accident would be acceptable if the calculated whole-body and thyroid doses at the exclusion area and low population zone outer boundaries do not exceed a small fraction (10%) of the dose guideline values of 10 CFR Part 100, viz., 2.5 rem and 30 rem respectively, for whole body and thyroid doses. As summarized in Table I, the estimated doses are a small fraction of these dose guideline values of 10 CFR Part 100.

TABLE 1

RADIOLOGICAL CONSEQUENCES FOR ACCIDENTAL RELEASES THROUGH BWR 2-INCH VENT AND PURGE LINES

	Exclusion Area Boundary (0-2 hr), rems		Low Population Zone Boundary (0-8 hr), rems	
	Thyroid	Whole Body	Thyroid	Whole Body
Limerick Unit 1	0.4	0.007	0.08	0.002
Peach Bottom Units 2 & 3	0.4	0.004	0.007	0.00006
Hatch Unit 1*	0.08	0.0008	0.04	0.0004
Hatch Unit 2*	0.08	0.002	0.04	0.0008
Pilgrim Unit 1	3.3	0.03	0.2	0.002

*The difference in whole body doses between Hatch Unit 1 and Unit 2 was a result of different Technical Specification primary coolant activity limits.

The magnitudes of these doses calculated by the staff are higher than would realistically be expected because of the many conservative assumptions in the staff's methodology, particularly with respect to iodine spiking behavior and to meteorology. For example, coolant iodine concentration levels generally are small fractions of equilibrium technical specification levels, iodine spiking does not always occur coincident with the transients, the iodine spiking concentrations assumed to occur are well in excess of any level recorded at an operating boiling water reactor, and the probability of better meteorological conditions is quite high. A more realistic analysis would yield dose estimates about 1/100th or less of the values noted above.

Since this evaluation assumes that operator action to close the purge or vent valve is taken within 30 minutes, for the BWROG evaluation to be acceptable the licensee must verify that the 30 minute operating time is valid based upon location and accessibility of the valve operators, and insturmentation necessary to determine the need for manual closure, and that plant procedure and operator training are sufficient to support the approach.

ENCLOSURE 2

BWR VENT & PURGE RADIATION MONITOR SET POINTS

BACKGROUND - In a meeting on June 20, 1985 the BWR Owners Group requested that the staff establish set point criteria for isolation signals for vent and purge line radiation monitors required under TMI Action Item II.E.4.2(7) of NUREG-0737. The monitors are not considered safety related, but are to be provided solely to assure diverse isolation signals in the event of an accident.

EVALUATION - Radiation monitors with vent and purge line isolation capability are required as a post TMI item to ensure containment isolation. Other diverse isolation signals, such as drywell pressure and reactor water level, are also provided. A review of the regulations indicates there are no explicit dose guidelines that apply to such monitors in the event of accidents, other than the siting values in 10 CFR 100. The Standard Review Plan contains design basis accident dose acceptance criteria which have previously been evaluated with respect to purge and vent valve closure time criteria. As discussed in Enclosure 1, the staff concluded that the use of acceptance criteria of calculated whole-body and thyroid doses at the exclusion area and low population zone outer boundaries which do not exceed a small fraction (10%) of the guideline values of 10 CFR Part 100 would be appropriate for use in the evaluation of the radiological consequences of accidental releases through open vent and purge lines. As a minimum requirement, vent and purge radiation monitor set points should be established such that this acceptance criteria is met.

The staff notes, however, that a guiding principle in establishing set point values for radiation monitors used to limit doses is to establish them as low as possible to avoid unnecessary exposures. If set too low, however, spurious signals resulting from minor changes in instrument detectability or background activity levels not representative of accident conditions can occur. As a practical matter, for radiation detectors which are located on the vent or purge line set points which do not exceed the highest radiation level expected in normal operation should provide suitable warning of accidents and avoid most spurious signals.

POSITION - Radiation monitors provided for assuring diverse isolation signals for BWR vent and purge valves should be set low enough to effectively limit accidental releases of radioactivity from being released offsite when such valves are open during operation. While such set points should be established as low as possible to limit offsite accident releases, the set points should not cause unnecessary isolation signals resulting from instrument uncertainties or non-accident variations in radiation levels. As a minimum requirement, vent and purge radiation monitor set points should be established such that the radiological consequences of accidental releases through open vent and purge lines do

not exceed a small fraction (10%) of the dose guideline values of 10 CFR Part 100. As a practical matter, for well shielded monitors which directly measure activity levels in the flow past such valves, set points at a level which does not exceed the highest radiation level expected in normal operation should provide adequate assurance of accident isolation.