TABLE OF CONTENTS

Amendment No. 11, 72, 129, 137, 142, 150, 155

TABLE OF CONTENTS

Amendment No. 11, 47, 72, 77, 129, 150

LIST OF TABLES

Amendment No. 59, 72, 100, 106, 118, 137, 142, 147, 150

1.9 DELETED

1.10 DELETED

1.11 DELETED

1.12 DOSE EQUIVALENT I-131

The DOSE EQUIVALENT I-131 shall be that concentration of I-131 (microcurie/gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134 and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID 14844, "Calculation of Distance Factors for Power and Test Reactor Sites". [Or in Table E-7 of NRC Regulatory Guide 1.109, Revision 1, October 1977.]

1.13 SOURCE CHECK

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

1.14 DELETED

1.15 OFFSITE DOSE CALCULATION MANUAL (ODCM)

The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluent, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Environmental Radiological Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Section 6.8.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Semi-annual Radioactive Effluent Release Reports required by Specifications 6.9.3 and 6.9.4.

1.16 PROCESS CONTROL PROGRAM (PCP)

The PROCESS CONTROL PROGRAM (PCP) shall contain the current formulas, sampling, analyses, test, and determinations to be made to ensure that processing and packaging of solid ioactive wastes based on demonstrated processing of actual or simulated wet d wastes will be accomplished in such a way as to assure compliance with J FR Parts 20, 61, and 71, State regulations, burial ground requirements, and her requirements governing the disposal of solid radioactive waste.

1.17 GASEOUS RADWASTE TREATMENT

The GASEOUS RADWASTE TREATMENT SYSTEM is the system designed and installed to reduce radioactive gaseous effluent by collecting primary coolant system off gases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

1.18 VENTILATION EXHAUST TREATMENT SYSTEM

A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluent by passing ventilation or vent exhaust gases through charcoal absorbers and/or HEPA filters for the purpose of removing iodine or particulates from the gaseous exhaust system prior to the release to the environment. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEMS.

1.19 PURGE - PURGING

PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating conditions in such a manner that replacement air or gas is required to purify the confinement.

1.20 VENTING

VENTING is the controlled process of discharging air as gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating conditions in such a manner that replacement air or gas is not provided. Vent used in system name does not imply a VENTING process.

1.21 REPORTABLE EVENT

A REPORTABLE EVENT shall be any of those conditions specified in 10 CFR 50.73.

1.22 MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the GPU System, GPU contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries.

.23 SUBSTANTIVE CHANGES

SUBSTANTIVE CHANGES are those which affect the activities associated with a document or the document's meaning or intent. Examples of non-substantive changes are: (1) correcting spelling; (2) adding (but not deleting) sign-off spaces; (3) blocking in notes, cautions, etc.; (4) changes in corporate and personnel titles which do not reassign responsibilities and which are not referenced in the Appendix A Technical Specifications; and (5) changes in nomenclature or editorial changes which clearly do not change function, meaning or intent.

1.24 CORE OPERATING LIMITS REPORT

The CORE OPERATING LIMITS REPORT is a TMI-1 specific document that provides core operating limits for the current operating reload cycle. These cycle-specific core operating limits shall be determined for each reload cycle in accordance with Specification 6.9.5. Plant operation within these operating limits is addressed in individual specifications.

1.25 FREQUENCY NOTATION

The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 1.2. All Surveillance Requirements shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the surveillance interval.

TABLE 1.2

FREQUENCY NOTATION

NOTATION	FREQUENCY
S	Shiftly (once per 12 hours)
D	Daily (once per 24 hours)
W	Weekly (once per 7 days)
M	Monthly (once per 31 days)
Q	Quarterly (once per 92 days)
S/A	Semi-Annually (once per 184 days)
R	Refueling Interval
P S/U	Prior to each reactor startup, if not done during the previous 7 days
P	Completed prior to each release
N/A (NA)	Not applicable
E	Once per 18 months

1.25 FREQUENCY NOTATION

Bases

Section 1.25 establishes the limit for which the specified time interval for Surveillance Requirements may be extended. It permits an allowable extension of the normal surveillance interval to facilitate surveillance scheduling and consideration of plant operating conditions that may not be suitable for conducting the surveillance; e.g., transient conditions or other ongoing surveillance or maintenance activities. It also provides flexibility to accommodate the length of a fuel cycle for surveillance that are performed at each refueling outage and are specified with a fuel cycle length surveillance interval. It is not intended that this provision be used repeatedly as a convenience to extend surveillance intervals beyond that specified for surveillance that are not performed during refueling outages. The limitation of Section 1.25 is based on engineering judgement and the recognition that the most probable result of any particular surveillance being performed is the verification of conformance with the Surveillance Requirements. This provision is sufficient to ensure that the reliability ensured through surveillance activities is not significantly degraded beyond that obtained from the specified surveillance interval.

3.22 RADIOACTIVE EFFLUENT

3.22.1 LIQUID EFFLUENT

3.22.1.1 CONCENTRATION

LIMITING CONDITION FOR OPERATION

3.22.1.1 The concentration of radioactive material released at anytime from the unit to unrestricted areas (see Figure 5-3) shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 3×10^{-3} uCi/cc total activity.

APPLICABILITY: At all times

ACTION:

With the concentration of radioactive material released from the unit to unrestricted areas exceeding the above limits, immediately restore concentration within the above limits.

BASES

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluent from the unit to unrestricted areas will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table II. This limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will not result in exposures with (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC and (2) the limits of 10 CFR Part 20.106 (e) to the population. The concentration limit for noble gases is based upon the assumption the Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

RADIOACTIVE EFFLUENT

3.22.2 GASEOUS EFFLUENT

3.22.2.1 DOSE RATE

LIMITING CONDITION FOR OPERATIONS

3.22.2.1 The dose rate due to radioactive materials released in gaseous effluent from the site (see Figure 5-3) shall be limited to the following:

a. For noble gases: less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin, and

b. For I-131, I-133, tritium and all radionuclides in particulate form with half lives greater than 8 days: less than or equal to 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTION:

With the release rate(s) exceeding the above limits, immediately decrease the release rate to comply with the above limit(s).

BASES

The specification is provided to ensure that the release rate at anytime at the site boundary from gaseous effluent from all units on the site will be within the annual dose limits of 10 CFR Part 20 for unrestricted areas. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II. These limits provide reasonable assurance that radioactive material discharged in gaseous effluent will not result in the exposure of a MEMBER OF THE PUBLIC in an unrestricted area, either within or outside the site boundary, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR Part 20.106(b)). For MEMBERS OF THE PUBLIC who may at times be within the site boundary, the occupancy of the MEMBER OF THE PUBLIC will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the exclusion area boundary. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the site boundary to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the cow-milk pathway to less than or equal to 1500 mrem/year for the nearest cow to the plant.

3.22.3 SOLID RADIOACTIVE WASTE

LIMITING CONDITION FOR OPERATION

DELETED

3.23 RADIOLOGICAL ENVIRONMENTAL MONITORING

3.23.1 MONITORING PROGRAM

LIMITING CONDITION FOR OPERATION

DELETED

TABLE 3.23-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

DELETED

RADIOLOGICAL ENVIRONMENTAL MONITORING

3.23.2 LAND USE CENSUS

LIMITING CONDITION FOR OPERATION

DELETED

TABLE 3.23-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS
IN ENVIRONMENTAL SAMPLES

DELETED

RADIOLOGICAL ENVIRONMENTAL MONITORING

3.23.3 INTERLABORATORY COMPARISON PROGRAM

LIMITING CONDITION FOR OPERATION

DELETED

4.22.3 SOLID RADIOACTIVE WASTE

SURVEILLANCE REQUIREMENTS

4.22.3.1 SOLID RADWASTE SYSTEM

DELETED

4.22.3.2 PROCESS CONTROL PROGRAM

DELETED

4.22.4 TOTAL DOSE

SURVEILLANCE REQUIREMENT

4.22.4.1 DOSE CALCULATION

Cumulative annual dose contributions from liquid and gaseous effluents shall be determined in accordance with TS 4.22.1.2, 4.22.2.2 and 4.22.2.3, including direct radiation contributions from the Unit and from outside storage tanks, and in accordance with the methodology contained in the ODCM.

(Pages 4-109 to 4-116 intentionally blank)

4.23.1

DELETED

TABLE 4.23-1

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

DELETED

4.23.2

DELETED

4.23.3

DELETED

6.8 PROCEDURES AND PROGRAMS

6.8.1 Written procedures shall be established, implemented and maintained covering the items referenced below:

a. The applicable procedures recommended in Appendix "A" of Regulatory Guide 1.33, Revision 2, February 1978.

b. Surveillance and test activities of equipment that affects nuclear safety and radioactive waste management equipment.

c. Refueling Operations.

d. Security Plan Implementation.

e. Fire Protection Program Implementation.

f. Emergency Plan Implementation.

g. Process Control Program Implementation.

h. Offsite Dose Calculation Manual Implementation.

i. Quality Assurance Program for effluent and environmental monitoring using the guidance in Regulatory Guide 4.15, Revision 1.

j. Plant Staff Overtime, to limit the amount worked by staff performing safety-related functions in accordance with NRC Policy Statement on working hours (Generic Letter No. 82-12).

6.8.2 Further, each procedure required by 6.8.1 above, and substantive changes thereto, shall be reviewed and approved as described in 6.5.1 prior to implementation and shall be reviewed periodically as set forth in administrative procedures.

6.8.3 Temporary changes to procedures of 6.8.1 above may be made provided:

a. The intent of the original procedure is not altered;

b. The change is approved by two members of GPUNC Management Staff qualified in accordance with 6.5.1.14 and knowledgeable in the area affected by the procedure. For changes which may affect the operational status of unit systems or equipment, at least one of these individuals shall be a member of unit management or supervision holding a Senior Reactor Operator's License on the unit.

c. The change is documented, reviewed and approved as described in 6.5.1 within 14 days of implementation.

6.8.4 Radiological Environmental Monitoring Program

A program shall be provided to monitor the radiation and radionuclides in the environs of the plant. The program shall provide (1) representative measurements of radioactivity in the highest potential exposure pathways, and (2) verification of the accuracy of the effluent monitoring program and modeling of environmental exposure pathways. The program shall (1) be contained in the ODCM, (2) conform to the guidance of Appendix I to 10 CFR Part 50, and (3) include the following:

(1) Monitoring, sampling, analysis, and reporting of radiation and radionuclides in the environment in accordance with the methodology and parameters in the ODCM,

(2) A Land Use Census to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census, and

(3) Participation in an Interlaboratory Comparison Program to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

6.9.3 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

6.9.3.1 The Annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year.

The Report shall include summaries, interpretations, and an analysis of trends of the results of the Radiological Environmental Monitoring Program for the reporting period. The material provided shall be consistent with the objectives outlined in: (1) the ODCM; and, (2) Sections IV.B.2, IV.B.3, and IV.C of Appendix I to 10 CFR Part 50.

