

EXECUTIVE SUMMARY

Three Mile Island Nuclear Station Unit 1 Effluent and Off Site Dose Report for the Period of January 1, 1990 through June 30, 1990

This report summarizes the radioactive liquid and gaseous releases (effluents) from Three Mile Island Unit 1 and the calculated maximum hypothetical radiation exposure to the public resulting from these releases. This report covers the period of operation from January 1 through June 30, 1990.

Radiological releases from the plant are monitored by installed plant radiation monitors which survey the plant stack for gaseous releases and liquid discharges to the Susquehanna River for liquid releases. These monitors and associated sample analyses provide a means to accurately determine the type and quantities of radioactive materials being released to the environment.

Calculations of the maximum hypothetical dose to an individual and the total population around Three Mile Island due to radioactive releases from the plant are made utilizing environmental conditions existing at the time of the release. Susquehanna River flow data are used to calculate the maximum hypothetical doses to an individual and the population downstream of TMI due to liquid releases. Actual or "real-time" meteorological data from an onsite tower is used to determine the doses resulting from gaseous releases from the plant. The use of real-time meteorological information permits the determination of both the direction in which the release traveled and the dispersion of radioactive material in the environment.

Utilizing gaseous effluent data and real-time meteorology, the maximum hypothetical dose to any individual and to the total population within 50 miles of the plant is calculated. Similarly, Susquehanna River flow and liquid effluent data are used to calculate a maximum hypothetical dose to an individual and a population dose from liquid effluents for any shoreline exposure down to the Chesapeake Bay. Exposure to the public from consumption of water and fish withdrawn from the Susquehanna River downstream of the plant is also calculated.

Dose calculations for liquid and gaseous effluents are performed using a mathematical model which is based on the methods defined by the U.S. Nuclear Regulatory Commission.

The maximum hypothetical doses are conservative overestimates of the actual off site doses which are likely to occur. For example, the dose does not take into consideration the removal of radioactive material from the river water by precipitation of insoluble salts, absorption onto river sediment, biological removal, or removal during processing by water companies prior to distribution and consumption.

Liquid discharges made during the reporting period January 1 through June 30, 1990 consisted of 57.8 curies of tritium, 0.00205 curies of noble gases, predominately Kr-85, and 0.0216 curies of other beta and gamma emitters, predominately Co-58. The quantities of effluents are similar to average semiannual releases from Unit 1 operations.

During the reporting period January 1 through June 30 of 1990, the maximum hypothetical calculated whole body dose to an individual due to liquid effluents from Three Mile Island Unit 1 was about 0.11 millirem. The maximum hypothetical calculated dose to any organ of an individual was 0.15 millirem to the liver.

Airborne discharges made during this same time period consisted of 10.16 curies of tritium, 661.31 curies of noble gases, and 0.00149 curies of iodines and particulates. These quantities of effluents are also similar to semiannual releases from previous Unit 1 operation, since 1985 restart.

The maximum hypothetical calculated dose to any individual from noble gases was 0.042 mrem to the skin and 0.016 mrem to the whole body. Airborne iodine and particulates are calculated to produce 0.003 mrem to the thyroid of the maximum hypothetical individual.

The total maximum hypothetical whole body dose of 0.126 mrem, received by any individual from effluents from the Three Mile Island Nuclear Station Unit 1 during the reporting period is 400 times lower than the dose the average individual in the Three Mile Island area receives from natural background during the same time period. Natural background averages about 50 millirem whole body semiannually in the Three Mile Island area. In addition, the average equivalent dose to the total body from natural radon is about 100 millirem.

The calculated whole body population dose from all plant releases is 0.62 person-rem. This is 177,000 times lower than the dose attributed to natural background radiation for the reporting period. The doses which could have been received by the maximum hypothetical individual are each less than 4.00 percent of the annual limits established by the Nuclear Regulatory Commission in Appendix I of 10 CFR 50.

