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TECHNICAL DATA REPORT

PROJECT:

DOCUMENT TITLE: TMI-1; POST ACCIDENT RMA-5 GRAB SAMPLING AND MAP-5 FILTER REMOVAL RADIOLICAL ANALYSES

ORIGINATOR SIGNATURE	DATE	APPROVAL(S) SIGNATURE	DATE
<i>M. Mahgerefteh</i>	<u>6/27/84</u>	<i>G.R. Bond</i>	<u>6-27-84</u>
		APPROVAL FOR EXTERNAL DISTRIBUTION	DATE
		<i>J. Broughton</i>	<u>7-2-84</u>

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- * P. S. Walsh
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ABSTRACT:

This report estimates the TMI-on-site radiological conditions in terms of personnel radiation exposure during the post accident condition for both grab sampling and MAP-5 filter sampling in the off-gas stream.

RESULTS AND CONCLUSION

The radiation exposure to personnel during sampling activities are:

	WHOLE BODY DOSE (REM)	EXTREMITY DOSE (REM)
NOBLE GAS SAMPLING		
• USING MARINNELI BEAKER TO CARRY THE SAMPLE	1.3(-1)	9.9(-2)
• USING 25 cc BULB TO CARRY THE SAMPLE	9.3(-2)	8.5(-3)
MAP-5 FILTER REMOVAL	1.1	6.0
NUREG-0737 LIMITS	5	75

These results demonstrate that the integrated dose for each activity, during Post Accident condition, is in compliance with NUREG-0737 limits.

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PDR ADOCK 05000289
G PDR

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1.0 INTRODUCTION

The purpose of this TDR is to estimate radiation exposures under post accident conditions for: 1) obtaining a noble gas sample at RMA-5; and 2) collecting and analyzing MAP-5 filters. Based on time-and-motion data during the post accident condition, the exposure for compliance with the radiation criteria set by NUREG-0737, II B.3 is evaluated.

The radiation source terms in this report are those as stipulated in NUREG-0737. Radiation dose rates are analyzed by using the computer code ISOSHL D II (Ref. 1), which employs a point kernel integration method.

2.0 METHODS

2.1 Dose Acceptance Criteria

Criterion of GDC19, Appendix A, 10CFR Part 50 requires that radiation protection be provided such that the dose to personnel should not be in excess of:

5 rem Whole Body

75 rem Extremities

2.2 Exposure Analysis for Obtaining Noble Gas Sample at RMA-5

2.2.1 Source Term

The source term from RMA-5 was assumed to be 100 uci/cc. This assumption was based on the design basis maximum range for capability to detect and measure concentrations of noble gas in plant gaseous effluent during and following an accident, given in Table II.F.1-1 of NUREG-0737 (Ref. 2).

For isotopic distribution, 100% noble gas and 5% iodine core inventory for 310 effective full power days were normalized to 100 uci/cc. The normalized source term are presented in Table 1.

2.2.2 Sampling Activity Scenario

The time and motion study for the post accident RMA-5 grab sampling was conducted by the plant Radiological Engineering. This study was based on the use of no protective breathing apparatus. In this report, we have assumed a 25% increase in the motion time to account for the slowdown due to the wearing the breathing apparatus.

The time and motion data of the technician moving from the radiochemistry lab to the grab sample panel and back to the lab for both with and without protective breathing apparatus are shown in Table 2.

2.2.3 Radioactive Exposure to the Personnel During RMA-5 Grab Sampling Activities

In order to account for the radioactive exposure to the personnel while conducting the post accident RMA-5 grab sampling, two cases were considered: (1) using a Marinelli beaker to carry the sample; and (2) using the 25 cc bulb.

2.2.3.1 Dose Rate Due to Piping of the Sample Panel

The piping that carry the RMA-5 gas sample consist of: (1) the piping that runs under the floor panel beneath the sample panel; (2) the piping that runs along the sample panel. The outside diameter of these piping is either 1/2 or 1/4 inch. The analysis conservatively assumed that the entire radius of the piping is filled with source term shown in Table 1, with no credit for piping wall thickness shielding.