Note: A single submittal may be made for the station.

6.9.4 SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

6.9.4.1 The Semiannual Radioactive Effluent Release Report covering the operations of the unit during the previous 6 months of operation shall be submitted within 60 days after January 1 and July 1 of each year.

The Report shall include a summary of the quantities of radioactive liquid and gaseous effluent and solid waste released from the unit. The material provided shall be: (1) consistent with the objectives outlined in the ODCM and PCP; and, (2) in conformance with 10 CFR 50.36(a) and Section IV.B.1 of Appendix I to 10 CFR Part 50.

Note: A single submittal may be made for the station. The submittal should combine those sections that are common to both units at the station.

6.9.5 CORE OPERATING LIMITS REPORT

6.9.5.1 The core operating limits addressed by the individual Technical Specifications shall be established and documented in the CORE OPERATING LIMITS REPORT prior to each reload cycle or prior to any remaining part of a reload cycle.

6.9.5.2 The analytical methods used to determine the core operating limits addressed by the individual Technical Specifications shall be those previously reviewed and approved by the NRC for use at TMI-1, specifically:

(1) BAW-10122A Rev. 1, "Normal Operating Controls," May 1984.

(2) BAW-10116-A, "Assembly Calculations and Fitted Nuclear Data," May 1977.

(3) BAW-10117P-A, "Babcock & Wilcox Version of PDQ User's Manual," January 1977.

(4) BAW-10118A, "Core Calculational Techniques and Procedures," December 1979.

(5) BAW-10124A, "FLAME 3 - A Three-Dimensional Nodal Code for Calculating Core Reactivity and Power Distributions," August 1976.

(6) BAW-10125A, "Verification of Three-Dimensional FLAME Code," August 1976.

(7) BAW-10152A, "NOODLE - A Multi-Dimensional Two-Group Reactor Simulator," June 1985.

(8) BAW-10119, "Power Peaking Nuclear Reliability Factors," June 1977.

6.9.5.3 The core operating limits shall be determined so that all applicable limits (e.g. fuel thermal-mechanical limits, core thermal-hydraulic limits, ECCS limits, nuclear limits such as shutdown margin, and transient/accident analysis limits) of the safety analysis are met.

6.9.5.4 The CORE OPERATING LIMITS REPORT, including any mid-cycle revisions or supplements thereto, shall be provided upon issuance for each reload cycle to the NRC Document Control Desk with copies to the Regional Administrator and Resident Inspector.

6.10 RECORD RETENTION

6.10.1 The following records shall be retained for at least five years:

a. Records of normal station operation including power levels and periods of operation at each power level.

b. Records of principal maintenance activities, including inspection, repairs, substitution, or replacement of principal items of equipment related to nuclear safety.

c. All REPORTABLE EVENTS.

d. Records of periodic checks, tests and calibrations.

e. Records of reactor physics tests and other special tests related to nuclear safety.

f. Changes to procedures required by Specification 6.8.1.

g. Records of solid radioactive shipments.

m. Records of the service lives of all safety related hydraulic snubbers including the date at which the service life commences and associated installation and maintenance records.

6.10.3 The following records shall be retained for the duration of the unit Operating License:

o. Records of reviews performed for changes made to the OFFSITE DOSE CALCULATION MANUAL and the PROCESS CONTROL PROGRAM.

6.11 RADIATION PROTECTION PROGRAM

Procedures for personnel radiation protection shall be prepared consistent with the requirements of 10 CFR Part 20 and shall be approved, maintained and adhered to for all operations involving personnel radiation exposure.

6.12 HIGH RADIATION AREA

6.12.1 In lieu of the "control device" or "alarm signal" required by paragraph 20.203 (c)(2) of 10 CFR 20:

a. Each High Radiation Area as defined by paragraph 20.202 (b)(3) shall be barricaded and conspicuously posted as a High Radiation Area, and personnel desiring entrance shall obtain a Radiation Work Permit (RWP). Any individual or group of individuals entering a High Radiation Area shall (a) use a continuously indicating dose rate monitoring device or (b) use a radiation dose rate integrating device which alarms at a pre-set dose level (entry into such areas with this monitoring device may be made after the dose rate level in the area has been established and personnel have been made knowledgeable of them), or (c) assure that a radiological control technician provides positive control over activities within the area and periodic radiation surveillance with a dose rate monitoring instrument.

b. Any area accessible to personnel where a major portion of the body could receive in any one hour a dose in excess of one thousand mrem shall be locked or guarded to prevent unauthorized entry. The keys to these locked barricades shall be maintained under the administrative control of the respective Radiological Controls Supervisor.

The Radiation Work Permit is not required by Radiological Controls personnel during the performance of their assigned radiation protection duties provided they are following radiological control procedures for entry into High Radiation Areas.

6.13 PROCESS CONTROL PROGRAM (PCP)

6.13.1 GPU Nuclear Corporation initiated changes to the PCP:

1. Shall be submitted to the NRC in the Semiannual Radioactive Effluent Release Report for the period in which the changes were made. This submittal shall contain:

   a. sufficiently detailed information to justify the changes without benefit of additional or supplemental information;

   b. a determination that the changes did not reduce the overall conformance of the solidified waste product to existing criteria for solid wastes; and

   c. documentation that the changes have been reviewed and approved pursuant to 6.8.2.

2. Shall become effective upon review and approval by GPUNC Management.

6.14 OFFSITE DOSE CALCULATION MANUAL (ODCM)

6.14.1 The ODCM shall be approved by the Commission prior to implementation.

6.14.2 GPU Nuclear Corporation initiated changes to the ODCM:

1. Shall be submitted to the NRC in the Semiannual Radioactive Effluent Release Report for the period in which the changes were made. This submittal shall contain:

   a. sufficiently detailed information to justify the changes without benefit of additional or supplemental information;

   b. a determination that the changes did not reduce the accuracy or reliability of dose calculations or setpoint determinations; and

   c. documentation that the changes have been reviewed and approved pursuant to 6.8.2.

2. Shall become effective upon review and approval by GPUNC Management.

6.15 DELETED

6.16 POST-ACCIDENT SAMPLING PROGRAMS NUREG 0737 (II.B.3, II.F.1.2)

Program which will ensure the capability to accurately sample and analyze vital areas under accident conditions have been implemented.

The following programs have been established:

1. Iodine and Particulate Sampling

2. Reactor Coolant System

3. Containment Atmosphere Sampling

Each program shall be maintained and shall include the following:

1. Training of personnel,

2. Procedures, and

3. Provisions for maintenance of sampling and analysis equipment.

6.17 MAJOR CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS

6.17.1 GPU Nuclear Corporation initiated safety related changes to the radioactive waste system (liquid, gaseous and solid):

1. Shall be reported to the Commission in the Annual Report (Specification 6.9.1B) for the period in which the evaluation was reviewed. The discussion of each change shall contain:

   a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;

   b. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;

   c. A detailed description of the equipment, components and processes involved and the interfaces with other plant systems;

   d. An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto;

   e. An evaluation of the change which shows the expected maximum exposures to individuals in the unrestricted area and to the general population that differ from those previously estimated in the license application and amendments thereto;

   f. A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made;

   g. An estimate of the exposure to plant operating personnel as a result of the change; and

   h. Documentation of the fact that the change was reviewed andapproved.

2. Shall become effective upon review and approval in accordance with Section 6.5.1.

GPU Nuclear

TMI Radiological Controls Departmental Procedure

Number: 6610-PLN-4200.01

Title: Offsite Dose Calculation Manual (ODCM)

Revision No.: 1

Applicability/Scope: Calculate offsite doses due to radioactive effluents for demonstrating compliance with Site Technical Specifications 10 CFR 20 & 10 CFR 50 - Appendix I

Responsible Office: 6610

This document is within QA plan scope	X	Yes	___	No
Safety Reviews Required	X	Yes	___	No

Effective Date: 12/20/91

List of Effective Pages

Page	Revision	Page	Revision	Page	Revision	Page	Revision
1.0	1	27.0	1	53.0	1	79.0	1
2.0	1	28.0	1	54.0	1	80.0	1
3.0	1	29.0	1	55.0	1	81.0	1
4.0	1	30.0	1	56.0	1	82.0	1
5.0	1	31.0	1	57.0	1	83.0	1
6.0	1	32.0	1	58.0	1	84.0	1
7.0	1	33.0	1	59.0	1	85.0	1
8.0	1	34.0	1	60.0	1	86.0	1
9.0	1	35.0	1	61.0	1	87.0	1
10.0	1	36.0	1	62.0	1	88.0	1
11.0	1	37.0	1	63.0	1	89.0	1
12.0	1	38.0	1	64.0	1	90.0	1
13.0	1	39.0	1	65.0	1	91.0	1
14.0	1	40.0	1	66.0	1	92.0	1
15.0	1	41.0	1	67.0	1	93.0	1
16.0	1	42.0	1	68.0	1	94.0	1
17.0	1	43.0	1	69.0	1	95.0	1
18.0	1	44.0	1	70.0	1	96.0	1
19.0	1	45.0	1	71.0	1	97.0	1
20.0	1	46.0	1	72.0	1	98.0	1
21.0	1	47.0	1	73.0	1	99.0	1
22.0	1	48.0	1	74.0	1	100.0	1
23.0	1	49.0	1	75.0	1	101.0	1
24.0	1	50.0	1	76.0	1	102.0	1
25.0	1	51.0	1	77.0	1	103.0	1
26.0	1	52.0	1	78.0	1	104.0	1

	Signature	Concurring Organizational Element	Date
Originator	S E Williams	Radiological Engineer, TMI	11-25-91
Concurred By	J. A Bradley	Env. Controls	12/4/91
	D W Fetterolf	Rad. Eng. Manager, TMI	12-4-91
	R F Wilson	Rad. Con. Director, TMI	12-6-91
	per telecon Adam Miller	Chairman, TMI-2 Plant Review Group	12-6-91
	J J Colitz	TMI-2, Site Operations Director	12/13/91
Approved By	R F Wilson for	Rad Con and Env Controls, Director	12/13/91

Page	Revision	Page	Revision	Page	Revision	Page	Revision
105.0	1	E6-1	1				
106.0	1	E7-1	1				
107.0	1	E7-2	1				
108.0	1	E7-3	1				
109.0	1	E7-4	1				
110.0	1						
111.0	1						
112.0	1						
113.0	1						
114.0	1						
115.0	1						
116.0	1						
117.0	1						
118.0	1						
119.0	1						
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128.0	1						
129.0	1						
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131.0	1						
132.0	1						
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134.0	1						
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136.0	1						
137.0	1						
138.0	1						
139.0	1						
140.0	1						
141.0	1						
142.0	1						
143.0	1						
144.0	1						
E1-1	1						
E2-1	1						
E3-1	1						
E4-1	1						
E4-2	1						
E5-1	1						
E5-2	1						

INTRODUCTION

The OFFSITE DOSE CALCULATION MANUAL (ODCM) is a supporting document of the GPUNC Three Mile Island Nuclear Station (TMINS) Unit 1 and Unit 2 Technical Specifications. The ODCM describes the methodology and parameters to be used in the calculation of off-site doses due to radioactive liquid and gaseous effluents. This document also describes the methodology used for calculation of the liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints. Liquid and Gaseous Radwaste Treatment System configurations are also included.