**EFFLUENT & WASTE DISPOSAL SEMIANNUAL REPORT
SUPPLEMENTAL INFORMATION**

FACILITY: TMI UNIT 1

LICENSE: DPR 50-289

1. **REGULATORY LIMITS:- - - REFER TO TMI UNIT 1 TECHNICAL SPECIFICATIONS**
 - A. FISSION AND ACTIVATION GASES:
 - B. IODINES:
 - C. PARTICULATES, HALF-LIVES > 8 DAYS:
 - D. LIQUID EFFLUENTS:

2. **MAXIMUM PERMISSIBLE CONCENTRATIONS:- - - 10 CFR 20, APPENDIX B TABLE II
PROVIDE THE MPCs USED IN DETERMINING ALLOWABLE RELEASE
RATES OR CONCENTRATIONS.**
 - A. FISSION AND ACTIVATION GASES:
 - B. IODINES:
 - C. PARTICULATES, HALF-LIVES > 8 DAYS:
 - D. LIQUID EFFLUENTS:

3. **AVERAGE ENERGY:**
 PROVIDE THE AVERAGE ENERGY (E-BAR) OF THE RADIONUCLIDE
 MIXTURE IN RELEASES OF FISSION AND ACTIVATION GASES, IF APPLICABLE

 E-BAR BETA=3.53E-01/E-BAR GAMMA=8.97E-01 E-BAR BETA AND GAMMA = 1.25E+00

4. **MEASUREMENTS AND APPROXIMATIONS OF TOTAL RADIOACTIVITY:**
 PROVIDE THE METHODS USED TO MEASURE OR APPROXIMATE THE TOTAL RADIOACTIVITY
 IN EFFLUENTS AND THE METHODS USED TO DETERMINE RADIONUCLIDE COMPOSITION:
 - A. FISSION AND ACTIVATION GASES: HpGe SPECTROMETRY, LIQUID SCINTILLATION.
 - B. IODINES: HpGe SPECTROMETRY.
 - C. PARTICULATES: HpGe SPECTROMETRY, GAS FLOW PROPORTIONAL,
BETA SPECTROMETRY.
 - D. LIQUID EFFLUENTS: HpGe SPECTROMETRY, LIQUID SCINTILLATION.

5. **BATCH RELEASES:**
 PROVIDE THE FOLLOWING INFORMATION RELATING TO BATCH RELEASES OF
 RADIOACTIVITY MATERIALS IN LIQUID AND GASEOUS EFFLUENTS.

	QUARTER 1	QUARTER 2
A. LIQUID		
1. NUMBER OF BATCH RELEASES:	44	17
2. TOTAL TIME PERIOD FOR BATCH RELEASES: (MIN.)	17945.	4798.
3. MAXIMUM TIME PERIOD FOR A BATCH RELEASE: (MIN.)	950.	332.
4. AVERAGE TIME PERIOD FOR BATCH RELEASES: (MIN.)	408.	282.
5. MINIMUM TIME PERIOD FOR A BATCH RELEASE: (MIN.)	145.	245.
6. AVERAGE STREAM FLOW DURING PERIODS OF RELEASE OF EFFLUENT INTO A FLOWING STREAM: (CFM)	2.9E+06	2.41E+06
B. GASEOUS		
1. NUMBER OF BATCH RELEASES:	13	10
2. TOTAL TIME PERIOD FOR BATCH RELEASES: (MIN.)	23745.	7123.
3. MAXIMUM TIME PERIOD FOR A BATCH RELEASE: (MIN.)	1140.	900.
4. AVERAGE TIME PERIOD FOR BATCH RELEASES: (MIN.)	720.	712.
5. MINIMUM TIME PERIOD FOR A BATCH RELEASE: (MIN.)	1.	10.
6. ABNORMAL RELEASES		
A. LIQUID		
1. NUMBER OF RELEASES:	-0-	-0-
2. TOTAL ACTIVITY RELEASED: (CURIES)	N/A	N/A
B. GASEOUS		
1. NUMBER OF RELEASES:	-0-	-0-
2. TOTAL ACTIVITY RELEASED: (CURIES)	N/A	N/A

