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NUCLEAR REGULATORY COMMIS_ION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DUQUESNE LIGHT COMPANY

BEAVER VALLEY POWER STATION, UNIT 2

DOCKET NO. 50-412

1.0 INTRODUCTION

The Safety Evaluation Report (SER) supporting the licensing of Beaver Valley Unit 2 (NUREG-1057, dated October 1985) identified a confirmatory issue to be resolved. The NRC staff requested further analysis of whether a steam generator could be isolated in 30 minutes following a steam generator tube rupture (SGTR) accident. SER Supplement 5, dated May 1987 noted that generic analyses had been completed, but that plant specific analyses were required to apply the generic results to Beaver Valley Unit 2. The evaluation below addresses the plant specific analyses submitted by Duquesne Light Company (DLC) in a letter dated January 3, 1991, including the Westinghouse report, "LOFTTR2 Analysis for a Steam Generator Tube Rupture for Beaver Valley Power Station Unit 2, "WCAP-12738, October 1990.

2.0 BACKGROUND

Following the Ginna SGTR event on January 25, 1982, the SGTR subgroup of the Westinghouse Owners Group (WOG) submitted WCAP-10698, "SGTR Analysis Methodology to Determine the Margin to Steam Generator Overfill," dated December 1984 for the NRC staff review, which also references WCAP-10698, Supplement 1, "Evaluation of Offsite Radiation Doses for a Steam Generator Tube Rupture Accident." In our evaluation of these WCAPs (letter from C. E. Rossi (NRC) to Alan E. Ladieu (WOG) dated March 30, 1987), the staff concluded that the WOG provided an acceptable and conservative methodology for the generic SGTR analysis, but that five specific parameters used in the analysis may vary significantly from plant to plant, altering the steam generator overfill and radiological dose results. The staff concluded that each member of the SGTR subgroup and that all Westinghouse near-term operating licenses (NTOLs) would be required to submit plant-specific information as follows before the methodology from WCAP-10698 could be applied on a plant-specific basis:

(1) Demonstrate that the operator action times assumed in the analysis are realistic;

(2) Perform a site specific SGTR radiation offsite consequence analysis;

(3) Evaluate the adequacy of the main steam lines and associated supports under water-filled conditions as a result of SGTR overfill;

(4) Provide a list of systems, components and instrumentation which are credited for accident mitigation in the plant-specific SGTR emergency operating procedures(s) EOP(s).

(5) Survey the designs of the primary and balance-of-plant systems design to determine the compatibility with the bounding analysis in WCAP-10698.

3.0 EVALUATION

3.1 Steam Generator Overfill

Westinghouse performed the plant-specific margin to steam generator overfill SGTR analysis using the LOFTTR 2 computer code for Beaver Valley Power Station Unit 2. The SGTR analysis assumptions and operator actions times were consistent with the reference plant analysis. The results of this analysis indicate that the recovery actions can be completed to terminate the primary to secondary break flow before overfill of the ruptured steam generator (SG) would occur. Therefore, it is concluded that steam generator overfill is not likely for a design-basis SGTR for Beaver Valley Power Station Unit 2. In addition, DLC responded satisfactorily to items 3, 4, and 5 listed above as required by the staff.

3.2 Operator Action Times

The NRC staff's evaluation of the WOG WCAP-10698 stipulates plant-specific criteria for assessing operator action times in the event of an SGTR. Those criteria were employed to evaluate the information provided by DLC regarding operator action times during an SGTR at Beaver Valley Power Station Unit 2. The evaluation is based on the following:

Criterion 1. Provide simulator and EOP training related to a potential SGTR.

The licensee documented by letter dated January 3, 1991, that onsite simulator and EOP training relevant to an SGTR are provided. The staff finds that the licensee has satisfied Criterion 1.

Criterion 2. Utilizing typical control room staff as participants in demonstration runs, show that the operator action times assumed in the SGTR analysis are realistic and achievable.