The ODCM also is used to define the requirements for the TMINS radiological environmental monitoring program (REMP) and contains a list and graphical description of the specific sample locations used in the REMP.

The ODCM is maintained at the Three Mile Island (TMI) site for use as a reference guide and training document of accepted methodologies and calculations. Changes in the calculation methods or parameters will be incorporated into the ODCM to ensure the ODCM represents the present methodology in all applicable areas. GPUNC initiated changes to the ODCM will be implemented in accordance with the TMI-1 and TMI-2 Technical Specifications.

The ODCM follows the methodology and models suggested by NUREG-0133, and Regulatory Guide 1.109, Revision 1 for calculation of off-site doses due to plant effluent releases. Simplifying assumptions have been applied in this manual where applicable to provide a more workable document for implementation of the Radiological Effluent Controls requirements.

GPUN implements the TMI Radiological Effluent Controls Program and Regulatory Guide 1.21, Revision 1 (Semiannual Radioactive Effluent Release Report) requirements by use of computerized system used to determine TMI effluent releases and to update cumulative effluent doses.

TABLE OF CONTENTS

PART I EFFLUENT DATA AND CALCULATIONAL METHODOLOGIES

TABLE OF CONTENTS (Cont'd)

PART I EFFLUENT DATA AND CALCULATIONAL METHODOLOGIES

TABLE OF CONTENTS (Cont'd)

PART I EFFLUENT DATA AND CALCULATIONAL METHODOLOGIES

TABLE OF CONTENTS (Cont'd)

PART I EFFLUENT DATA AND CALCULATIONAL METHODOLOGIES

TABLE OF CONTENTS (Cont'd)

PART I EFFLUENT DATA AND CALCULATIONAL METHODOLOGIES

TABLE OF CONTENTS (Cont'd)

PART II TMI-2 RADIOLOGICAL EFFLUENT CONTROLS

TABLE OF CONTENTS (Cont'd)

PART II TMI-2 RADIOLOGICAL EFFLUENT CONTROLS

TABLE OF CONTENTS (Cont'd)

PART III REPORTING REQUIREMENTS

PART I

EFFLUENT DATA AND CALCULATIONAL METHODOLOGIES

1.0 LIQUID EFFLUENT MONITORS

1.1 TMI-1 and TMI-2 Liquid Radiation Monitor Set Points

The liquid effluent off-line monitors are set such that the concentration(s) of radionuclides in the liquid effluents will not exceed the concentration limits specified in 10 CFR 20, Appendix B Table II, Col 2. Table 1.1 lists the Liquid Effluent Release Points and their parameters; Figure 1.1 provides a Liquid Release Pathway Diagram.

To meet the above limit, the alarm/trip set points for liquid effluent monitors and flow measuring devices are set in accordance with the following equation:

$$\frac{c * f}{F + f} \leq C \qquad \text{(eq 1.1)}$$

where:

C = the effluent concentration limit implementing 10 CFR 20 for the site, in µCi/ml.

c = the set point, in µCi/ml, of the liquid effluent monitor measuring the radioactivity concentration in the effluent line prior to dilution and release. The set point is proportional to the maximum volumetric flow of the effluent line and inversely proportional to the minimal volumetric flow of the dilution stream plus the effluent stream. The alert set point value is set to ensure that advance warning occurs prior to exceeding any limits. The high alarm set point value is such that if it were exceeded, it would result in concentrations exceeding the 10 CFR 20 limits for the unrestricted area.

f = flow set point as measured at the radiation monitor location, in volume per unit time, but in the same units as F below. Discharge flow ranges and flow recorder designations are listed in Table 1.1.

F = flow rate of dilution water measured prior to the release point, in volume per unit time. On site dilution minimal flows are listed in Table 1.1.

The set point concentration is reduced such that concentration contributions from multiple release points would not combine to exceed 10 CFR 20 limits. The set point concentration is converted to set point scale units using appropriate radiation monitor calibration factors.

This section of the ODCM is implemented by the Radiation Monitor System Set Points procedure and, for batch releases, the Releasing Radioactive Liquid Waste procedure.

1.2 TMI Liquid Effluent Release Points and Liquid Radiation Monitor Data

TMI-1 has three required liquid radiation monitors. These are RM-L6, RM-L10, and RM-L12. These liquid release point radiation monitors and sample points are shown in Table 1.1. The TMI outfall radiation monitor, RM-L7, is also listed.

TMI-2 does not have any required liquid radiation monitors, but does utilize RM-L12, and RM-L7 for release of non-accident water. TMI-2 does not release any processed water to the environment.

1.2.1 RM-L6

RM-L6 is an off-line system, monitoring radioactive batch discharges from the TMI-1 liquid radwaste system (see Figure 1.1). These batch releases are sampled and analyzed per site procedures prior to release. The release rate is based on releasing one of two Waste Evaporator Condensate Storage Tanks (WECST) at less than 10% MPC for each identified radionuclide, including conservative default values for Sr-89, Sr-90, and Fe-55. This ensures this batch release will meet the following equation:

$$(C_i/MPC_i) \leq 0.10, \qquad \text{(eq 1.2)}$$

where: C_i = diluted concentration of the i^{th} radionuclide,

MPC_i = The most limiting concentration for that radionuclide in the unrestricted area (10 CFR 20, App. B, Table II, Col. 2). A value of 3E-3 µCi/ml for dissolved and entrained noble gases shall be used.

The set points for RM-L6 are set for each release based on the monitor response to each radionuclide identified in the gamma scan sample results as follows:

$$(1.5)^* [\Sigma i\ (\mu Ci/cc)_i * (CPM/\mu Ci/cc)_i] + (CPM_{BKD}) = \text{ALERT CPM}$$

$$(2.0)^* [\Sigma i\ (\mu Ci/cc)_i\ (CPM/\mu Ci/cc)_i] + (CPM_{BKD}) = \text{HIGH ALARM CPM}$$

where: $(\mu Ci/cc)_i$ = positively identified radionuclides

$(CPM/\mu Ci/cc)_i$ = RM-L6 sensitivity to radionuclide i.

(CPM_{BKD}) = RM-L6 background prior to batch release

A high alarm on RM-L6 will close valve WDL-V-257 and terminate any WECST releases to the environment.

1.2.2 RM-L12

RM-L12 is an off-line system, monitoring combined releases from the Industrial Waste Treatment System/Industrial Waste Filtration System (IWTS/IWFS). The input to IWTS/IWFS originates in TMI-2 sumps, (see Figures 1.1 and 1.2) and the TMI-1 Turbine Building sump (see Figure 1.1). The set points are based on the maximum release rate from both IWTS and IWFS simultaneously, (see Figure 1.1) a minimum dilution flow rate, and 50% MPC for I-131, which is the most limiting radionuclide at an MPC level of 3E-7 µCi/ml. These inputs are used in equation 1.1 to determine the RM-L12 High Alarm set point. The alert set point is then 50% of the High Alarm set point. A high alarm on RM-L12 will close IWTS and IWFS release valves and trip release pumps to stop the release.

1.2.3 RM-L10

RM-L10 is a NaI detector submerged in the TMI-1 Turbine Building Sump (see Figure 1.1). The set points are based on the calculated RM-L12 set point concentration, since the TBS discharges directly to the IWTS, which in turn discharges to the Susquehanna River. Therefore, the concentration from the Turbine Building Sump should not exceed the set point calculated for the IWTS/IWFS release point. This monitor's high alarm will isolate power to the TBS sump pumps to terminate releases to the IWTS.

1.2.4 RM-L7

RM-L7 is an off-line system, monitoring the TMINS outfall to the Susquehanna River (see Figures 1.1 and 1.2). RM-L7 has an associated proportional to flow compositor which is used to collect composite samples. This monitor is the final radiation monitor for TMI-1 and TMI-2 normal liquid effluent releases.

1.3 Control of Liquid Releases

TMI liquid effluent releases are controlled to less than 1.0 MPC by limiting the percentage MPC allowable from the two TMI liquid release points. RM-L6, and effluent sampling, limits batch releases to less than or equal to 10% MPC, and RM-L12, and effluent sampling, limits releases from TMI-1 and TMI-2 to less than or equal to 50% MPC for I-131.

These radiation monitor set points also include built in meter error factors to further ensure that TMI liquid effluent releases are less than 1.0 MPC to the environment.

The radioactivity content of each batch of radioactive liquid waste is determined prior to release by sampling and analysis in accordance with TMI-1 Tech. Spec. Table 4.22-1. The results of pre-release analyses are used with the calculational methods in Section 1.1, to assure that the concentration at the point of release is maintained within the TMI-1 Tech. Spec. Section 3.22.1.1.

Post-release analysis of samples composited from batch releases are performed in accordance with TMI-1 Tech. Spec. Table 4.22-1. The results of the previous post-release analysis shall be used with the calculational methods in the ODCM to assure that the concentrations at the point of release were maintained within the TMI-1 Tech. Spec. Section 3.22.1.1.

The radioactivity concentration of liquids discharged from continuous release points are determined by collection and analysis of samples in accordance with TMI-1 Tech. Spec. Table 4.22-1. The results of the analysis are used with the calculational methods of the ODCM to assure that the concentration at the point of release is maintained within the TMI-1 Tech. Spec. Section 3.22.1.1.