TABLE 1A
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1990)
GASEOUS EFFLUENTS-SUMMATION OF ALL RELEASES

UNIT	QUARTER 1	QUARTER 2	EST. TOTAL ERROR, %
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A. FISSION AND ACTIVATION GASES

1. TOTAL RELEASE	CI	6.60E+02	1.33E+00	2.50E+01
2. AVG. RELEASE RATE FOR PERIOD	uCi/s	8.49E+01	1.67E-01	
3. PERCENT OF TECH. SPECIFICATION LIMIT	%	*	*	

B. IODINES

1. TOTAL IODINE I-131	CI	1.48E-03	6.77E-06	2.50E+01
2. AVG. RELEASE RATE FOR PERIOD	uCi/s	1.90E-04	8.61E-07	
3. PERCENT OF TECH. SPECIFICATION LIMIT	%	*	*	

C. PARTICULATES

1. PART. WITH HALF- LIVES > 8 DAYS	CI	1.27E-07	<1.00E-04	2.50E+01
2. AVG. RELEASE RATE FOR PERIOD	uCi/s	1.64E-08	NA	
3. PERCENT OF TECH. SPECIFICATION LIMIT	%	*	NA	
4. GROSS ALPHA RADIOACTIVITY	CI	<1.00E-11	<1.00E-11	

D. TRITIUM

1. TOTAL RELEASE	CI	5.01E+00	5.15E+00	2.50E+01
2. AVG. RELEASE RATE FOR PERIOD	uCi/s	6.45E-01	6.55E-01	
3. PERCENT OF TECH. SPECIFICATION LIMIT	%	*	*	

NOTE: ALL LESS THAN VALUES (<) ARE IN uCi/cc.

*% TECH. SPEC. LIMITS: LISTED ON DOSE SUMMARY TABLE.

TABLE 1C
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1990)
GASEOUS EFFLUENTS-GROUND-LEVEL RELEASES

CONTINUOUS MODE

BATCH MODE

NUCLIDES RELEASED	UNIT	QUARTER 1	QUARTER 2	QUARTER 1	QUARTER 2
1. FISSION GASES					
AR 41	CI	5.79E-02	5.65E-02	2.85E-01	2.36E-01
KR 85	CI	<8.00E-06	<8.00E-06	8.69E-01	1.98E-02
KR 85M	CI	3.12E-02	1.92E-03	6.97E-01	4.45E-04
KR 87	CI	2.98E-02	1.16E-03	5.88E-02	<8.00E-08
KR 88	CI	5.79E-02	2.70E-04	5.69E-01	<1.00E-07
XE 131M	CI	<3.00E-07	<3.00E-07	4.49E+00	1.52E-03
XE 133	CI	1.16E+00	7.19E-02	6.32E+02	6.94E-01
XE 133M	CI	1.64E-02	<2.00E-07	5.11E+00	4.12E-03
XE 135	CI	3.36E-01	9.64E-02	1.37E+01	3.05E-02
XE 135M	CI	7.94E-02	9.70E-02	7.65E-08	<5.00E-07
XE 138	CI	2.12E-02	<3.00E-07	<3.00E-07	<3.00E-07
TOTAL FOR PERIOD	CI	1.79E+00	3.25E-01	6.58E+02	9.86E-01

2. IODINES

I 131	CI	3.06E-04	6.76E-06	1.17E-03	<1.00E-08
I 133	CI	1.95E-04	8.74E-05	1.15E-06	3.62E-07
I 135	CI	9.99E-06	<1.00E-10	7.65E-08	<1.00E-10
TOTAL FOR PERIOD	CI	5.11E-04	9.41E-05	1.18E-03	3.62E-07

3. PARTICULATES

CO 58	CI	<1.00E-12	<1.00E-12	2.28E-08	<1.00E-12
CS 134	CI	<1.00E-11	<1.00E-11	4.80E-08	<1.00E-11
CS 137	CI	<1.00E-11	<1.00E-11	5.66E-08	<1.00E-11

NOTE: ALL LESS THAN VALUES (<) ARE IN uCi/cc.

