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November 7, 1994

Docket No. 50-423
B15019

Re: Millstone Unit No. 3
SER, NUREG 1031

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station, Unit No. 3
Steam Generator Tube Rupture - Analysis
Additional Information on Operator
Response Times (TAC No. M83307)

In a letter dated April 28, 1992,[1] Northeast Nuclear Energy Company (NNECO) submitted a plant-specific steam generator tube rupture (SGTR) analysis for four-loop and three-loop operation for Millstone Unit No. 3. The analysis was performed for a design basis SGTR event for Millstone Unit No. 3 to demonstrate margin to overfill assuming the limiting single failure relative to overfill. The results were summarized in WCAP-13002, "Margin to Overfill Analysis for a Steam Generator Tube Rupture for Millstone Nuclear Power Station, Unit No. 3 Four Loop Operation," and WCAP-13056, "Margin to Overfill Analysis for a Steam Generator Tube Rupture for Millstone Nuclear Power Station Unit No. 3 Three-Loop Operation."

The operator response times used for the SGTR analysis for both four-loop and three-loop operations were based on the results of simulator studies of the SGTR recovery operations which were performed during the years 1990 and 1991 by the Millstone Unit No. 3 operating and administrative crews using the plant training simulator. The analysis showed that there was sufficient margin to steam generator overfill. The simulator response times showed some variation in performance of the individual steps. In a letter dated April 13, 1994,[2] the NRC requested additional information

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(1) J. F. Opeka letter to the U.S. Nuclear Regulatory Commission, "SGTR Analysis, (TAC No. 67054)," dated April 28, 1992.

(2) V. L. Rooney letter to J. F. Opeka, "Request for Additional Information Concerning Review of Generic Steam Generator Tube Rupture (SGTR) Analysis (TAC No. M83307)," dated April 13, 1994.

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concerning the simulator response times (i.e., operator response times) in performance of the individual steps. Specifically, the NRC requested NNECO to show that the operator action times assumed in the SGTR analysis are realistic and achievable. The NRC subsequently requested in a conference call that NNECO evaluate the impact of the variations in the operator response times on the margin to overfill as predicted by the analysis and on the offsite radiological doses. Attachment 1 provides the results of the evaluation regarding margin to steam generator overfill and offsite radiological doses.

Since the analysis assumptions are reasonable and there is margin available to allow for variations in operator performance, NNECO concludes that the analysis results are acceptable and have no impact on the offsite doses. In order to assure ourselves that Millstone Unit No. 3 continues to meet the SGTR analysis basis, NNECO has determined to revalidate the operator response times assumed in the plant specific SGTR analysis by conducting additional operating crew design basis SGTR simulations. This action is expected to be completed by April 1995.

If you have any questions regarding this matter, please contact our licensing representative, Mr. R. G. Joshi at (203) 440-2080.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

J. F. Opeka
Executive Vice President

cc: T. T. Martin, Region I Administrator
V. L. Rooney, NRC Project Manager, Millstone Unit No. 3
P. D. Swetland, Senior Resident Inspector, Millstone Unit Nos. 1, 2, and 3

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Attachment 1

Millstone Unit No. 3

Steam Generator Tube Rupture - Analysis
Additional Information on Operator
Response Times

November 1994

Attachment 1
Millstone Unit No. 3
Steam Generator Tube Rupture - Analysis
Additional Information on Operator Response Times

A. Margin to Steam Generator Overfill

I. BACKGROUND

In 1991, an analysis to determine the margin to overfill for a steam generator tube rupture was performed for Millstone Unit No. 3. The results were summarized in Westinghouse reports WCAP-13002, "Margin to Overfill Analysis for a Steam Generator Tube Rupture for Millstone Nuclear Power Station Unit No. 3 Four-Loop Operation," and WCAP-13056, "Margin to Overfill Analysis for a Steam Generator Tube Rupture for Millstone Nuclear Power Station Unit No. 3 Three-Loop Operation." The analysis showed that for four loop operation, with the sequence of events shown in Table 1, there was approximately 354 ft^3 margin to steam generator overfill. The sequence of events was based upon assumptions made for the timing of operator actions. The key time intervals are summarized in Table 2.

To ensure the reasonableness of the assumptions on operator actions, the various operating and administrative crews were timed on execution of a steam generator tube rupture scenario in four loop operation on the simulator The times measured from the simulator were used as the basis to select operator action times. The results from the simulator runs are compared to the analysis assumptions in Table 3. The analysis assumption times compare favorably to the average response times.