By letter dated January 3, 1991, the licensee provided the assumed operator response times for the overfill scenario. The assumed response times were as follows:

ACTIONS	OVERFILL SCENARIO (ASSUMED TIME)
• Identify and isolate ruptured steam generator	11.75 minutes
• Initiate cooldown of reactor coolant system	9.00 minutes
• Initiate depressurization of reactor coolant system	2.50 minutes
• Initiate safety injection termination	1.24 minutes

Further, the licensee indicated that all operating crews participated in demonstration runs regarding the overfill scenario, but due to a simulator malfunction, one crew's data could not be obtained. The licensee compared the operator response times for each crew and the longest time for each operator action was used as the assumed times (shown in Table above) for the overfill scenario analysis. The staff finds that such an approach for the SGTR analysis is acceptable, and based on this information, the staff concludes that the licensee has satisfied Criterion 2.

Criterion 3. Complete demonstration runs to show that the postulated SGTR accident can be mitigated within a period of time compatible with overfill prevention, using design basis assumptions regarding available equipment and its impact on operator response times.

As noted in the previous section, the assumed times for the licensee's SGTR analysis employed the longest time for each operator action demonstrated during simulator exercises for the overfill scenario. The staff finds that the licensee has satisfied Criterion 3.

Criterion 4. If the EOPs specify SG sampling as a means of identifying the SG with the ruptured tube, provide the expected time period for obtaining the sample results and discuss the effect on the duration of the accident.

The staff determined that the licensee's EOPs do not specify manual SG sampling as a means of identifying the SG with the ruptured tube. Therefore, the staff finds that the licensee has satisfactorily addressed Criterion 4.

The staff has reviewed DLC's responses regarding operator action times during an SGTR, concluding that the licensee has satisfactorily verified the times assumed in the SGTR analysis for Beaver Valley Power Station Unit 2.

3.3 Radiological Consequences

Beaver Valley Power Station Unit No. 2 is a 3-loop Westinghouse pressurized water reactor licensed to operate at a thermal power level of 2652 megawatts.

As a result of a SGTR event, isotopes of radioactive iodine as well as radioactive noble gas isotopes could be released to the environment. It is noted that determinations of the radiological releases of noble gases and iodines involves consideration of a number of factors related to initial isotopic concentration, activity release rates from primary and secondary systems and the flashed fraction of reactor coolant system activity.

In the evaluation of the consequences of a SGTR event, the licensee assumed the parameters identified in Table I. The iodine releases assumed by the licensee for both the Pre-Accident Iodine Spike and Event-Generated Iodine Spike cases are presented in Table II. In conducting this analysis, the licensee calculated site boundary thyroid doses for both the accident-initiated and preaccident iodine spike cases as presented in Table III.

In performing this analysis, the licensee assumed that releases to the atmosphere consisted of two basic components: (1) iodine which had flashed to the vapor phase and which was not subsequently scrubbed prior to release to the atmosphere via the steam volume and (2) iodine in the liquid phase from (unflashed) primary coolant as well as (condensed) primary coolant vapor, both of which were assumed to be released via the steam volume to atmosphere after appropriate partitioning.

For iodines mixed in the steam generator liquid, the ratio of the activity concentrations in the exhaust steam to that in the secondary coolant (partition factor) was assumed to be 0.01 in accordance with the Standard Review Plan (SRP) 15.6.3, "Radiological Consequences of Steam Generator Tube Failure." The iodine releases assumed by the licensee for both the Preaccident Iodine Spike and Event-Generated Iodine Spike cases are presented in Table II. Other assumptions utilized by the licensee in evaluating the radiological consequences of a steam generator tube failure are also defined in SRP 15.6.3. In performing the radiological consequence evaluations, DLC considered two different accident scenarios, the first assuming a preexisting spike and the second assuming an accident-generated iodine spike.

In evaluating the radiological consequences of a SGTR for the accident-initiated spike case, the licensee assumed that an iodine spike was initiated in the primary system which increased the iodine release rate from fuel to the coolant to a value 500 times greater than the release rate that corresponds to the initial primary system iodine concentration.

For the pre-existing iodine spike case, the licensee assumed that a reactor transient occurred prior to the SGTR and that resulting primary coolant iodine concentrations were 60 uCi/gm dose equivalent I-131. Further, no credit was taken for radioactive decay during transport or for cloud depletion by ground depositions during transport to the site boundary or outer boundary of the low population zone.