TABLE 2A
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1990)
LIQUID EFFLUENTS-SUMMATION OF ALL RELEASES

UNIT	QUARTER 1	QUARTER 2	EST. TOTAL ERROR, %
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A. FISSION AND ACTIVATION PRODUCTS

1. TOTAL RELEASE (EX. H-3, GASES, ALPHA)	CI	1.93E-02	2.30E-03	2.50E+01
2. AVG. DILUTED CONC. DURING PERIOD	uCi/ml	1.35E-09	1.99E-10	
3. PERCENT OF APPLICABLE LIMIT	%	*	*	

B. TRITIUM

1. TOTAL RELEASE	CI	4.11E+01	1.67E+01	2.50E+01
2. AVG. DILUTED CONC. DURING PERIOD	uCi/ml	2.87E-06	1.44E-06	
3. PERCENT OF APPLICABLE LIMIT	%	*	*	

C. DISSOLVED AND ENTRAINED GASES

1. TOTAL RELEASE	CI	2.05E-03	<1.00E-04	2.50E+01
2. AVG. DILUTED CONC. DURING PERIOD	uCi/ml	1.43E-10	0.00E+00	
3. PERCENT OF APPLICABLE LIMIT	%	*	*	

D. GROSS ALPHA RADIOACTIVITY

1. TOTAL RELEASE	CI	<1.00E-07	<1.00E-07	2.50E+01
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E. VOL. OF WASTE RELEASED (NO DIL.)	LITERS	1.64E+07	1.04E+07	1.00E+01
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F. VOL. OF DILUTION WATER DURING PERIOD	LITERS	1.43E+10	1.16E+10	1.00E+01
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NOTE: ALL LESS THAN VALUES (<) ARE IN uCi/ml.

*% TECH. SPEC. LIMITS: LISTED ON DOSE SUMMARY TABLE.

TABLE 2B
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1990)
LIQUID EFFLUENTS

CONTINUOUS MODE				BATCH MODE	
NUCLIDES RELEASED	UNIT	QUARTER 1	QUARTER 2	QUARTER 1	QUARTER 2
CR 51	CI	<5.00E-07	<5.00E-07	1.23E-04	<5.00E-07
MN 54	CI	<1.00E-06	<1.00E-06	4.32E-05	<1.00E-06
FE 55	CI	<5.00E-07	<5.00E-07	4.95E-04	1.09E-03
CO 58	CI	3.11E-04	<5.00E-07	7.23E-03	7.82E-04
FE 59	CI	<5.00E-07	<5.00E-07	3.02E-05	1.16E-05
CO 60	CI	<5.00E-07	<5.00E-07	1.83E-04	1.19E-05
ZN 65	CI	<5.00E-07	<5.00E-07	<5.00E-07	<5.00E-07
SR 89	CI	<5.00E-07	<5.00E-07	1.91E-05	<5.00E-07
SR 90	CI	<1.00E-06	<1.00E-06	<1.00E-06	<1.00E-06
NB 95	CI	<5.00E-07	<5.00E-07	6.21E-05	<5.00E-07
ZR 95	CI	<5.00E-07	<5.00E-07	9.00E-06	<5.00E-07
AG 110M	CI	<5.00E-07	<5.00E-07	1.99E-04	2.65E-05
SB 125	CI	<5.00E-07	<5.00E-07	5.51E-04	<5.00E-07
I 131	CI	6.70E-04	<5.00E-07	8.39E-04	<5.00E-07
CS 134	CI	3.02E-03	<5.00E-07	4.56E-04	5.92E-05
CS 137	CI	4.06E-03	2.14E-04	1.03E-03	1.12E-04
LA 140	CI	<5.00E-07	<5.00E-07	7.14E-06	<5.00E-07
TOTAL FOR PERIOD	CI	8.06E-03	2.14E-04	1.13E-02	2.09E-03
KR 85	CI	<1.00E-04	<1.00E-04	2.05E-03	<1.00E-04

NOTE: ALL LESS THAN VALUES (<) ARE IN uCi/ml.