The simulator response times showed some variation in performance of the individual steps. An evaluation has been performed to evaluate the impact of the variations on the margin to overfill as predicted by the analysis.

II. EVALUATION

From the data on Table 3, it is seen that five crews exceeded the summation of the analysis assumption interval of 30.5 minutes. These crews are listed in Table 4. The analysis results have been extrapolated to estimate the margin to overfill for each of these crews.

Figure 1 shows a plot of the predicted steam generator level as a function of time. From the plot, it is seen that in general, the plot can be characterized by straight lines. The steepest line occurs in the first 16.5 minutes where auxiliary feedwater is being added to the affected steam generator. The first interval time frame was selected as the longer of 16.5 minutes or the time when steam generator wide range level reached 58% in the affected steam generator.

In order to extrapolate the results of the analysis, the appropriate fill rate was multiplied by the difference between the analysis assumption and the crew performance for each time interval. That is:

$$\Delta \text{ SG level} = \Sigma \text{ fill rate}_i * (\text{operator time}_i - \text{analysis time}_i)$$

With the exception of the first interval, the appropriate fill rate for the given time interval was determined by linear regression of the analysis results. For the first interval, the fill rate is dominated by the auxiliary feedwater addition. However, the operating crews are trained to control steam generator level. This is independent of steam generator isolation and thus it is reasonable to assume that the crews will control auxiliary feedwater based upon steam generator level irrespective of the time it takes to accomplish steam generator isolation. Thus, the extra time taken to achieve steam generator isolation would not occur with the high fill rate. Instead, it is more appropriate to treat the extra time for steam generator isolation as an extension of the time for initiating cooldown. Thus, the same fill rate was assumed for the first and second operator action intervals.

The fill rates that were used and the results of the extrapolation of the analysis are shown in Table 5. The largest increase in steam generator level for all of the crews is 282 ft^3 for Admin "E" - 07/05/90. Since this is less than the available margin of 354 ft^3, the extrapolated results indicate that steam generator overfill would be prevented even using the longest times of those measured on the simulator. Table 6 summarizes the extrapolated margin to overfill for five crews that exceeded the cumulative analysis intervals.

III. CONCLUSIONS

The analysis assumptions were selected based upon performance of the operating and administrative crews in handling steam generator tube rupture using the Millstone Unit No. 3 simulator. As such, the analysis assumptions are reasonable. While the simulator exercises showed that there were some variations in operator performance, extrapolation of the analysis results show that all of the crews would have prevented overfill. Since the analysis assumptions are reasonable and there is margin available to allow for variations in operator performance, we conclude that analysis results are acceptable.

B. Effects of Increased Isolation Time on Radiological Consequences of Millstone Unit No. 3 SGTR

The SGTR analysis included in WCAP 13002 considered different single failures to determine the margin to overfill. The worst single failure with respect to margin to overfill (Table 1 and Table 3 events) was a failure of the power operated relief valve (PORV) on an intact steam generator to open for the cooldown of the reactor coolant system. An evaluation was performed to determine the offsite doses for a design basis SGTR considering various single failures.[3] The worst case single failure with respect to the offsite doses is different than for the margin to overfill. Specifically, the worst case single failure with respect to the offsite doses is a failed-open PORV on the ruptured steam generator. The variation in operator response times in performance of the individual steps (i.e., summation of operator action times [30.5 minutes, Table 2] assumed in the analysis, and the worst case of the summation of the operator action times [34.6 minutes, Table 3]) is for the worst case for margin to overfill calculations. The three minute time increase would increase the calculated dose for this particular case by a small factor (1-2 times higher), but this case would still be well bounded by the worst case radiological dose scenario which is controlled predominantly by the time assumed to close the stuck open PORV on the ruptured steam generators. Hence, the increased operator times for the case presented have no effect

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(3) E. J. Mroczka letter to the U.S. Nuclear Regulatory Commission, "SGTR, Plant Specific Information," dated January 22, 1988.

on the estimated worst case offsite doses.

C. CONCLUSION

Since the analysis assumptions are reasonable and there is a margin available to allow for variations in operator performance, NNECO concludes that analysis results are acceptable and have no impact on the offsite doses.

