LOFT TECHNICAL REPORT LTR 112-144

SEPTEMBER 14, 1978

OFFSITE EXPOSURE FROM FAILURE OF WASTE GAS
PROCESSING SYSTEM PIPING FAILURE

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DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

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A calculation has been performed to determine the offsite exposure to the general public in the unlikely event of the failure of Waste Gas Processing System (WGPS) piping. The consequences for this type of accident is limited by DOE 0524 with a offsite dose of 1.5 REM. As can be seen in this LTR, the doses from this accident are far in excess of the 0524 limits. Also included in this LTR is a calculation of the BST gas space contents vs. time in the event of a WGPS piping failure.

NOTE:

Since the initial writing of this report, the piping discussed inside has been upgraded to ASME Section III, Class 2 piping. With inservice inspection, this upgrade puts the accident category as extremely unlikely event. With this rating, the allowable limits are set by 10 CFR 100 as 300 rem inhalation dose to the thyroid. Conversion of the ingestion dose to inhalation dose gives an approximate dose of 540 Rem at the site boundary for the 2000 EFPH, 3 to 15 minutes release. Other doses are reduced by the same factor (~ 400). With the Class 2 piping and inservice inspection the system should be isolated within five minutes of the break to limit the offsite exposure to 10 CFR 100 limits.

Provisions to insure system isolation within five minutes is new work for FY 79 and was submitted for Change Control Board Action under Task 521617.

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AUTHOR R. B. Swartzwelder <i>R. Swartzwelder</i>		GWA NO.
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LOFT APPROVAL <i>SA&CSB Supvr. PSE PSB Mgr. C&BSS Supvr. P&CSB Mgr. RSB Mgr.</i>		

ABSTRACT

A calculation has been performed to determine the offsite exposure to the general public in the unlikely event of the failure of Waste Gas Processing System (WGPS) piping. The consequences for this type of accident is limited by DOE 0524 with a offsite dose of 1.5 REM. As can be seen in this LTR, the doses from this accident are far in excess of the 0524 limits. Also included in this LTR is a calculation of the BST gas space contents vs. time in the event of a WGPS piping failure.

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OFFSITE EXPOSURE FROM FAILURE OF WASTE GAS PROCESSING SYSTEM PIPING

1.0 INTRODUCTION

The offsite exposure resulting from the failure of the Waste Gas Processing System (WGPS) piping has been calculated. The WGPS piping rupture is assumed to occur approximately 15 minutes after a LOCE in which there is 20% fuel pin perforation. Exposures from the WGPS piping accident are calculated for several release mechanisms.

2.0 DISCUSSION OF THE PROBLEM AND METHODS OF ANALYSIS

The failure of the WGPS piping has been postulated to be potential, but unlikely accident (one/plant life). The offsite exposure has been calculated for several release modes of this accident.

The piping break of process piping downstream of the isolation valves (CV-P138-50 and 54) up and including the halogen remover⁽⁴⁾ was selected to be the most severe failure of the WGPS. If a break occurred inside containment, the release would be held inside and if the break occurred downstream of the halogen remover⁽⁴⁾, low flow and differential temperature alarms and trips would shut AOV-M1⁽⁴⁾ as well as removing the halogens from the process stream via the halogen remover and limit the consequences of an accident. At present, no automatic isolation of the system occurs if the break is between the containment and the vaults. Therefore this is the limiting break. The scoping assumptions and calculational methods of analysis were the same as those used in LTR 112-7,⁽¹⁾ "Offsite Exposure From Ruptured Waste Gas Decay Tank" except the BST gas space contents were released at 15 minutes after a LOCE and not 3×10^5 seconds (~ 3.5 days) as assumed in LTR 112-7. The BST inventory at 15 minutes was calculated and ratioed to the BST inventory at 3×10^5 seconds; this ratio was used to arrive at site boundary (10^4 meters) doses for this release time. Site boundary doses are shown in Table 1 and include dose contributions from the short half-life iodine isotopes not included in LTR 112-7.

TABLE I

OFFSITE THYROID DOSE
THYROID INGESTION EXPOSURE (REM) (*)

	<u>>15 Min Release</u>		<u>3-15 Min Release</u>	
	<u>200 EFPH</u>	<u>2000 EFPH</u>	<u>200 EFPH</u>	<u>2000 EFPH</u>
Total Dose	3.16×10^4	6.16×10^4	1.15×10^5	2.16×10^6

(*) for 15 minute decay after blowdown

3.0 SUMMARY AND CONCLUSIONS

The rupture of the WGPS piping as described previously, is classified as an unlikely situation⁽²⁾. Because of the accident classification, the guidelines in DOE 0524 for release rates apply. These guidelines limit ingestion dose at the site boundary to 1.5 Rem exposure to the thyroid.

In reviewing the dose calculated in this LTR, it is shown that the 3 to 5 minute release doses greatly exceed the DOE 0524 limits for the 200 and 2000 EFPH cases.

It is recommended that design changes be made to the present system to limit offsite exposures. Attachment A shows a calculation of LOCE blowdown gases in the BST gas space over a period of time, in the event of a WGPS pipe break. This calculation can be used to assist in the design of any system changes that may be made to reduce the consequences of a WGPS pipe break.

References

- (1) LTR 112-7, "Offsite Exposure from Ruptured Waste Gas Decay Tank", G. A. Dinneen, April 21, 1972
- (2) Kau-4-78, "Review of Postulated Pipe Rupture and Missile Hazard Evaluation"
- (3) Sketch Sk-2 for WGPS
- (4) Drawing (CV1) B695-0200

FRACTION OF LOCE BLOWDOWN GAS IN BST VS. TIME

A calculation of the fraction of blowdown gas in the BST vs time after a pipe rupture was made to help evaluate the consequences in the event of a WGPS failure.

The calculation was based on the following conditions:

Volume: 1400 ft³

Pressure_{init}: 70 psig

Pressure_{final}: Atmospheric

Pipe length: 100 ft, 3-90° bends, entrance and exit considered

Pipe diameter: 1½ inch

Break: Double ended shear

Temp_{init}: 260°F

The pressure and temperatures are per EG&G Spec. 60224

In doing the calculation, a Modified Darcy Formula

$$W = 1891 Y d^2 \sqrt{\frac{\Delta R \rho}{K}}$$

as described in Reference A-2 was used using iterative steps based on a ΔP determined for sequential steps of one minute of blowdown.

Table A-1 shows the fraction of BST contents released as a function of time for 15 minutes of the blowdown from the BST to the basement of TAN 650 or the annulus.

TABLE A-1

MASS IN BST VS TIME AFTER BREAK

Time	Mass left in BST (lbm)	% left in BST
0	448	100
1	398	89
2	346	77
3	301	67
4	272	61
5	236	53
6	204	46
7	176	39
8	152	34
9	131	29
10	113	25
11	96	21
12	80	18
13	66	15
14	53	12
15	43	10

If the assumption that the radionuclides are evenly distributed in the BST Gas Space, the line break would have to be isolated in approximately 5 minutes or less to meet the 2000 EFPH, 3 to 15 minute release case for 10 CFR 100 limits or must be isolated in much less than 1 sec. to meet DOE 0524 limits.

References

A-1 EG&G Specification 60224, "LOFT Waste Gas Cleanup System", Rev. D, April 25, 1975

A-2 "Flow of Fluids", Crane Technical Paper No. 410, Crane Company 1976