TMI-1 EFFLUENT & WASTE DISPOSAL SEMIANNUAL REPORT
January 1, 1990 - June 30, 1990

TABLE 3A
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. Solid waste shipped off-site for burial or disposal (not irradiated fuel)

1. Type of waste	UNIT	6 month period	EST. TOTAL ERROR %
a. Spent resins, filter sludges, evaporator bottoms, etc.	m ³ Ci	78.25 m ³ 641.7 Ci	5%
b. Dry compressible waste, contaminated equipment, etc.	m ³ Ci	354.6 m ³ 5.04 Ci	5%
c. Irradiated components, control rods, etc.	m ³ Ci	N/A	N/A
d. Other (describe)	m ³ Ci	N/A	N/A

2. Estimate of major nuclide composition (by type of waste)		
a. Cs ¹³⁷		
Cs ¹³⁴	47.6 %	
Co ⁵⁸	29.4 %	
Ni ⁶³	10.34 %	
	4.71 %	
b. I ¹³¹		
Ni ⁶³	32.31 %	
Cs ¹³⁷	13.86 %	
Co ⁵⁸	12.98 %	
Fe ⁵⁵	12.73 %	
c.	10.74 %	
	%	
	%	
	%	
	%	
	%	
d.	%	
	%	
	%	
	%	
	%	

3. Solid Waste Disposition	Mode of Transportation	Destination
Number of Shipments		
See Attached		

B. Irradiated Fuel Shipments (Disposition)

Number of Shipments	Mode of Transportation	Destination
N/A		

TMI-1 EFFLUENT & WASTE DISPOSAL SEMIANNUAL REPORT

January 1, 1990 through June 30, 1990

Table A.3.a

<u>No. of Shipments</u>	<u>Mode of Transportation</u>	<u>Destination</u>
Four (4) Shipments	Tractor - Cask (HN-100 Series 3)	Chem-Nuclear-Barnwell, SC
Three (3) Shipments	Tractor - Flatbed	US Ecology-Richland, WA
*Two (2) Shipments	Tractor - Flatbed	Scientific Ecology Group- Oak Ridge, TN

Table A.3.b

<u>No. of Shipments</u>	<u>Mode of Transportation</u>	<u>Destination</u>
One (1) Shipment	Tractor-Flatbed	US Ecology-Richland WA
*Nine (9) Shipments	Tractor-Flatbed	Scientific Ecology Group Oak Ridge, TN

WASTE SHIPPED AS FOLLOWS:

Table A.1.a:

Four (4) Radlok 500 High Integrity Containers at 135.8 Ft.³ Each
 Three (3) Steel Liners at 170 Ft.³ Each
 Three (3) Steel Liners at 178 Ft.³ Each - Solidified with Cement
 *Six (6) Steel Liners at 196 Ft.³ Each

Table A.1.b:

*Twelve (12) 8' x 8' x 20' Cargo Containers at 1,040 Ft.³ Each
 One (1) Steel Box at 44 Ft.³

*Material Sent Off-Site to a Waste Processor for Volume Reduction

INTERPRETATION OF DOSE SUMMARY TABLE

The Dose Summary Table presents the maximum hypothetical doses to an individual and the general population resulting from the release of gaseous and liquid effluents from TMI-1 during the first half reporting period of 1990.

A. Liquid (Individual)

The first two lines present the maximum hypothetical dose to an individual. Presented are the whole body and critical organ doses. Calculations are performed on the four age groups and eight organs recommended in Regulatory Guide 1.109. The pathways considered for TMI are drinking water, irrigated cow milk, irrigated goat milk, irrigated beef, consumption of fish, and standing on the shoreline influenced by TMI effluents. The latter two pathways are considered to be the primary recreational activities associated with the Susquehanna River in the vicinity of TMI. The irrigation pathways apply to the sewage sludge. The "receptor" would be that individual who consumes water from the Susquehanna River and fish residing in the plant discharge, while occupying an area of shoreline influenced by the plant discharge and consuming the milk and beef fed irrigated vegetation.

After calculating the doses to all age groups for all eight organs resulting from the three pathways described above, the Dose Summary Table presents the maximum whole body dose and affected age group along with the organ and associated age group that received the largest dose.