TABLE 1
 NOBLE GAS AND IODINE CONCENTRATION NORMALIZED TO 100uCi/cc

Isotope	Normalized to 100 uCi/cc As Per NUREG-0737 (uCi/cc)
BR-84	1.685 + 0
KR-83m	1.990 + 0
-85m	4.709 + 0
-85	1.137 - 1
-87	8.599 + 0
-88	1.207 + 1
Xe-131m	9.431 - 2
-133m	6.595 - 1
-133	2.725 + 1
-135m	7.004 + 0
-135	4.494 + 0
-138	2.517 + 1
I-131	7.906 - 1
-132	9.293 - 1
-133	1.373 + 0
-134	1.720 + 0
-135	1.365 + 0
Total	100

TABLE 2
 TIME TAKEN FOR RMA-5 GRAB SAMPLING ACTIVITIES
 WITH AND WITHOUT BREATHING APPARATUS

Activity	Time Without Breathing Apparatus	Time With Breathing Apparatus
Transit time from Lab to grab sampling panel	1.5 min	2 min
Draw RMA-5 air sample to marinelli breaker	8 min	10 min
Draw RMA-5 air sample to 25cc bulb	2 min	3 min
Transit time from grab sample panel to lab	1.5 min	2 min

The dose rate, at different distances, due to sample panel piping and the piping beneath the sample panel are shown in Table 3.

2.2.3.2 Dose Rate Due to Marinelli Beaker

The marinnelli beaker is a 1640 cc container which may be used to carry the noble gas sample from the sample panel to the radiochemistry lab. Dose rates due to the marinnelli beaker when filled with sample gas, at different distances from the marinnelli beaker surface are computed and presented in Table 4.

2.2.3.3 Dose Rate Due to the 25 cc Bulb

Instead of the marinnelli beaker, a 25 cc bulb may be used to carry the noble gas sample from the sample panel to the lab. The bulb is a 25 cc container. Dose rates due to the 25 cc bulb, when filled with sample gas, at different distances from the bulb's surface are computed and presented in Table 5.

2.2.4 Radiation Exposure During Sample Analysis

The RMA-5 grab sample analysis is performed by removing the sample carrier (marinelli beaker of 25 cc bulb) from the bag, placing it in the Geiger detector, and a sample count rate is taken. Then the sample carrier is removed from the detector. The total exposure during this time will be approximately 7.84×10^{-2} whole body if the marinelli beaker is used and 6.85×10^{-2} whole body if the 25 cc bulb is used (Ref. 4). Details of these results are given below. Note that these values are based on assumption that the sample carrier is removed from the bag and placed in the detector with use of tongs.

<u>Stay time</u> <u>and work</u> <u>description</u>	<u>Radiation Source</u> <u>and Dose Rate</u> <u>(rem/hr)</u>	<u>Exposure Contribution</u> <u>(rem)</u>
20 min. to take for the sample rate count	o Airborne from containment = 2.0 (-1)	6.84(-2)
	o Containment direct shine = 5.0 (-3)	
1 min. to place and remove the sample in the detector	o Marinelli beaker (at 1 ft) = 6.08 (-2)	1.01 (-2)
	o 25 cc bulb (at 1 ft.) = 1.22 (-2)	2.03 (-4)

2.2.5 Dose Received by Personnel During Post Accident RMA-5 Grab Sample Activities

All the actions and motions by the personnel during the post accident RMA-5 grab sample activities are accounted for. The exposure for both whole body and extremities due each source are presented in Table 6. Note that the total exposure shown in Table 6a represent the exposure due to use of marinneli beaker. Table 6b represents the exposure rate due to use of 25 cc bulb for carrying the sample gas. Further, it is assumed that the technician carries the marinneli beaker or 25 cc from sample panel to lab, containing RMA-5 sample, in a bag one foot away from his body.

The integrated whole body and extremity doses during the post accident RMA-5 grab sampling activities are 1.3×10^{-1} rem and 9.9×10^{-2} rem respectively if the marinneli beaker is used to carry the sample. These values are 9.3×10^{-2} rem whole body and 8.5×10^{-3} rem extremity if the 25 cc beaker is used to carry the sample.

