UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

PDR per R. Emrit

~~OCT 15~~ 24 1983

Reference (682)

NOTE TO: W. Kane, Senior Program Manager
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SUBJECT: BACKGROUND INFORMATION RELATING TO THE ASSESSMENT OF THE OFFSITE CONSEQUENCES OF NON-CORE MELT, STEAM GENERATOR TUBE RUPTURE EVENTS

The purpose of this note is to provide backgound information on the subject of the assessment of the offsite consequences of non-core melt, steam generator tube rupture events. NRR will be prepared to discuss this subject in more detail at the October 24, 1983 CRGR meeting on this subject.

In response to CRGR's request for additional information and sensitivity analysis on the non-core melt SGTR events, we have studied several potential sources of conservatism in the analysis of SGTR following by SG overfill and failure of an SG Safety Valve.

For each class of event we reconsidered: the source of radioactive iodine (initial coolant activity and iodine spiking); primary to secondary transport; partition and water transport after leaving the secondary system; and meteorology. Table I (enclosed) summarizes the range of values and best estimate value for each of these items. The following sections discuss the bases for the values presented in Table I.

Initial Iodine Activity

The maximum and minimum values of initial primary coolant activity were chosen as 1% and 100% of the current Standard Technical Specifications (T/S) value of 1 µCi/gm. Although some plants have higher T/S limit and some exceed the T/S value for a short period of time, the 1 µ Ci/gm appears to be a reasonable upper limit for an initial value. The most recently published NRC report on fuel performance, Fuel Performance Annual Report for 1981, NUREG/CR 3001, PNL 4342, December 1982, was consulted to determine how frequently the 1 µ Ci/gm value was exceeded. We found that 9 PWRs exceeded the limit on one or more occasions for a total of 33 times. However, in every case the limit was only exceeded for a short period of time. The highest steady state operating value was approximately .5 µ Ci/gm. The best estimate value of .1 µ Ci/gm was chosen as representative of a plant operating with several failed fuel rods. While many plants run with lower coolant activity, some operate with values 2 to 5 times the best estimate value.

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Iodine Spiking

The range of iodine spiking assumption was chosen from no spiking to the Design Basis Spike of 500 times the steady state iodine production rate for two hours following a reactor trip. To establish a best estimate value, primary coolant activity values were calculated as a function of time following a reactor trip using various assumptions about the size of the iodine spike. The calculated increase in iodine concentration was then compared to the iodine spikes reported in the Fuel Performance Annual Report for 1981 (NUREG/CR-3001). Although there is considerable variation from event to event and some uncertainty about exactly when the post trip samples were taken, it appears that an iodine spike of 10% to 20% of the design basis spike is consistent with operating experience.

Primary to Secondary Iodine Transport

The transport of iodine from the primary system to the steam generator was calculated with a best estimate time dependent (finite difference) code which accounts for dilution by ECCS, mixing in the RCS, leakage to the SG, radioactive decay, cleanup (letdown and SG blowdown), partition, carryover to the condenser, feedwater addition and release to atmosphere.

Partition (and Plate-out) in the Steam Generator

The range of values presented in Table 1 actually represents best estimate values for different conditions in the steam generators. With the SG water level below the dryers and separators, the dryers and separator would be effective in capturing most of the droplets carrying the iodine. The value of .001 has been taken from "Iodine Transport Predicted for a Postulated Steam Line Break with Concurrent Rupture of Steam Generator Tubes," NUREG/CR 2659, PNL 3794, February 1983. The assumption of no partitioning (i.e., PF=1.0) for the case with the dryers and separators flooded is also taken from the above report, and represents a best estimate for these conditions.

Partition and Water Transport After Leaving the Steam Generators

The blowdown of a steam generator through a stuck open safety/relief valve will be in the form of a two phase mixture of steam and water droplets. The size of the water droplets during a high pressure blowdown is expected to be small (10 μm) based on drop size predictions made for LOCA blowdown conditions (Reference 3). A mixture with such small droplets resembles a fog or mist. For the expected range of weather conditions, droplets of such a small size would be expected to stay in suspension in the atmosphere and be carried away from the point of release. A recent analysis of iodine relased during a steam line break with a concurrent steam generator tube rupture supports this conclusion (Reference 2). In that analysis the retention on-site of liquid released from the steam generator was neglected partially based on containment system experiments. These experiments showed that only approximately 20% of the mass of water exiting from the break into the atmosphere was retained close to the point of discharge.

Meteorology

The range of X/Q values in Table I, which were used to calculate site boundary doses, represent the range from favorable conditions to typical FSAR 95% meteorology. The best estimate value was chosen to represent average conditions for a typical site. The offsite health effects (mean, latent deaths), were calculated with the CRAC code. These were best estimate calculations for the Byron site and were done in the same manner as for Final Environmental Statement reports.

Results

Table 2 (Enclosure 2) presents the calculated primary iodine inventory (RCI in curies), SG iodine inventory (SCI in curies), inventory of iodine released to atmosphere (ACI in curies) and the approximate dose for the case of a single SGTR followed by SG overfill and a stuck open SG safety valve (at 3600 seconds), with the best estimate assumptions from Table 1. Table 2 shows a total release of 105.6 curies over 6 hours with an estimated total dose of approximately 11 rem at the site boundary. Similar calculations were performed with other assumptions within the ranges shown in Table I. The overall results are presented in Table 3 (Enclosure 3).