For the first half of 1990 the calculated maximum whole body dose received by anyone would have been 0.11 mrem to an adult. Similarly, the maximum organ dose would have been 0.15 mrem to the liver of a teen.

B. Gaseous (Individual)

There are seven major pathways considered in the dose calculations for gaseous effluents. These are: (1) plume, (2) inhalation, consumption of (3) cow milk, (4) goat milk, (5) vegetables, (6) meat, and (7) standing on contaminated ground.

Lines 3 and 4 present the maximum plume exposure at or beyond the site boundary. The notation of "air dose" is interpreted to mean that these doses are not to an individual, but are considered to be the maximum dose that would have occurred at or beyond the site boundary. The Dose Summary Table presents the distance in meters to the location in the affected sector (compass point) where the theoretical maximum plume exposure occurred. It should be noted that real-time meteorology was used in all dose calculations for gaseous effluents. Lines 5 and 6 present the dose which could actually be received by an individual from the noble gas effluents for the first half of 1990. The calculated maximum whole body dose received by anyone from noble gases would have been 0.016 mrem. Similarly, the maximum dose to the skin would have been 0.042 mrem.

The iodines and particulates section described in line 7 represents the maximum exposed organ due to iodine and particulates. This does not include any whole body plume exposure which would be separated out by lines 5 and 6. The doses presented in this section again reflect the maximum exposed organ for the appropriate age group.

The first half 1990 iodines and particulates would have resulted in a maximum dose of $3.0E-3$ mrem to the thyroid of an infant residing 580 meters from the site in the WNW sector. No other organ of any age group would have received a greater dose.

C. Liquid and Gaseous (Population)

Lines 8 - 11 present the person-rem doses resulting from the liquid and gaseous effluents. These doses are summed over all pathways and the affected populations. Liquid person-rem is based upon the population encompassed within the region from the TMI outfall extending down to the Chesapeake Bay. The person-rem for gaseous effluents are based upon the 1980 population and consider the population out to a distance of 50 miles around TMI. Population doses are summed over all distances and sectors to give an aggregate dose.

Based upon the calculations performed for the first half of 1990, liquid effluents resulted in a whole body population dose of 0.39 person-rem. The maximum critical organ population dose to the thyroid was 0.54 person-rem. Gaseous effluents resulted in a whole body population dose of 0.23 person-rem. Maximum critical organ population dose to the skin was 0.47 person-rem.

TABLE 1

UNIT 1
First Half 1990 Dose Report

SUMMARY OF MAXIMUM INDIVIDUAL DOSES FOR UNIT 1 FROM
January 1, 1990 through June 30, 1990

Effluent	Applicable Organ	Estimated Dose (mrem)	Age Group	Location		% of Applicable Limit		Technical Specification Limits (mrem)	
				Dist (m)	Dir (toward)	Quarterly	Annual	Quarterly	Annual
(1) Liquid	Total Body	0.11	Adult	Receptor 1		7.3	3.7	1.5	3.0
(2) Liquid	Liver	0.15	Teen	Receptor 1		3.0	1.5	5.0	10.0
(3) Noble Gas	Air Dose (gamma-mrad)	0.032	---	2000	NNE	0.64	0.32	5.0	10.0
(4) Noble Gas	Air Dose (beta-mrad)	0.087	---	2000	NNE	0.87	0.44	10.0	20.0
(5) Noble Gas	Total Body	0.016	All	2150	NNE	---	---	---	---
(6) Noble Gas	Skin	0.042	All	2150	NNE	---	---	---	---
(7) Iodine & Particulates	Thyroid	3.0E-3	Infant	580	WNW	0.040	0.020	7.5	15.0

SUMMARY OF MAXIMUM POPULATION DOSES FOR UNIT 1 FROM
January 1, 1990 through June 30, 1990

Effluent	Applicable Organ	Estimated Population Dose (person-rem)
(8) Liquid	Total Body	0.39
(9) Liquid	Thyroid	0.54
(10) Gaseous	Total Body	0.23
(11) Gaseous	Skin	0.47