TABLE 3

DOSE RATE DUE TO SAMPLE PANEL PIPING (rem/hr)

Distance	<u>1 ft.</u>	<u>2 ft.</u>	<u>3 ft.</u>	<u>5 ft.</u>	<u>10 ft.</u>
Panel Piping	7.80-2	2.69-2	1.29-2	4.88-3	1.27-3
Piping Beneath the Panel	6.41-3	2.05-3	9.50-4	3.52-4	9.06-5

TABLE 4

DOSE RATE DUE TO THE MARINNELI BEAKER (rem/hr)

<u>Contact</u>	<u>1 ft.</u>	<u>2 ft.</u>	<u>3 ft.</u>	<u>5 ft.</u>	<u>10 ft.</u>
1.78+1	6.08-1	1.77-1	7.90-2	2.94-2	7.63-3

TABLE 5

DOSE RATE DUE TO THE 25 CC BULB (rem/hr)

<u>Contact</u>	<u>1 ft.</u>	<u>2 ft.</u>	<u>3 ft.</u>	<u>5 ft.</u>	<u>10 ft.</u>
1.53	1.22-2	3.17-3	1.45-3	5.41-4	1.36-4

TABLE 6A: RAD. EXPOSURE USING MARINNELI BEAKER
TO CARRY THE SAMPLE

<u>Description</u>	<u>Stay Time</u>	<u>Radiation Source</u>	<u>Radiation Level (rem/hr)</u>	<u>Rad Exposure During Work (rem)</u>
Transit from lab to grab sample panel	2 min	. Airborne from containment . Containment direct shine	2.0 (-1) 5.0 (-3)	6.8 (-3) (W.B.)
	10 min	. Airborne from containment . Containment direct shine . Marinelli Beaker	2.0 (-1) 5.0 (-3) 7.63 (-3)	3.6 (-2) (W.B.)
Draw RMA-5 Air Sample to Marinelli Beaker	9 min. & 40 sec. (10 ft. away from panel)	. Underneath Piping . Panel Piping	5.44 (-4) 1.27 (-3)	
	20 sec. (1 ft. away from panel)	. Marinelli Beaker . Underneath Piping . Panel piping	6.08 (-1) 3.26 (-2) 7.80 (-2)	
	20 sec.	. Marinelli Beaker (Contact)	1.78 (+1)	9.9 (-2) (extremity)
Transfer Marinelli Beaker to Lab.	2 min.	. Airborne from Containment . Containment Direct Shine . Marinelli Beaker (at 1 ft.)	2.0 (-1) 5.0 (-3) 3.3 (-2)	7.9 (-3) (W.B.)
Sample Analysis	20 min.	. See Section 2.3.4		7.84 (-2) (W.B.)
			Total Dose For the Task (rem)	1.3 (-1) W.B. 9.9 (-2) Extremity

TABLE 6B: RAD. EXPOSURE USING 25 CC BULB
TO CARRY THE SAMPLE

<u>Description</u>	<u>Stay Time</u>	<u>Radiation Source</u>	<u>Radiation Level (rem/hr)</u>	<u>Rad Exposure During Work (rem)</u>
Transit from lab to grab sample panel	2 min	. Airborne from containment	2.0 (-1)	6.8 (-3) (W.B.)
		. Containment direct shine	5.0 (-3)	
Draw RMA-5 Air Sample to 25 cc bulb	3 min	. Airborne from containment	2.0 (-1)	1.03 (-2) (W.B.)
		. Containment direct shine	5.0 (-3)	
		. 25 cc bulb	1.36 (-4)	
Sample to 25 cc bulb (10 ft. away from panel)	2 min. & 40 sec	. Underneath Piping	5.44 (-4)	(W.B.)
		. Panel Piping	1.27 (-3)	
Sample to 25 cc bulb (1 ft. away from panel)	20 sec.	. 25 cc Bulb	1.22 (-2)	(W.B.)
		. Underneath Piping	3.26 (-2)	
		. Panel piping	7.80 (-2)	
Transfer 25 cc bulb Basket to Lab.	20 sec.	. 25 cc Bulb (Contact)	1.53 (0)	8.5 (-3) (extremity)
		. Airborne from Containment	2.0 (-1)	
		. Containment Direct Shine	5.0 (-3)	
Sample Analysis	20 min.	. 25 cc Bulb (at 1 ft.)	1.22 (-2)	6.84 (-2) (W.B.)
		. See Section 2.3.4		
			Total Dose For the Task (rem)	9.3 (-2) W.B. 8.5 (-3) Extremity