TABLE 1.1

TMI LIQUID RELEASE POINT AND LIQUID RADIATION MONITOR DATA

LIQUID RADIATION MONITOR (DETECTOR)	LOCATION	LIQUID RELEASE POINT (Maximum Volume)	(f) DISCHARGE FLOW GPM (FLOW RECORDER)	(F) ON SITE DILUTION GPM	(FR) RIVER FLOW RATE GPM (Range)	(DF) NEAR FIELD DILUTION FACTOR	RADIATION MONITOR SENSITIVITY (CPM/μCi/cc)	RELEASE TERMINATION INTERLOCK (YES/NO) VALVES
RM-L6 (NaI) **	281' Elevation TMI-1 Auxiliary Bldg	WECST Batch Releases (8000 gal.)	0-30 gpm (FT-84)	>=5,000 (FT-146)	2E7 AVE. (1.4E6-5.4E8)	5	Cs-137 7.16E7	YES WDL-V257
RM-L7 (NaI) **	South end of TMI-1 MDCT	Station Discharge TMI-1 and TMI-2 Non-AGW	>=5,000 (FT-146)	N.A.	2E7 AVE. (1.4E6-5.4E8)	5	[illegible]	[illegible] WDL-V257 WDL-R-1311
RM-L10 (NaI)	Submerged in TMI-1 Turbine Bldg. Sump	Turbine Building Sump (10,000 gal.)	0-400 gpm (FE-301) (FQ-301)	>=15,000 (FT-146)	2E7 AVE. (1.4E6-5.4E8)		I-131 1.8E9 Cs-137 1.0E9	YES SD-P9A, SD-P9B
RM-L12 (NaI) **	IWFS Building NW Corner	IWTS/IWFS Continuous Releases (300,000/ 80,000 gal.)	0-200 gpm (FT-342)/ 0-100 gpm (FT-373)	>=15,000 (FT-146)	2E7 AVE. (1.4E6-5.4E8)	5	I-131 1.5E8 Cs-137 6.5E7	YES IW-V73, IW-P16,17,18 IW-V279, IW-P29,30

* WDL-R-1311 has been flanged off as a TMI-2 liquid outfall.
**These monitors are utilized for any normal liquid released from TMI-1 or TMI-2.

TABLE 1.2

TMI-2 SUMP CAPACITIES

Sump	Total Capacity Gallons	Gallons per Inch
Turbine Building Sump	1346	22.43
Circulating Water Pump House Sump	572	10.59
Control Building Area Sump	718	9.96
Tendon Access Galley Sump	538	9.96
Control to Service Building Sump	1346	22.43
Emer. Diesel Generator Sump A/B Wet	837	9.96
Emer. Diesel Generator Sump A/B Dry	1200	14.29
Chlorinator House Sump	----	----
Water Treatment Sump	1615	22.43
Air Intake Tunnel Normal Sump	700	----
Air Intake Tunnel Emergency Sump	100000	266.00
Condensate Polisher Sump	2617	62.31
Sludge Collection Sump	1106	26.33
Heater Drain Sump	----	----
Solid Waste Staging Facility Sump	1476	24.00
Auxiliary Building Sump	10102	202.00
Decay Heat Vault Sump	479	10.00
Building Spray Vault Sump	479	10.00

FIGURE 1.1

TMI-1 LIQUID EFFLUENT PATHWAYS

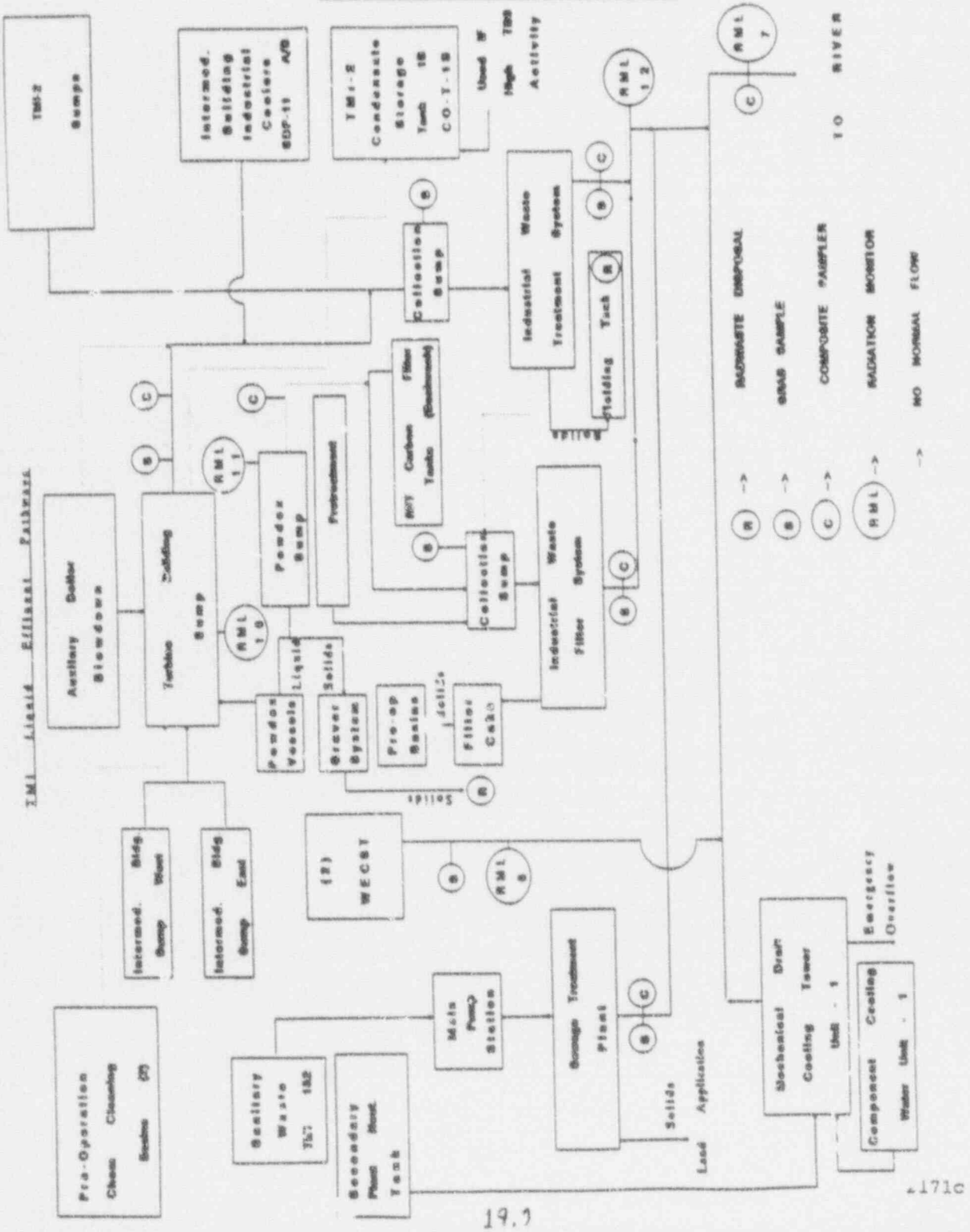
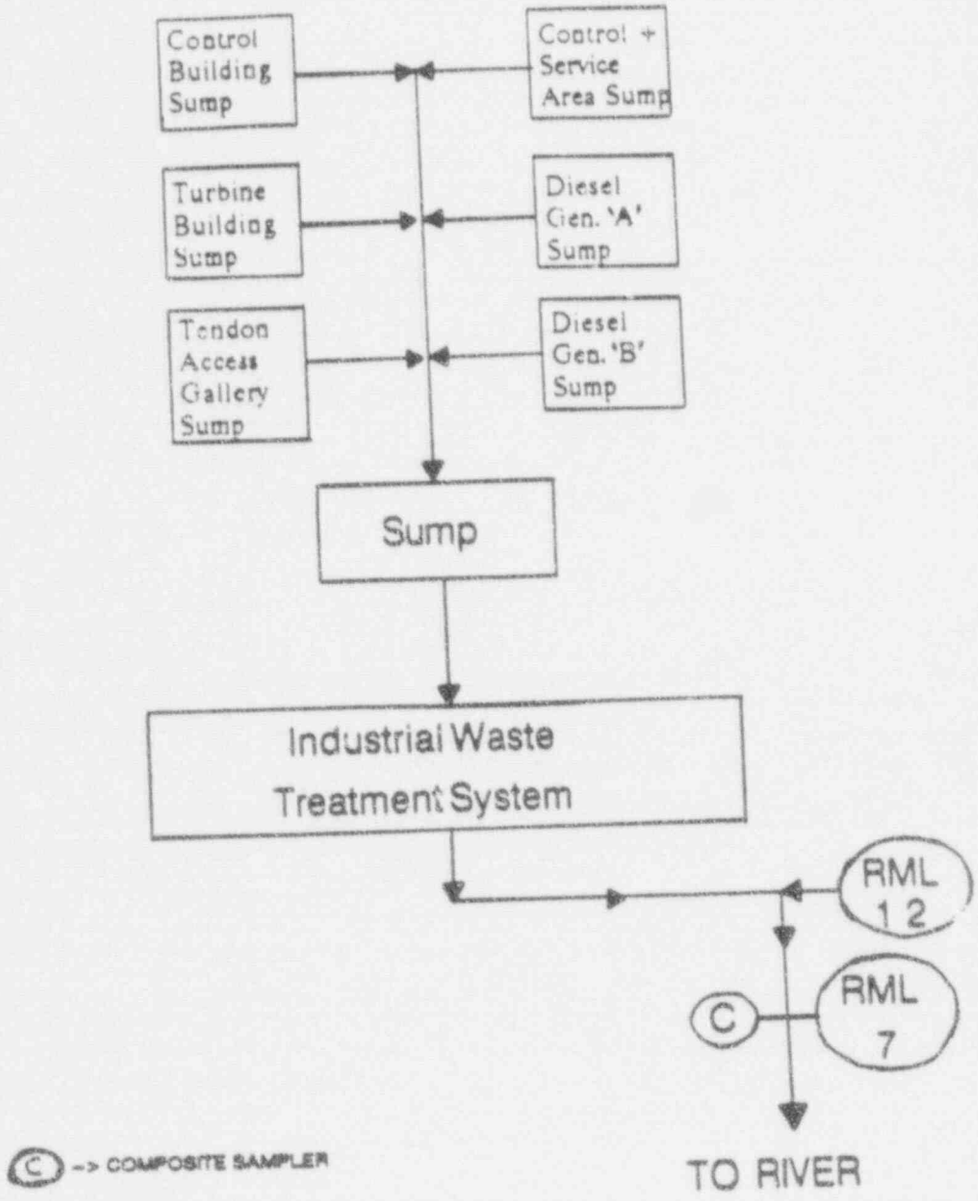


FIGURE 1.2

TMI-2 LIQUID EFFLUENT PATHWAYS



2.0 LIQUID EFFLUENT DOSE ASSESSMENT

2.1 Liquid Effluents - 10 CFR 50 Appendix I

The dose from liquid effluents results from the consumption of fish and drinking water. The location of the nearest potable water intake is PP&L Brunner Island Steam Electric Station located downstream of TMI. The use of the flow of the Susquehanna River as the dilution flow is justified based on the complete mixing in the river prior to the first potable water supply, adequately demonstrated by flume tracer die studies and additional liquid effluent release studies conducted using actual TMI-1 tritium releases. Other pathways contribute negligibly at Three Mile Island. The dose contribution from all radionuclides in liquid effluents released to the unrestricted area is calculated using the following expression:

$$\text{Dose } j = \sum_i \sum_j (\Delta t) \times (C_i) \times \left[(AW_{ij} \times \frac{f}{FR}) + (AF_{ij} \times \frac{f}{FD} \times \frac{1}{DF}) \right] \quad \text{(eq 2.1)}$$

where:

Dose j = the cumulative dose commitment to the total body or any organ, j, from the liquid effluents for the total time period, in mrem.