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Enclosures:
1. Table 1
2. Table 2
3. Table 3
4. References

DISTRIBUTION	FMiraglia	LHulman, AEB
ORAB Rdg	S. Stern	TMarsh
GHolahan	WSchwink (CRGR)	EMurphy
MCaruso	MTaylor (CRGR)	

ORAB:DL	C:ORAB:DL
MCaruso:dm	GHolahan
10/19/83	10/19/83

ENCLOSURE 1

TABLE I

	RANGE		
	Least Conservative	Most Conservative	Best Estimate Value
Initial Coolant Activity	.01 μCi/gm	1 μCi/gm	.1 μμCi/gm
Iodine Spiking	none	Design Basis (500x for 2 hrs)	10 to 20% of Design Basis
Primary to Secondary Iodine Transport	--	----	best estimate calculations
Partition (and Plate-out) in SG	1.0	.001	.001 when SG level below separators 1.0 when separators flooded
Partition and Water Transport after leaving SG	.8	1.0	1.0 (iodine held in water, water transported in small droplets
Meteorology (X/Q) for Site Dose Calculations	$1x10^{-5}$	$1x10^{-3}$	$2x10^{-4}$ average meteorology
Meteorology for Estimating Health Effects	--	----	Best estimate CRAC Code Calculations

ODE VERSION = DOSE102C

ENCLOSURE 2

TABLE 2

DT = 100
T END= 21700
SC= 4.5E-06 ...... .01 MICRO CI/CC
= 0
ZMSG= 165000
PF= 1E-03
WBD= 0
LAM= 9E-07
REM/CI= .1
ZRCSC= 4.5E-05 ...... .1 MICRO CI/CC
ALPHA= 100 ...... 20 % OF DESIGN BASIS SPIKE
T SPIKE= 7200
LDOWN= 3
MRCS= 550000
SOURCE CI/SEC= 1.57275E-04

T	RCI	SCI	ACI	DOSE
0	24.75	.7425	0	0
500	31.32	1.944	0	0
1000	38.144	2.87	0	0
1500	44.764	3.979	0	0
2000	51.184	5.264	0	0
2500	57.411	6.723	0	0
3000	63.45	8.349	0	0
3500	69.307	10.137	0	0
4000	73.421	12.802	.893	.089
4500	76.298	15.823	2.681	.268
5000	78.989	18.66	4.825	.482
500	81.505	21.325	7.304	.73
000	83.857	23.827	10.097	1.009
6500	86.057	26.173	13.184	1.318
7000	88.113	28.375	16.548	1.654
7500	83.932	30.326	20.166	2.016
8000	78.546	31.727	23.983	2.398
8500	73.511	32.646	27.935	2.793
9000	68.804	33.162	31.969	3.196
9500	64.403	33.34	36.042	3.604
10000	60.288	33.237	40.115	4.011
10500	56.441	32.903	44.158	4.415
11000	52.844	32.382	48.146	4.814
11500	49.479	31.71	52.059	5.205
12000	46.335	30.917	55.879	5.587
12500	43.395	30.033	59.596	5.959
13000	40.646	29.078	63.199	6.319
13500	38.076	28.073	66.682	6.668
14000	35.673	27.033	70.039	7.003
14500	33.428	25.974	73.267	7.326
15000	31.328	24.906	76.365	7.636
15500	29.365	23.84	79.332	7.933
16000	27.53	22.783	82.169	8.216
16500	25.813	21.741	84.879	8.487
17000	24.208	20.721	87.464	8.746
7500	22.708	19.726	89.924	8.992
3000	21.305	18.757	92.265	9.226
18500	19.994	17.819	94.489	9.448
19000	18.767	16.914	96.6	9.66
19500	17.621	16.042	98.603	9.86
20000	16.349	15.204	100.503	10.05
20500	15.547	14.401	102.303	10.23
21000	14.61	13.633	104.006	10.4

ENCLOSURE 3

TABLE 3

SUMMARY OF ESTIMATED RELEASES AND DOSES FOR
THE CASE OF AN SGTR PLUS STUCK OPENED SG SAFETY VALVE

FOR BEST ESTIMATE METEOROLOGY:

	.01 μCi/gm	.1 μCi/gm	1 μCi/gm
No Iodine Spike	2 Ci/.2 rem	22 Ci/2 rem	220 Ci/22 rem
20% Iodine Spike	11 Ci/1 rem	106 Ci/10.6 rem	1058 Ci/106 rem
100% Iodine Spike	44 Ci/4 rem	444 Ci/44 rem	4445 Ci/445 rem

FOR CONSERVATIVE METEOROLOGY

	.01 μCi/gm	.1 μCi/gm	1 μCi/gm
No Iodine Spike	2 Ci/1 rem	22 Ci/11 rem	220 Ci/110 rem
20% Iodine Spike	11 Ci/5 rem	106 Ci/53 rem	1058 Ci/500 rem
100% Iodine Spike	44 Ci/20 rem	444 Ci/200 rem	4445 Ci/2223 rem

FOR FAVORABLE METEOROLOGY

	.01 μCi/gm	.1 μCi/gm	1 μCi/gm
No Iodine Spike	2 Ci/.01 rem	22 Ci/1 rem	220 Ci/1 rem
20% Iodine Spike	10 Ci/.05 rem	106 Ci/.5 rem	1000 Ci/5 rem
100% Iodine Spike	44 Ci/.2 rem	444 Ci/2 rem	4445 Ci/20 rem

ENCLOSURE 4

REFERENCES

1. Bailey, W. J.; Tokar, M.; Fuel Performance Annual Report for 1981, NUREG/CR-3001, December 1982.

2. Postma, A. K.; Hesson, G. M.; Faletti, D. W.; Iodine Transport Predicted for a Postulated Steam Line Break with Concurrent Ruptures of Steam Steam Generator Tubes, NUREG/CR-2659, February 1983.

3. Gido, R. G., and A. Koestal 1978. "LOCA-Generated Drop Size Prediction - A Thermal Fragmentation Model, Trans. Amer. Nucl. Soc., 30. 371-372.