2.3 Exposure Analysis for Obtaining the MAP-5 (at RMA-5) Filters

2.3.1 Source Term

The source term for MAP-5 filter was based 100 uci/cc of radioiodine concentration in the gaseous flow stipulated in Table II F.1-2 of NUREG-0737 (Ref. 2).

For radioiodine distribution, the iodine core inventory for 310 effective full power days were normalized to 100 uci/cc. The normalized source term are presented in Table 7. Flow rate of 3000 cc/min (Ref. 3) for 3 min flow is used. All the radioiodine in the stream is assumed to be deposited on the MAP-5 filters. The integrated activity of radioiodines deposited on the filter at 3000 cc/min for 3 min. collection time are shown in Table 7. In this study the MAP-5 filters are treated as point source.

2.3.2 Filter Removal Activity Scenario

The time and motion study for the post accident MAP-5 filter removal was conducted by the plant Radiological

TABLE 7

RADIOIODINE CONCENTRATION NORMALIZED TO 100 uci/cc

<u>Isotope</u>	<u>Normalized to 100 uci/cc As Per NUREG-0737 uCi/cc</u>	<u>Total Activity Collected in Filter for 3 min (Ci)</u>
I-131	12.7	1.15-1
I-132	15.0	1.35-1
I-133	22.6	2.01-1
I-134	27.7	2.50-1
I-135	22.0	1.99-1
Total	100	9.0-1

Engineering. This study was based on use of no protective breathing apparatus. A 25% time increase added to the motion time to account for the breathing apparatus.

The time and motion data for the technician moving from the lab to the MAP-5 panel and back to the lab for both with and without protective breathing apparatus are shown in Table 8.

2.3.3 Radioactive Exposure to the Personnel During MAP-5 Filter Removal

MAP-5 sample panel has three cartridge holders, each connected to a channel which transfer gaseous air from RMA-5 to MAP-5 filters in the cartridge holders for sampling. The flow rate through each channel is 3000 cc/min. During the 30 min sampling period, the normal settings are: channel 1, continuous sample; channel 2, 4 sec. sample, 36 sec. purge; channel 3, 4 sec. sample, 396 sec. purge (Ref. 3).

Cartridge No. 1 is enclosed in a one inch lead shielding and cartridges No. 2 and 3 are each enclosed in cartridge holders approximately 0.5 cm. shielding. During high level activity concentration in the stream, the No. 1 cartridge filter is bypassed. In this report the dose contributions due to the cartridges No. 2 and 3 are considered. According to the plant radiological engineering staff (Ref. 4), in case of a low level activity concentration in the flow, the filter cartridge is placed manually in cartridge holder No. 1.

2.3.3.1 Dose Rate Due to Piping of the MAP-5 Sample Panel

The piping that carry the sample air to MAP-5 cartridges have an outside diameter of 1/4 inch. In the analysis we have assumed that the entire radius of piping is filled with sample air with no credit taken for piping wall thickness shielding. The source term in MAP-5 piping are the same as those shown in Table 1. The dose rate, at different distances, due to the MAP-5 sample panel piping are shown in Table 9.

TABLE 8
TIME TAKEN FOR MAP-5 FILTER REMOVAL ACTIVITIES
WITH AND WITHOUT BREATHING APPARATUS

Activity	Time Without Breathing Apparatus	Time With Breathing Apparatus
Transit time from lab to MAP-5 panel	1.5 min	2 min
Time at MAP-5 panel (including time handling holder) *	4 min & 30 sec	4 min & 30 sec
Additional time in general area *	6 min	6 min
Transit time from MAP-5 panel to lab	1 min & 45 sec	2 min & 15 sec

* 25% time increase for the breathing apparatus is not added for this activity.