Δt = the length of the time period over which C_i and f are averaged for all liquid releases, in hours.

C_i = the average concentration of radionuclide, i, in undiluted liquid effluent during time period Δt from any liquid release, in µCi/ml.

NOTE: For Fe-55, Sr-89, Sr-90, prior to batch releases conservative concentration values will be used in the initial dose calculation based on similar past plant conditions. LLD values are not used in dose calculations.

f = undiluted liquid waste flow, in gpm.

FD = plant dilution water flowrate, in gpm

FR = river flowrate, in gpm.

DF = dilution factor as a result of mixing effects in the near field of the discharge structure of 0.2 (Reg. Guide 1.109, Rev. 1, Table A-2) or taken to be 5 based on the inverse of 0.2.

AW_{ij} and AF_{ij} = the site-related ingestion dose commitment factor to the total body or any organ, j, for each identified principle gamma and beta emitter, in mrem/hr per µCi/ml. AW is the factor for the water pathway and AF is the factor for the fish pathway.

Values for AW_{ij} are determined by the following equation:

$$AW_{ij} = (1.14E5) \times (U_w) \times (DF_{ij}) \qquad \text{(eq 2.2)}$$

where:

1.14E5 = (1.0E6 pCi/μCi) x (1.0E3 ml/kg) ÷ (8760 hr/yr)

U_w = Water consumption rate for adult is 730 kg/yr (Reg. Guide 1.109, Rev. 1).

DF_{ij} = ingestion dose conversion factor for radionuclide, i, for adults total body and for "worst case" organ, j, in mrem/pCi, from Table 2.1 (Reg. Guide 1.109)

Values for AF_{ij} are determined by the following equation:

$$AF_{ij} = (1.14E5) \times (U_f) \times (DF_{ij}) \times (BF_i) \qquad \text{(eq 2.2.2)}$$

where:

1.14E5 = defined above

U_f = adult fish consumption, assumed to be 21 kg/yr (Reg. Guide 1.109, Rev. 1).

DF_{ij} = ingestion dose conversion factor for radionuclide, i, for adult total body and for "worst case" organ, j, in mrem/pCi, from Table 2.1 (Reg. Guide 1.109, Rev. 1).

BF_i = Bioaccumulation factor for radionuclide, i, in fish, in pCi/kg per pCi/L from Table 2.2 (Reg. Guide 1.109, Rev. 1).

2.2 TMI-1 Liquid Radwaste System Dose Calcs Once/Month

TMI-1 Tech. Spec. Section 3.22.1.3 requires that appropriate portions of the liquid radwaste treatment system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the monthly projected doses due to the liquid effluent releases from each unit to unrestricted areas would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in any calendar month. The following calculational method is provided for performing this dose projection.

At least once a calendar month, the total dose from all liquid releases for the month will be integrated. An estimated projected dose for the next month will be determined based on plant operation and the integrated dose for the previous month. If this estimated projected dose exceeds 0.06 mrem total body or 0.2 mrem any organ, appropriate portions of the Liquid Radwaste Treatment System shall be used to reduce radioactivity levels prior to release.

(This section does not apply to TMI-2.)

2.3 Alternative Dose Calculational Methodology

As an alternative, models in, or based upon, those presented in Regulatory Guide 1.109 (Rev. 1) may be used to make a comprehensive dose assessment. Default parameter values from Reg. Guide 1.109 (Rev. 1) and/or actual site specific data would be used where applicable.

TABLE 2.1

LIQUID DOSE CONVERSION FACTORS (DCF): DF_{ij}

Page 1 of 3

INGESTION DOSE FACTORS FOR ADULTS*
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T. BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
C 14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
NA 24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
CR 51	NO DATA	NO DATA	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN 54	NO DATA	4.57E-06	8.72E-07	NO DATA	1.36E-06	NO DATA	1.40E-05
MN 56	NO DATA	1.15E-07	2.04E-08	NO DATA	1.46E-07	NO DATA	3.67E-06
FE 55	2.75E-06	1.90E-06	4.43E-07	NO DATA	NO DATA	1.06E-06	1.09E-06
FE 59	4.34E-06	1.02E-05	3.91E-06	NO DATA	NO DATA	2.85E-06	3.40E-05
CO 58	NO DATA	7.45E-07	1.67E-06	NO DATA	NO DATA	NO DATA	1.51E-05
CO 60	NO DATA	2.14E-06	4.72E-06	NO DATA	NO DATA	NO DATA	4.02E-05
NI 63	1.30E-04	9.01E-06	4.36E-06	NO DATA	NO DATA	NO DATA	1.88E-06
NI 65	5.28E-07	6.86E-08	3.13E-08	NO DATA	NO DATA	NO DATA	1.74E-06
CU 64	NO DATA	8.33E-08	3.91E-08	NO DATA	2.10E-07	NO DATA	7.10E-06
ZN 65	4.84E-06	1.54E-05	6.96E-06	NO DATA	1.03E-05	NO DATA	9.70E-06
ZN 69	1.03E-08	1.97E-08	1.37E-09	NO DATA	1.28E-08	NO DATA	2.96E-09
BR 83	NO DATA	NO DATA	4.02E-08	NO DATA	NO DATA	NO DATA	5.79E-08
BR 84	NO DATA	NO DATA	5.21E-08	NO DATA	NO DATA	NO DATA	4.09E-13
BR 85	NO DATA	NO DATA	2.14E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	2.11E-05	9.83E-06	NO DATA	NO DATA	NO DATA	4.16E-06
RB 88	NO DATA	6.05E-08	3.21E-08	NO DATA	NO DATA	NO DATA	8.36E-19
RB 89	NO DATA	4.01E-08	2.82E-08	NO DATA	NO DATA	NO DATA	2.33E-21
SR 89	3.08E-04	NO DATA	8.84E-06	NO DATA	NO DATA	NO DATA	4.94E-05
SR 90	7.58E-03	NO DATA	1.86E-03	NO DATA	NO DATA	NO DATA	2.19E-04
SR 91	5.67E-06	NO DATA	2.29E-07	NO DATA	NO DATA	NO DATA	2.70E-05
SR 92	2.15E-06	NO DATA	9.30E-08	NO DATA	NO DATA	NO DATA	4.26E-05
Y 90	9.62E-09	NO DATA	2.58E-10	NO DATA	NO DATA	NO DATA	1.02E-04

TABLE 2.1 (Cont'd)

LIQUID DOSE CONVERSION FACTORS (DCF): DF_{ij}

INGESTION DOSE FACTORS FOR ADULTS*
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T. BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 91M	9.09E-11	NO DATA	3.52E-12	NO DATA	NO DATA	NO DATA	2.67E-10
Y 91	1.41E-07	NO DATA	3.77E-09	NO DATA	NO DATA	NO DATA	7.76E-05
Y 92	8.45E-10	NO DATA	2.47E-11	NO DATA	NO DATA	NO DATA	1.48E-05
Y 93	2.68E-09	NO DATA	7.40E-11	NO DATA	NO DATA	NO DATA	8.50E-05
ZR 95	3.04E-08	9.75E-09	6.60E-09	NO DATA	1.53E-08	NO DATA	3.09E-05
ZR 97	1.68E-09	3.39E-10	1.55E-1[illegible]	NO DATA	5.12E-10	NO DATA	1.05E-04
NB 95	6.22E-09	3.46E-09	1.86E-09	NO DATA	3.42E-09	NO DATA	2.10E-05
MO 99	NO DATA	4.31E-06	8.20E-07	NO DATA	9.76E-06	NO DATA	9.99E-06
TC 99M	2.47E-10	6.98E-[illegible]	8.89E-09	NO DATA	1.06E-08	3.42E-10	4.13E-07
TC 101	2.54E-10	3.66E-10	3.59E-09	NO DATA	6.59E-09	1.87E-10	1.10E-21
RU 103	1.85E-07	NO DATA	7.97E-08	NO DATA	7.06E-07	NO DATA	2.16E-05
RU 105	1.54E-08	NO DATA	6.08E-09	NO DATA	1.99E-07	NO DATA	9.42E-06
RU 106	2.75E-06	NO DATA	3.48E-07	NO DATA	5.31E-06	NO DATA	1.78E-04
AG 110M	1.60E-07	1.48E-07	8.79E-08	NO DATA	2.91E-07	NO DATA	6.04E-05
SB 125	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.0	1.38E-06	1.97E-05
TE 125M	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	NO DATA	1.07E-05
TE 127M	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	NO DATA	2.27E-05
TE 127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	NO DATA	8.68E-06
TE 129M	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	NO DATA	5.79E-05
TE 129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	NO DATA	2.37E-08
TE 131M	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	NO DATA	8.40E-05
TE 131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	NO DATA	2.79E-09
TE 132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	NO DATA	7.[illegible]-05
I 130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	NO DATA	1.[illegible]-06
I 131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	NO DATA	1 57E-06
I 132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	NO DATA	1.02E-07
I 133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	NO DATA	2.22E-06
I 134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	NO DATA	2.51E-10

TABLE 2.1 (Cont'd)

LIQUID DOSE CONVERSION FACTORS (DCF): DF_{ij}

INGESTION DOSE FACTORS FOR ADULTS*
(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T. BODY	THYROID	KIDNEY	LUNG	GI-LLI
I 135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	NO DATA	1.31E-06
CS 134	6.22E-05	1.48E-04	1.21E-04	NO DATA	4.79E-05	1.59E-05	2.59E-06
CS 136	6.51E-06	2.57E-05	1.85E-05	NO DATA	1.43E-05	1.96E-06	2.92E-06
CS 137	7.97E-05	1.09E-04	7.14E-05	NO DATA	3.70E-05	1.23E-05	2.11E-06
CS 138	5.52E-08	1.09E-07	5.40E-08	NO DATA	8.01E-08	7.91E-09	4.65E-13
BA 139	9..)E-08	6.91E-11	2.84E-09	NO DATA	6.46E-11	3.92E-11	1.72E-07
BA 140	2.03E-05	2.55E-08	1.33E-06	NO DATA	8.67E-09	1.46E-08	4.18E-05
BA 141	4.71E-08	3.56E-11	1.59E-09	NO DATA	3.31E-11	2.02E-11	2.22E-17
BA 142	2.13E-08	2.19E-11	1.34E-09	NO DATA	1.85E-11	1.24E-11	3.00E-26
LA 140	2.50E-09	1.26E-09	3.33E-10	NO DATA	NO DATA	NO DATA	9.25E-05
LA 142	1.28E-10	5.82E-11	1.45E-11	NO DATA	NO DATA	NO DATA	4.25E-07
CE 141	9.36E-09	6.33E-09	7.18E-10	NO DATA	2.94E-09	NO DATA	2.42E-05
CE 143	1.65E-09	1.22E-06	1.35E-10	NO DATA	5.37E-10	NO DATA	4.56E-05
CE 144	4.88E-07	2.04E-07	2.62E-08	NO DATA	1.21E-07	NO DATA	1.65E-04
PR 143	9.20E-09	3.69E-09	4.56E-10	NO DATA	2.13E-09	NO DATA	4.03E-05
PR 144	3.01E-11	1.25E-11	1.53E-12	NO DATA	7.05E-12	NO DATA	4.33E-18
ND 147	..29E-09	7.27E-09	4.35E-10	NO DATA	4.25E-09	NO DATA	3.49E-05
W 187	1.03E-07	8.61E-08	3.01E-08	NO DATA	NO DATA	NO DATA	2.82E-05
NP 239	1.19E-09	1.17E-10	6.45E-11	NO DATA	3.65E-10	NO DATA	2.40E-05

* Dose factors of internal exposure are for continuous intake over a one-year period and include the dose commitment over a 50-year period; from Reg. Guide 1.109 (Rev. 1). Additional dose factors for nuclides not included in this table may be obtained from NUREG-0172.