The NRC staff independently calculated maximum hypothetical offsite radiological consequences from the postulated SGTR event assuming a limiting single failure and other assumptions as provided in Table I. In performing the radiological dose consequence analysis, the X/Q values assumed by the licensee and the staff are summarized below:

LOCATION	X/Q VALUE ASSUMED BY LICENSEE	X/Q ASSUMED BY STAFF FROM UNIT 2 SER
Site boundary (0.2 hrs)	1.44×10^{-3}	1.6×10^{-3} sec/m^3
Low population zone (0-8 hrs)	7.07×10^{-5}	7.2×10^{-5} sec/m^3

While the results of the staff's evaluations differ slightly from those calculated by the licensee, calculated offsite dose consequences are within staff acceptance criteria and do not exceed (1) a small fraction (10%) of the dose guideline values of 10 CFR Part 100 assuming an event-initiated iodine spike and (2) the dose guideline values set forth in 10 CFR Part 100 for the case of a preaccident iodine spike. Results of both the staff and the licensee's analyses are presented in Table III.

Based on the above, the staff concludes that the SGTR radiological consequence analysis provided by the licensee is acceptable. The analysis performed by both the licensee and the staff demonstrate that the calculated radiological consequences of a steam generator tube rupture event at the Beaver Valley Unit 2 exclusion area and low population zone boundary meet the acceptance criteria provided by SRP Sections 15.6.3. Consequently, the staff considers the licensee's response to this confirmatory issue regarding the plant-specific SGTR radiological consequence analysis acceptable.

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Table I
Beaver Valley Unit 2 SGTR Analysis
Assumptions

1.	Core power level, MWt	2766
2.	Tube leakage prior to event, gpm	1.0
3.	Secondary activity DE-I_{131}, uci/gm	0.1
4.	Reactor coolant activity	
	4.1 pre-accident spike	60 uci/gm DE-I_{131}
	4.2 accident-initiated spike	Factor of 500 increase in iodine release rate from the fuel
5.	Noble gas activity	Based on 0.26% fuel defects
6.	Secondary system initial activity	0.1 uci/gm DE-I_{131}
7.	Reactor coolant mass gms	$1.97x10^8$ gms
8.	SG water mass (each) gms	$4.5x10^7$
9.	Offsite power	Lost at time of trip
10.	Total mass released from ruptured SG 0-2 hrs	43,500 lbs.
11.	Total mass released from intact SGs, 0-2 hrs.	387,400 lbs.
12.	Iodine partition factor for iodines mixed in secondary coolant	0.01
13.	0-2 hour relative concentrations X/Q sec/m^3 at EAB	$1.44x10^{-3}$
14.	0-8 hour relative concentration X/Q sec/m^3 at LPZ	7.07x10-5

Table II
2 HR. Iodine Releases Assumed by DLC
for SGTR

Isotope	Pre-Accident Iodine Spike (Ci)	Concurrent Iodine Spike (Ci)
I-131	6.5 E + 01	9.9
I-132	2.1 E + 01	1.6 E + 01
I-133	1.0 E + 02	2.2 E + 01
I-134	1.2 E + 01	2.2 E + 01
I-135	5.3 E + 01	1.9 E + 01

Table III
Calculated Radiological
Consequences of SGTR Event

		Licensee Calculated Value	Staff Calculated Value
1.	Pre-Accident Iodine Spike Case		
	a) whole-body dose in rem from noble gases		
	i exclusion area boundary -	0.2	0.2
	II low population zone -	7.0×10^{-3}	7.0×10^{-3}
	b) thyroid dose in rem from inhaled radioiodines		
	i exclusions area/boundary -	71.6	78.8
	ii low population zone -	3.6	3.6
2.	Accident-Initiated Iodine Spike Case		
	a) whole body dose in rem from noble gases		
	i exclusion area boundary -	0.2	0.2
	ii low population zone -	0.09	0.09
	b) thyroid dose in rem from inhaled iodines		
	i exclusion area boundary -	13.4	14.7
	ii low population zone -	0.8	0.8