TABLE 1: SEQUENCE OF EVENTS

EVENT	TIME (sec)
SG Tube Rupture	0
Reactor Trip	110
Safety Injection (SI) Actuation	338
Ruptured SG Isolated	992
Reactor Coolant System (RCS) Cooldown Initiated	1476
RCS Cooldown Terminated	2300
RCS Depressurization Initiated	2484
RCS Depressurization Terminated	2612
SI Terminated	2794
Steam Relief to Maintain RCS Subcooling	3420
Break Flow Terminated	4040

TABLE 2: KEY OPERATOR ACTION TIME INTERVALS

ACTION	TIME INTERVAL (min)
Steam Generator (SG) rupture to SG isolation	16.5
SG isolation to initiation of cooldown	8
Termination of cooldown to initiation of depressurization	3
Termination of depressurization to initiation of SI termination	3

TABLE 3

STEAM GENERATOR TUBE RUPTURE
OPERATOR ACTION TIMES

	Analysis Assumption	Ops "E"	Ops "F"	Ops "B"	Ops "C"	Ops "D"	Ops "F"	Ops "D"	Ops "D"	Ops "C"	Ops Avg.
Date		05/30/90	06/05/90	06/19/90	06/26/90	07/05/90	09/20/90	09/27/90	12/12/90	12/13/90	
Identify and Isolate Ruptured SG	16.5	13.5	16.5	10.5	22.5	13.3	13.0	12.0	16.8	13.0	14.6
Initiate Cooldown	8.0	7.0	5.5	5.5	8.0	8.5	9.0	6.0	6.3	15.0	7.9
Initiate Depress	3.0	1.0	1.0	2.2	2.6	2.4	2.0	1.0	2.2	2.0	1.8
Initiate SI Term	3.0	3.0	3.5	4.0	1.5	3.0	3.0	3.0	5.3	4.0	3.4
Total	30.5	24.5	26.5	22.2	34.6	27.3	27.0	22.0	30.4	34.0	27.6

	Analysis Assumption	Admin "B"	Admin "C"	Admin "A"	Admin "F"	Admin "D"	Admin "E"	Admin "C"	Admin "D"	Admin Avg.
Date		05/30/90	06/05/90	06/12/90	06/19/90	06/26/90	07/05/90	09/20/90	09/27/90	
Identify and Isolate Ruptured SG	16.[illegible]	18.5	15.5	19.4	11.5	14.0	26.2	14.9	1[illegible].8	17.0
Initiate Cooldown	6.0	6.5	7.0	6.8	9.0	6.0	8.2	8.2	8.0	7.5
Initiate Depress	3.0	1.0	0.5	1.2	1.0	1.0	1.6	3.5	0.5	1.3
Initiate SI Term	3.[illegible]	[illegible]	3.2	4.1	2.8	3.3	2.5	5.1	4.0	3.5
Total	30.5	29.5	26.2	31.4	24.3	24.3	38.4	31.7	28.3	29.2

TABLE 4: EVALUATED CREWS

CREW	CUMULATIVE TIME (min)
Ops "C" - 06/26/90	34.6
Ops "C" - 12/13/90	34.0
Admin "A" - 06/12/90	31.4
Admin "E" - 07/05/90	38.4
Admin "C" - 09/20/90	31.7

TABLE 5: EXTRAPOLATED RESULTS

		Analysis	Ops E	Ops F	Ops B	Ops C	Ops D	Ops F	Ops D	Ops D	Ops C
Step	Fill Rate		05/30/90	06/05/90	06/19/90	06/26/90	07/05/90	09/20/90	09/27/90	12/12/90	12/13/90
	(ft3/sec)			Time to Execute Step (min)							
Isolate	0.61	16.5	13.5	16.5	10.5	22.5	13.3	13	12	16.8	13
Cooldown	0.61	8	7	5.5	5.5	8	8.5	9	6	6.3	15
Depress	0.76	3	1	1	2.2	2.6	2.4	2	1	2.2	2
Term SI	0.49	3	3	3.5	4	1.5	3	3	3	5.3	4
Delta			-237	-168	-317	156	-126	-137	-328	-20	111

		Analysis	Admin B	Admin C	Admin A	Admin F	Admin D	Admin E	Admin C	Admin D	
Step	Fill Rate		05/30/90	06/05/90	06/12/90	06/19/90	06/26/90	07/05/90	09/20/90	09/27/90	
	(ft3/sec)			Time to Execute Step (min)							
Isolate	0.61	16.5	18.5	15.5	19.4	11.5	14	26.2	14.9	15.8	
Cooldown	0.61	8	6.5	7	6.8	9	6	8.2	8.2	8	
Depress	0.76	3	1	0.5	1.2	1	1	1.6	3.5	0.5	
Term SI	0.49	3	3.5	3.2	4.1	2.8	3.3	2.5	5.1	4	
Delta			-58	-181	12	-243	-247	282	33	-111	