TABLE 2.2

BIOACCUMULATION FACTORS, BF_i

BIOACCUMULATION FACTORS TO BE USED IN THE ABSENCE OF SITE-SPECIFIC DATA*
(pCi/kg per pCi/liter)

ELEMENT	FRESHWATER	
	FISH	INVERTEBRATE
H	9.0E-01	9.0E-01
C	4.6E+03	9.1E+03
NA	1.0E+02	2.0E+02
CR	2.0E+02	2.0E+03
MN	4.0E+02	9.0E+04
FE	1.0E+02	3.2E+03
CO	5.0E+01	2.0E+02
NI	1.0E+02	1.0E+02
CU	5.0E+01	4.0E+02
ZN	2.0E+03	1.0E+04
BR	4.2E+02	3.3E+02
RB	2.0E+03	1.0E+03
SR	3.0E+01	1.0E+02
Y	2.5E+01	1.0E+03
ZR	3.3E+00	6.7E+00
NB	3.0E+04	1.0E+02
MO	1.0E+01	1.0E+01
TC	1.5E+01	5.0E+00
RU	1.0E+01	3.0E+02
RH	1.0E+01	3.0E+02
*SB	1.0E+00	1.0E+00
TE	4.0E+02	6.1E+03
I	1.5E+01	5.0E+00
CS	2.0E+03	1.0E+03
BA	4.0E+00	2.0E+02
LA	2.5E+01	1.0E+03
CE	1.0E+00	1.0E+03
PR	2.5E+01	1.0E+03
ND	2.5E+01	1.0E+03
W	1.2E+03	1.0E+01
NP	1.0E+01	4.0E+02

* Bioaccumulation factor values are taken from Reg. Guide 1.109 (Rev. 1), Table A-1j.

** Sb bioaccumulation factor value is taken from EPRI NP-3840.

3.0 TMI LIQUID EFFLUENT WASTE TREATMENT SYSTEMS

3.1 TMI-1 Liquid Effluent Waste Treatment System

3.1.1 Description of the Liquid Radioactive Waste Treatment System (see Figure 3.1)

Reactor Coolant Train

a. Water Sources - (3) Reactor Coolant Bleed Tanks (RCBT)
- (1) Reactor Coolant Drain Tank (RCDT)

b. Liquid Processing - Reactor Coolant Waste Evaporator (see Figure 3.2)
- Demineralizers prior to release

c. Liquid Effluent for Release - (2) Waste Evaporator Condensate Storage Tanks (WECST)

d. Dilution - Mechanical Draft Cooling Tower (0-60k gpm)
- River Flow (2E7 gpm average)

Miscellaneous Waste Train

a. Water sources:
- Auxiliary Building Sump
- Reactor Building Sump
- Miscellaneous Waste Storage Tank
- Laundry Waste Storage Tank
- Neutralizer Mixing Tank
- Neutralizer Feed Tank
- Used Precoat Tank
- Borated Water Tank Tunnel Sump
- Heat Exchanger Vault Sump
- Tendon Access Galley Sump
- Spent Fuel Pool Room Sump

b. Liquid Processing - Miscellaneous Waste Evaporator, MWE (see Figure 3.2)
- Demineralizers prior to release

c. Liquid Effluent for Release - (2) Waste Evaporator Condensate Storage Tanks (WECST)

d. Dilution - Mechanical Draft Cooling Towers, MDCT (0-60k gpm)
- River Flow (2E7 gpm average)

3.2 Operability of the TMI-1 Liquid Effluent Waste Treatment System

3.2.1 The TMI-1 Liquid Waste Treatment System as described in Section 11 of the TMI-1 Final Safety Analysis Report is considered to be operable when one of each of the following pieces of equipment is available to perform its intended function:

a) Miscellaneous Waste Evaporator (WDL-Z1B) or Reactor Coolant Evaporator (WDL-Z1A)

b) Waste Evaporator Condensate Demineralizer (WDL-K3 A or B)

c) Waste Evaporator Condensate Storage Tank (WDL-T 11 A or B)

d) Evaporator Condensate Pumps (WDL-P 14 A or B)

3.2.2 TMI-1 Representative Sampling Prior to Discharge

All liquid releases from the TMI-1 Liquid Waste Treatment System are made through the Waste Evaporator Condensate Storage Tanks. To provide thorough mixing and a representative sample, the contents of the tank are recirculated using one of the Waste Evaporator Condensate Transfer Pumps.

3.3 TMI-2 Liquid Effluent Waste Treatment System

3.3.1 Description of the TMI-2 Liquid Radioactive Waste Treatment System

The TMI-2 Liquid Radioactive Waste Treatment System has been out of service since the TMI-2 Accident in 1979. TMI-2, however, releases Non-Accident Generated Water (AGW) from various sumps and tanks to the river (see Figures 1.1 and 1.2). This process is governed by plant procedures that encompass proper sampling, sample analysis, and radiation monitoring techniques.

FIGURE 3.1

TMI-1 LIQUID RADWASTE

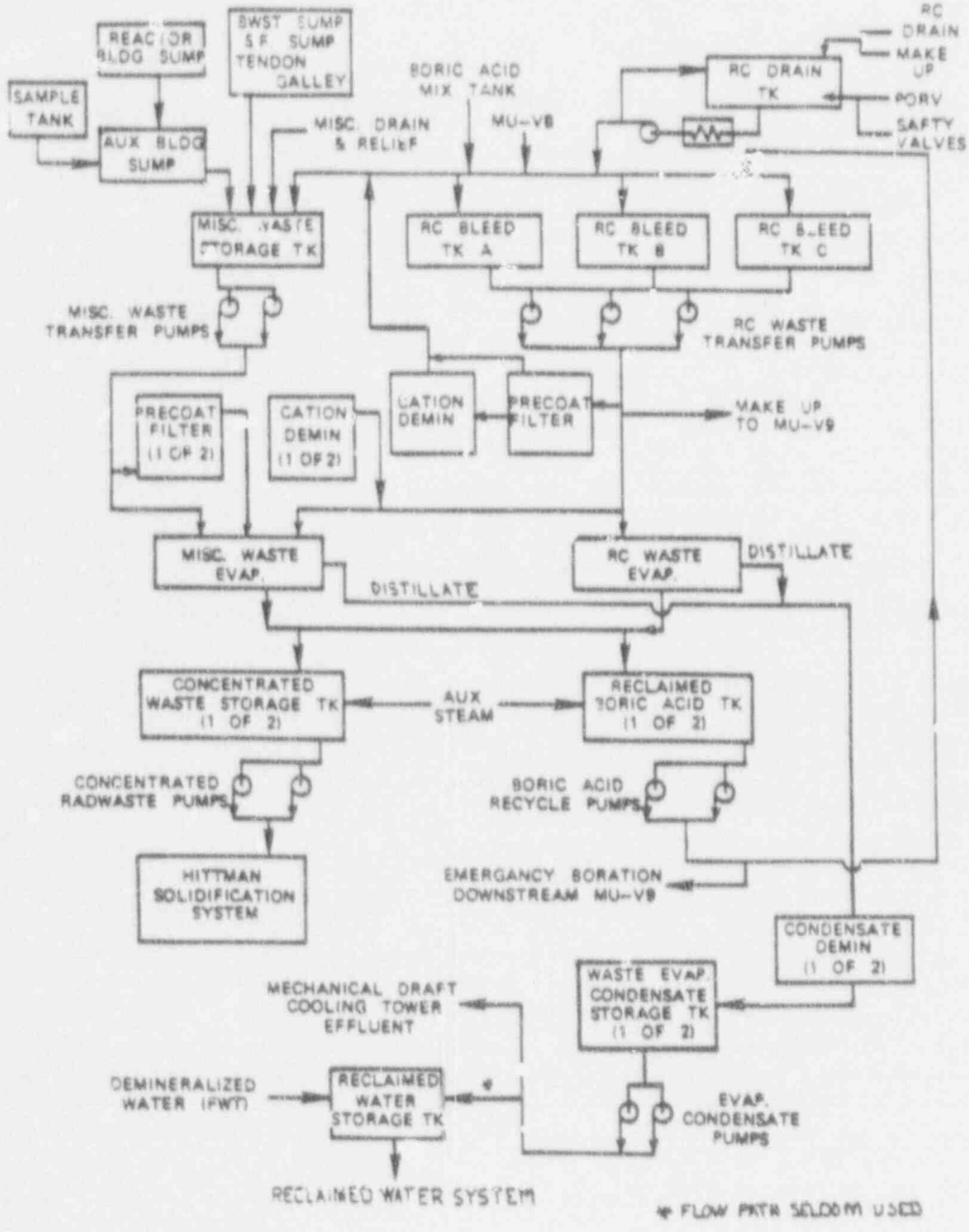
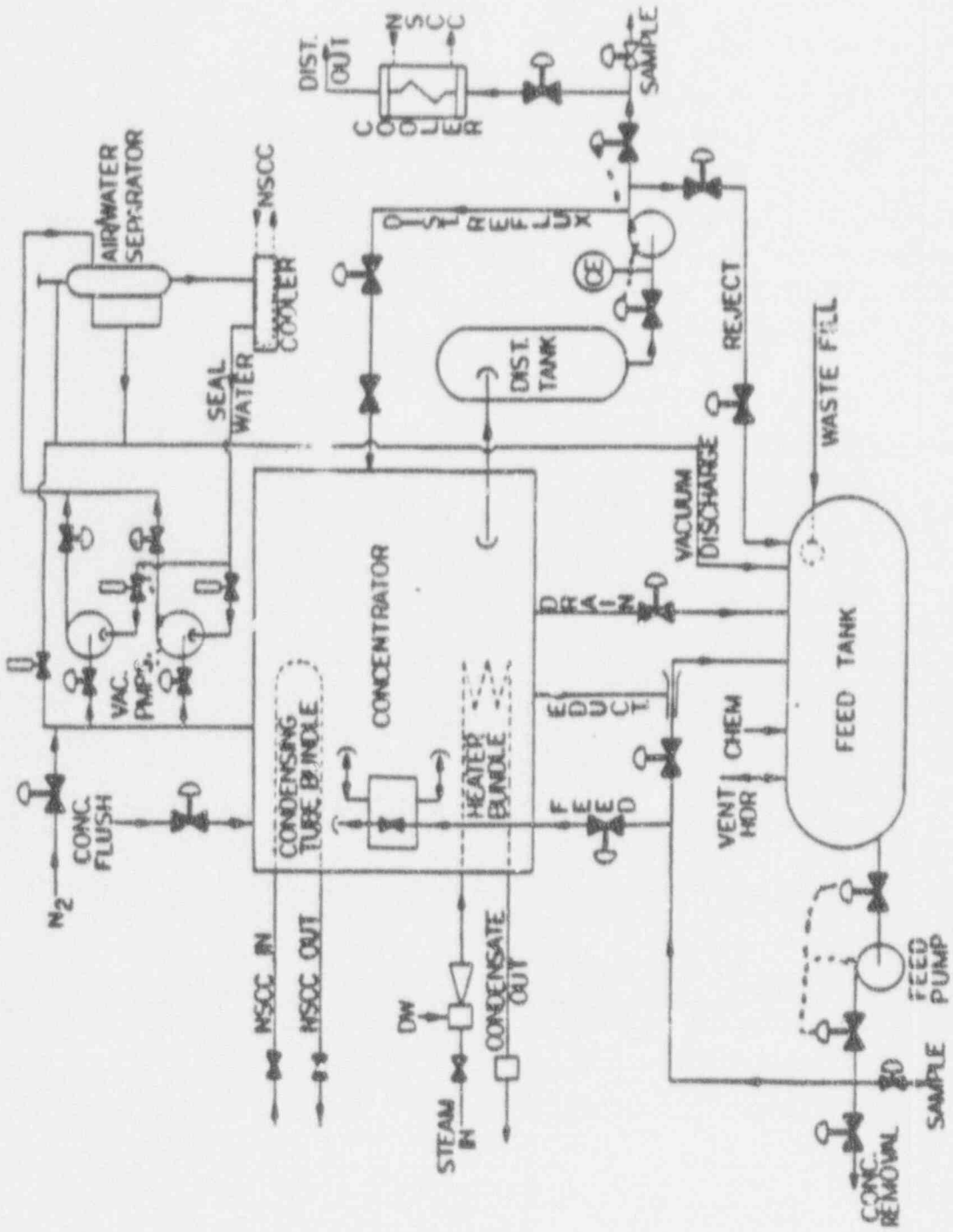