TABLE 9

DOSE RATE DUE TO THE MAP-5 PIPING (rem/hr)

Distance	<u>1 ft.</u>	<u>2 ft.</u>	<u>3 ft.</u>	<u>5 ft.</u>	<u>10 ft.</u>
	6.41-2	2.05-2	9.50-3	3.52-3	9.06-5

TABLE 10

DOSE RATE DUE TO THE MAP-5 FILTERS (rem/hr)

Distance	<u>Contact</u>	<u>1 ft.</u>	<u>2 ft.</u>	<u>3 ft.</u>	<u>5 ft.</u>	<u>10 ft.</u>
Cartridge No. 2 3 min collection	6.59+2	6.54+0	1.91+0	8.81-1	3.37-1	8.90-1
Cartridge No. 3 0.3 min collection	6.59+1	6.54-1	1.91-1	8.81-2	3.37-2	8.90-2

2.3.3.2 Dose Rate Due to the MAP-5 Filters

As already mentioned in this report the dose contribution due to cartridges No. 2 and 3 are considered. Cartridge No. 2, connected to channel No. 2, obtains 3 min. sample over a period of 30 min.; and cartridge No. 3, 0.3 min. out of 30 min. The flow through each channel is 3000 cc/min. The cartridges are treated as point source and the dose rate due to each cartridge at different distances from the surface of cartridge holder are shown in Table 10. No shielding credit for the thickness of the cartridge holder is taken.

2.2.4 Radiation Exposure During Sample Analysis

The MAP-5 grab sample analysis is performed by removing the sample filter from the bag, placing it in the Geil detector, and a sample count rate is taken. Then the sample filter is removed from the detector (Ref. 4). The total exposure during this time will be approximately 1.88×10^{-1} whole body. Details of these results are given below. These values are based on assumption that the sample filters are is removed from the bag and placed in the detector with use of tongs.

<u>Stay time and work description</u>	<u>Radiation Source and Dose Rate (rem/hr)</u>	<u>Exposure Contribution (rem)</u>
20 min. to take for the sample rate count	o Airborne from containment = 2.0 (-1)	6.84(-2)
	o Containment direct shine = 5.0 (-3)	
1 min to place and remove the sample in the detector	o Filter Cartridge No. 2 (at 1 ft) = 6.54	1.09 (-1)
	o Filter Cartridge No. 3 (at 2 ft.) = 6.54 (-1)	1.09 (-2)

2.3.5 Radioactive Exposure to the Personnel During Post Accident MAP-5 Filter Removal Activities

All the action and motions by the personnel during the post accident MAP-5 (at RMA-5) filter removal activities are accounted for. The exposure for both whole body and extremities due to each source are presented in Table 11. Note that it is assumed that the technician carries the MAP-5 filter cartridges in a bag one foot away from his body.

The integrated whole body and extremity doses during the post accident MAP-5 filter removal at RMA-5 are 1.1 rem and 6.0 rem respectively.

2.4 Radioactive Exposure to the Personnel During Post Accident MAP-5 (at RMA-8 and RMA-9) Filter Removal Activities

The MAP-5 for RMA-8 and RMA-9 are used for sampling Reactor Building Purge and Auxiliary and Fuel Handling Building exhaust. The function of MAP-5 at RMA-8 and RMA-9 is the same as MAP-5 at RMA-5. Since the source term for all MAP-5 is based on NUREG-0737 source term recommendation, the radioactive exposure to the personnel for MAP-5 filter removal at RMA-8 and RMA-9 is approximately the same as for MAP-5 at RMA-5 filter removal task.