TABLE 6: EXTRAPOLATED RESULTS

CREW	MARGIN TO OVERFILL (ft^3)
Ops "C" - 06/26/90	198
Ops "C" - 12/13/90	243
Admin "A" - 06/12/90	342
Admin "E" - 07/05/90	72
Admin "C" - 09/20/90	321

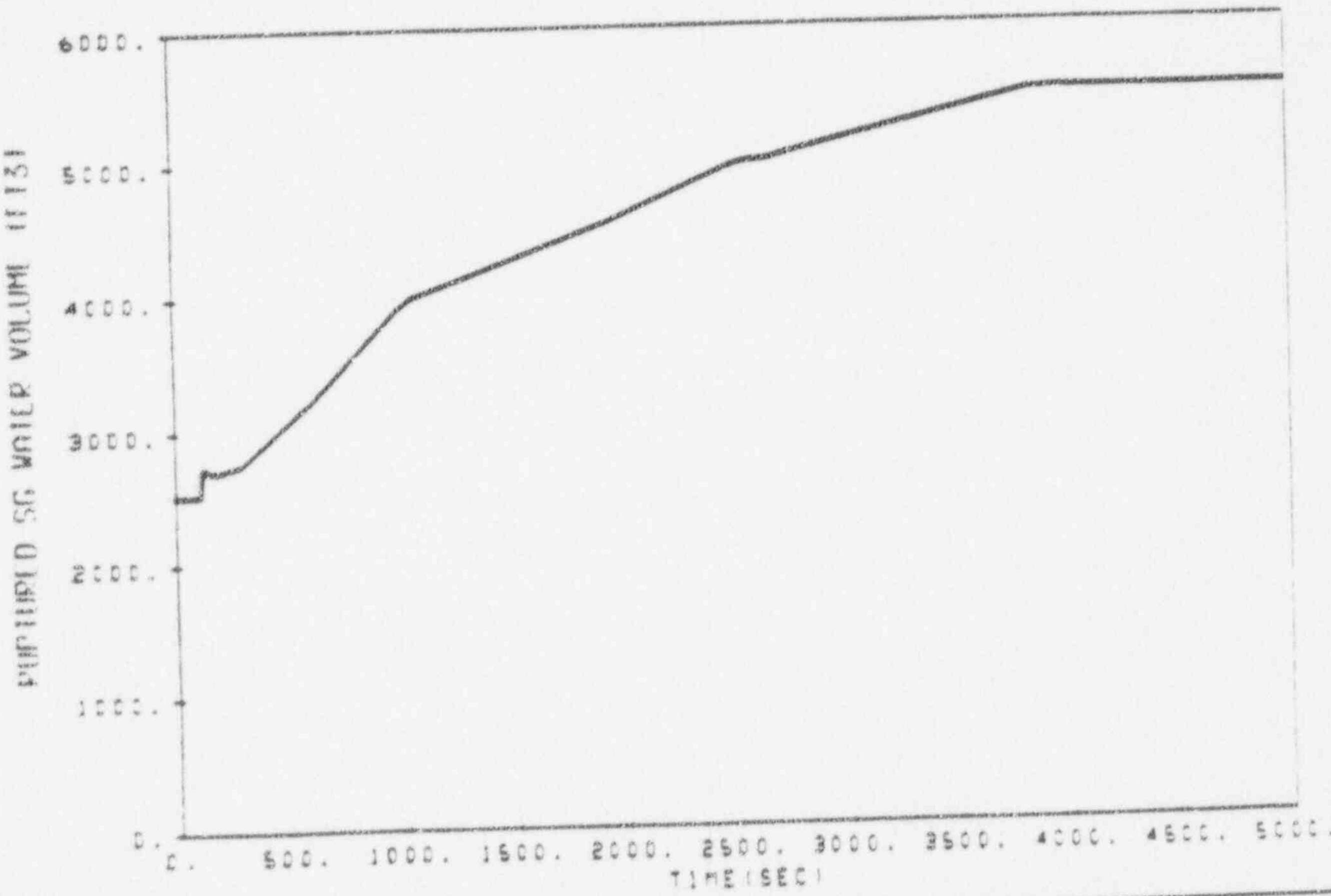

Figure 1 Ruptured SG Water Volume