FIGURE 3.2

TMI-1 LIQUID WASTE EVAPORATORS



4.0 GASEOUS EFFLUENT MONITORS

4.1 TMI-1 Noble Gas Monitor Set Points

The gaseous effluent monitor set points are established for each gaseous effluent radiation monitor to assure concentrations of radionuclides in gaseous effluents do not exceed the limits set forth in 10 CFR 20. Table 4.1 lists Gaseous Effluent Release Points and their associated parameters; Figure 4.1 provides a Gaseous Effluent Release Pathway Diagram.

The set points are established to satisfy the more restrictive set point concentration in the following two equations:

$$500 > \sum_i (c_i)(F)(K_i)(Dv) \qquad \text{(eq 4.1.1)}$$

and

$$3000 > \sum_i (c_i)(L_i + 1.1\ M_i)(Dv)(F) \qquad \text{(eq 4.1.2)}$$

where:

c_i = set point concentration, in $\mu Ci/cc$

F = gaseous effluent flowrate at the monitor, in cc/sec (reference Table 4.1)

K_i = total body dose factor, in mrem/yr per $\mu Ci/m^3$ from Table 4.2

Dv = highest sector annual average atmospheric dispersion factor (X/Q) at the unrestricted area boundary, in sec/m^3, from Table 4.4 for station vent releases and Table 4.5 for all other releases, (Condenser off gas, ESF FHB, and ground releases). Maximum values presently used are 4.19E-7 sec/m^3 at sector SE for station vent, and 1.16E-5 sec/m^3 at sectors N and WNW for all other releases.

L_i = skin dose factor due to beta emissions from radionuclide i, in mrem/yr per $\mu Ci/m^3$ from Table 4.3.

M_i = air dose factor due to gamma emissions from radionuclide i, in mrad/yr per $\mu Ci/m^3$ from Table 4.3.

1.1 = mrem skin dose per mrad air dose.

500 = annual whole body dose limit for unrestricted areas, in mrem/yr.

3000 = annual skin dose limit for unrestricted areas, in mrem/yr.

The set point concentration is further reduced such that the concentration contributions from multiple release points would not combine to exceed 10 CFR 20 limits.

The set point concentration is converted to set point scale units on each radiation monitor using appropriate calibration factors.

This section of the ODCM is implemented by the Radiation Monitor System Set Points procedure and the procedure for Releasing Radioactive Gaseous Waste.

4.2 TMI-1 Particulate and Radioiodine Monitor Set Points

Set points for monitors which detect radionuclides other than noble gases are also established to assure that concentrations of these radionuclides in gaseous effluents do not exceed the limits in 10 CFR 20.

Set points are established so as to satisfy the following equations:

$$1500 > \sum_i (c_i)(F)(P_i)(Dv) \qquad \text{(eq 4.2)}$$

where:

c_i = set point concentration, in $\mu Ci/cc$

F = gaseous effluent flow rate at the monitor, in cc/sec (Table 4.1)

P_i = pathway dose parameter, in mrem/yr per $\mu Ci/m^3$ for the inhalation pathway from Table 4.6. The dose factors are based on the actual individual organ and most restrictive age group (infant) (NUREG-0133).

NOTE: Appendix A contains P_i calculational methodology.

1500 = annual dose limit to any organ from particulates and radioiodines and radionuclides (other than noble gases) with half lives greater than eight days.

Dv = the annual average atmospheric dispersion factor for the worst-case sector; maximum X/Q, in sec/m^3 for the inhalation pathway at the unrestricted area. Dispersion factors may be read or interpolated from Table 4.4 for releases from the station vent and Table 4.5 for all other releases. Maximum values of X/Q presently used are 4.19E-7 sec/m^3 for station vent, at sector SE, and 1.16E-5 sec/m^3 for all other releases, at sectors N and WNW.

The set point concentration is further reduced such that concentration contributions from multiple release points would not combine to exceed 10 CFR 20 limits.

The set point concentration is converted to set point scale units on each radiation monitor using appropriate calibration factors.

This section of the ODCM is implemented by the Radiation Monitor Systems Set Points procedure and the procedure for Releasing Radioactive Gaseous Waste.

4.3 TMI-2 Gaseous Radiation Monitor Set Points

TMI-2 Gaseous Radiation Monitors have their set points described in TMI-2 Plant Procedure 4210-OPS-3661.02. Figure 4.5 provides a gaseous effluent release pathway diagram. Table 4.2 provides TMI-2 Radiation Monitor Data.

These set points are set in accordance with the Controls delineated in Part II of this ODCM.

4.4 TMI-1 Gaseous Effluent Release Points and Gaseous Radiation Monitor Data

TMI-1 has eight (8) required effluent gaseous radiation monitors. These are RM-A4, RM-A5, RM-A15, RM-A6, RM-A7, RM-A8, RM-A9 and RM-A14. These gaseous release points, radiation monitors, and sample points are shown in Table 4.1.

4.4.1 RM-A4/RM-A6 Fuel Handling and Auxiliary Building Exhaust

RM-A4 is the particulate, radioiodine and gaseous radiation monitor for the TMI-1 Fuel Handling Building Ventilation (see Figures 4.1 and 4.2). RM-A6 is the particulate, radioiodine, and gaseous radiation monitor for the TMI-1 Auxiliary Building Ventilation (see Figures 4.1 and 4.2). High alarms on RM-A4 or RM-A6 noble gas channels will initiate shutdown of the related building ventilation air supply system. These two radiation monitors concurrently will satisfy requirements for the Station Vent release point in place of RM-A8.

4.4.2 RM-A8 Station Ventilation Exhaust

RM-A8 is the particulate, radioiodine and gaseous radiation monitor for the TMI-1 Station Ventilation (see Figures 4.1 and 4.2). This in plant effluent radiation monitor also has an associated sampling panel with sampling lines located before the sample filters. High alarm on RM-A8 noble gas low channel will initiate shutdown of the Station Ventilation air supply systems. (The Fuel Handling and Auxiliary Building Ventilation). This radiation monitor satisfies requirements for the Station Vent release point in place of RM-A4 and RM-A6.

4.4.3 RM-A5/RM-A15 Condenser Off Gas Exhaust

RM-A5 is the gaseous radiation monitor for the TMI-1 Condenser Off Gas exhaust (see Figures 4.1 and 4.4). RM-A15 is the back up gaseous radiation monitor for the TMI-1 Condenser Off Gas exhaust (see Figures 4.1 and 4.4). High alarms on RM-A5 low channel or RM-A15 noble gas channels will initiate the MAP-5 Radioiodine Processor Station. These two radiation monitors together satisfy requirements for the Condenser Off Gas release point.

4.4.4 RM-A7 Waste Gas Decay Tank Exhaust

RM-A7 is the gaseous radiation monitor for the TMI-1 Waste Gas Decay tanks (see Figures 4.1 and 4.2). This in plant effluent radiation monitor also has an associated sampling panel. High alarm on RM-A7 noble gas channel will initiate shutdown of the Waste Gas Decay Tank release in progress. This radiation monitor satisfies requirements for batch gaseous releases to the Station Vent release point.

4.4.5 RM-A9 Reactor Building Purge Exhaust

RM-A9 is the particulate, radioiodine and gaseous radiation monitor for the TMI-1 Reactor Building Purge system (see Figures 4.1 and 4.3). This in plant effluent radiation monitor also has an associated sampling panel with sampling lines located before the sample filters. High alarm on RM-A9 noble gas low channel will initiate shutdown of the Reactor Building Purge System. This radiation monitor satisfies requirements for the Reactor Building Purge System release point.