TABLE 11
RAD EXPOSURE FOR MAP-5 FILTER REMOVAL ACTIVITIES

<u>Description</u>	<u>Stay Time</u>	<u>Radiation Source</u>	<u>Radiation Level (rem/hr)</u>	<u>Rad Exposure During Work (rem)</u>
Transit from lab to MAP-5 panel	2 min	. Airborne from containment	2.0 (-1)	6.8 (-3) (W.B.)
		. Containment direct shine	5.0 (-3)	
Preparation and removal of the filters	4 min & 30 sec	. Airborne from containment	2.0 (-1)	5.6 (-1) (W.B.) 6.0(+0) (Extremity)
		. Containment direct shine	5.0 (-3)	
		. Panel piping (at 1 ft.)	6.41 (-2)	
		. Cartridge No. 2 (at 1 ft.)	6.54 (+0)	
		. Cartridge No. 3 (at 1 ft.)	6.54 (-1)	
		. Cartridge No. 2 (contact, 30 sec.)	6.59 (+2)	
. Cartridge No. 3 (contact, 30 sec.)	6.59 (+1)			
Additional Time in general area	6 min	. Airborne from containment	2.0 (-1)	5.8 (-2) (W.B.)
		. Containment direct shine	5.0 (-3)	
		. Panel piping (at 5 ft.)	3.52 (-3)	
		. Cartridge No. 2 (at 5 ft.)	3.37 (-1)	
		. Cartridge No. 3 (at 5 ft.)	3.37 (-2)	
Transit from MAP-5 to lab	2 min & 15 sec	. Airborne from containment	2.0 (-1)	2.8 (-1) (W.B.)
		. Containment direct shine	5.0 (-3)	
		. Cartridge No. 2 (at 1 ft.)	6.54 (+0)	
		. Cartridge No. 3 (at 1 ft.)	6.54 (-1)	
Sample Analysis	20 min.	. See Section 2.3.4		1.9 (-1) (W.B.)
Total Dose for the Task (rem)			1.1 W.B. 6.0 Extremity	

2.5 Exposure Rate Common for RMA-5 Grab Sampling and MAP-5 Filter
Removal Activities

2.5.1 Dose Rate Due to the Airborne From the Containment

According to reference 5, the maximum exposure due to the airborne activity in the vicinity of the containment is 200 mrem/hr. This was based on Atmospheric Dilution Factor (X/Q) of 3.44×10^{-3} sec/m³ with wind speed of 0.782 m/sec and Pasquill Type of "F" condition.

Technicians are expected to follow plant procedure for protective respirator requirements (RCP-1613) to reduce inhalation doses during the sampling.

2.5.2 Dose Rate Due to the Containment Direct Shine

Radiation dose rate of 5 mrem/hr due to the containment shine used in this report was taken from reference 6.

3.0 SUMMARY OF RESULTS

The radiation exposure to the technicians during post accident conditions for RMA-5 grab sampling and MAP-5 filter removal are:

		<u>Whole Body</u> <u>(rem)</u>	<u>Extremity</u> <u>(rem)</u>
NUREG-0737		5	75
Limits			
RMA-5 grab	. using Marinelli beaker to carry the sample	1.3 (-1)	9.9 (-2)
sampling	. using 25 cc bulb to carry the sample	9.3 (-2)	8.5 (-3)
MAP-5			
filter removal		1.1 (+0)	6.0 (+0)

These values are in compliance with the limits set by NUREG-0737.

4.0 REFERENCES

1. BNWL-236, UC-34 "User's Manual for ISOSHL D Code," June, 1966
2. "Clarification of TMI Action Plan Requirements," Office of Nuclear Reactor Regulation, Division of Licensing, U.S. Nuclear Regulatory Commission (NUREG-0737)
3. TMI-1 Operating Procedure 1004.31, Rev. 9, "Airborne Radioactivity Sampling and Analysis," 1/16/84
4. Conversation with Pat Connachie (Plant Radiological Engineering)
5. GPU Calculation No. A120-5412-016 "TMI-1; Post LOCA Airborne and Direct Shine Dose," 2/1/83
6. TDR No. 529 "TMI-1; Post Accident Containment Sampling Radiological Analysis," 6/4/84, Rev. 0