4.4.6 RM-A14 ESF FHB Ventilation System

RM-A14 is the gaseous radiation monitor for the TMI-1 Emergency Safeguards Features (ESF) Fuel Handling Building Exhaust system (see Figures 4.1 and 4.2). This in plant effluent radiation monitor also has an associated sampling panel with sampling lines located before the sampler filters. High alarm on RM-A14 noble gas channel will initiate shutdown of the ESF Fuel Handling Building Exhaust System. This radiation monitor satisfies requirements for the ESF Fuel Handling Building Exhaust System release point.

4.5 TMI-2 Gaseous Effluent Release Points and Gaseous Radiation Monitor Data

TMI-2 has seven (7) regulatory required gaseous effluent radiation monitors. These are HP-R-219, HP-R-219A, ALC-RMI-18, WHP-RIT-1, HP-R-225, HP-R-226, and PWD-RML-1. Also included in this discussion is RLM-RM-1, which monitors effluents from the Respirator Cleaning and Laundry Maintenance (RLM) facility. These gaseous release points, radiation monitors, and sample points are shown in Table 4.2, and various gaseous effluent pathways are depicted in Figure 4.5.

4.5.1 HP-R-219 Station Ventilation Exhaust

HP-R-219 is a Victoreen particulate, radioiodine, and gaseous radiation monitor for the TMI-2 ventilation exhaust. This in-plant effluent radiation monitor is located in the TMI-2 Auxiliary Building 328 foot elevation and has an associated sample panel. A high alarm will initiate shutdown of the ventilation air exhaust system.

4.5.2 HP-R-219A Station Ventilation Exhaust

HP-R-219A is an Eberline PING particulate, radioiodine, and gaseous radiation monitor for the TMI-2 ventilation exhaust. This in-plant effluent radiation monitor is located on the TMI-2 Auxiliary Building roof and has an associated sample panel.

4.5.3 ALC-RMI-18 EPICOR II Chemical Cleaning Facility (CCF) Ventilation Exhaust

ALC-RMI-18 is an Eberline PING particulate, radioiodine, and gaseous radiation monitor for the TMI-2 EPICOR II radwaste processing building exhaust. Presently, the radioiodine channel is not in use. This monitor is located in the EPICOR II building on the ground floor, and has an associated sample panel. Sampling for particulate activity is performed off of the monitor.

4.5.4 WHP-RIT-1 Waste Handling and Packaging Facility (WHPF) Exhaust

WHP-RIT-1 is an Eberline PING particulate, radioiodine, and gaseous radiation monitor for the TMI WHPF. Presently, the radioiodine and gaseous channels are not in use. The monitor is located in the Mechanical Equipment Room in the WHPF. Sampling for particulate and radioiodine activity is performed off of the monitor. A high alarm will initiate shutdown of the ventilation air exhaust system.

4.5.5 PWD-RML-1 TMI-2 Accident Generated Water (AGW) Evaporator Distillate Discharge

PWD-RML-1 is a Nuclear Research Corporation liquid radiation monitor that evaluates evaporator distillate prior to the liquid being vaporized and released to the environment. The monitor is

located in the TMI-2 Evaporator Building. This monitor has an associated sample system. A high alarm will initiate shutdown of the TMI-2 Processed Water Disposal System.

4.5.6 RLM-RM-1 Respirator Cleaning and Laundry Maintenance (RLM) Facility

RLM-RM-1 is an Eberline PING particulate, radioiodine, and gaseous radiation monitor for the TMI RLM Facility. Presently, the radioiodine and gaseous channels are not in use. The monitor is located in the Mechanical Equipment Room in the RLM. Sampling for particulate and radioiodine activity is performed off of the monitor.

4.5.7 HP-R-225 Reactor Building Purge Air Exhaust Duct "A"

HP-R-225 is a Victoreen particulate, radioiodine, and gaseous radiation monitor for the TMI-2 Reactor Building Purge Air Exhaust System. This in-plant effluent radiation monitor is located in the TMI-2 Auxiliary Building 328' elevation area. A high alarm will initiate a shutdown of the TMI-2 Reactor Building Purge Exhaust System by tripping exhaust fans and dampers.

4.5.8 HP-R-226 Reactor Building Purge Air Exhaust Duct "B"

HP-R-226 is a Victoreen particulate, radioiodine, and gaseous radiation monitor for the TMI-2 Reactor Building Purge Air Exhaust System. This in-plant effluent radiation monitor is located in the TMI-2 Auxiliary Building 328' elevation area. A high alarm will initiate a shutdown of the TMI-2 Reactor Building Purge Exhaust System by tripping exhaust fans and dampers.

4.6 Control of Gaseous Effluent Releases

TMI gaseous effluent combined releases are controlled (per TMI-1 Tech. Spec. Section 3.22.2.1 and ODCM Part II for TMI-2) by effluent sampling and radiation monitor set points. These measures assure that releases from the various vents do not combine to produce dose rates at the site boundary exceeding the most restrictive of 500 mrem per year to the total body or 3000 mrem per year to the skin, and 1500 mrem per year to the thyroid. This is done by restricting simultaneous releases and by limiting the dose rates that may be contributed by the various vents at any time. The various vent radiation monitor set points are each based on fractions of the above limits and do not exceed the above limits when summed together. These effluent radiation monitor set points are calculated using the methodology described in equations 4.1.1, or 4.1.2 and 4.2. The actual set points are then listed in TMI-1 Operations Procedure 1101-2.1.

The radioactive content of each batch of gaseous waste is determined prior to release by sampling and analyses in accordance with TMI-1 Tech. Spec. Table 4.22-2 and ODCM Part II for TMI-2. The results of pre-release analyses are used with the calculational methods in Sections 4.1 and 4.2 to assure that the dose rates at the site boundary are maintained below the limits in TMI-1 Tech. Spec. Section 3.22.2.1 and ODCM Part II for TMI-2.

Post-release analyses of samples composited from batch and continuous releases are performed in accordance with TMI-1 Tech. Spec. Table 4.22-2 and ODCM Part II for TMI-2. The results of the analyses are used to assure that the dose rates at the site boundary are maintained within the limits of TMI-1 Tech. Spec. Section 3.22.2.1 and ODCM Part II for TMI-2.

TABLE 4.1

TMI-1 GASEOUS RELEASE POINT AND GASEOUS RADIATION MONITOR DATA

GASEOUS RADIATION MONITOR (DETECTOR)	LOCATION	GASEOUS RELEASE POINT	(F) EXHAUST FLOW CFM (FLOW RECORDER)	RADIATION MONITOR SENSITIVITY (CPM/MIN/μCi/cc) PARTICULATE	RADIATION MONITOR SENSITIVITY (CPM/MIN/μCi/cc) IODINE	RADIATION MONITOR SENSITIVITY (CPM/μCi/cc) GAS	RELEASE TERMINATION INTERLOCK (YES/NO) VALVES
RM-A4	306' Elevation Auxiliary Bldg.	Fuel Hand. Building Exhaust	0-50,000 (FR-149)	1.30E10 (Sr-90)	1.22E9 (I-131)	3.96E7 (Xe-133)	YES AH-E-10 AH-D-120 AH-D-121 AH-D-122
RM-A6	306' Elevation Auxiliary Bldg.	Auxiliary Building Exhaust	0-100,000 (FR-150)	1.30E10 (Sr-90)	1.22E9 (I-131)	3.96E7 (Xe-133)	YES AH-E-11
RM-A8	RMA-8/9 Bldg. Near BWST	Station Vent Exhaust	0-150,000 (FR-151)	1.60E10 (Sr-90)	1.30E9 (I-131)	3.69E7 (Xe-133)	YES WDG-V47 AH-E-10 AH-E-11 Starts MAP-5 Radioiodine Sampler
RM-A5	322' Elevation Second Floor Turbine Bldg.	Condenser Off Gas Exhaust	0-200 FR-1113	-----	-----	4.00E7 (Xe-133) 8.70E7 (Kr-85)	YES Starts MAP-5 Radioiodine Sampler
RM-A15	322' Elevation Second Floor Turbine Bldg.	Condenser Off Gas Exhaust	0-200 FR-1113	-----	-----	3.25E7 (Xe-133) 9.11E7 (Kr-85)	YES Starts MAP-5 Radioiodine Sampler
RM-A7	306' Elevation Auxiliary Bldg.	Waste Gas Decay Tanks (A,B,C)	0-10 FR-123	-----	-----	4.00E5 (Xe-133)	YES WDG-V47
RM-A9	RMA-8/9 Bldg. Near BWST	Reactor Building Purge Exhaust	0-150,000 FR-909/ FR-148	1.80E10 (Sr-90)	1.40E9 (I-131)	3.96E7 (Xe-133)	YES AH-V-1A/B/C/D WDG-534/535 Starts MAP-5 Radioiodine Sampler
RM-A14	331' Elevation ESF FHB Outside Chem. Addition Bldg.	ESF Fuel Handling Building Exhaust	0-7000 FR-1104A/B	-----	-----	1.05E7 (Xe-133) 4.21E7 (Kr-85)	NO Manual Actions

TABLE 4.2

TMI-2 GASEOUS RELEASE POINT AND GASEOUS RADIATION MONITOR DATA

GASEOUS RADIATION MONITOR (DETECTOR)	LOCATION	GASEOUS RELEASE POINT	EXHAUST FLOW CFM	RADIATION MONITOR SENSITIVITY (CPM/MIN/μCi/cc) PARTICULATE BETA SCINTILLATOR	RADIATION MONITOR SENSITIVITY (CPM/MIN/μCi/cc) IODINE BETA SCINTILLATOR	RADIATION MONITOR SENSITIVITY (CPM/μCi/cc) GAS NaI DETECTOR	RELEASE TERMINATION INTERLOCK (YES/NO) VALVES
HPR-219	328' Elevation Auxiliary Building	Station Vent Exhaust	140,000	5.30E11 (Sr-90)	3.89E12 (I-131)	7.81E7 (KR-85)	YES Trips AH-E-23A/B, 9A/B 12A/B, 7A/B Closes WDG-V-30A/B, D-5129A/B/C/D
HPR-219A	Adjacent to Station Stack	Station Vent Exhaust	140,000	..30E5 (SR-90)	2.90E4 (I-131)	2.06E7 (KR-85)	NONE
ALC-RMI-18	Chemical Cleaning Bldg. 304' Elevation	EPICOR II Exhaust System	8,000	1.40E5 CPM/μCi (SR-90)	2.86E4 CPM/μCi (I-131)	2.06E7 (KR-85)	NONE
WHP-RIT-1	WHPF Mechanical Equipment Room	WHPF Exhaust System	7,500	1.40E5 CPM/μCi (SR-90)	2.86E4 CPM/μCi (I-131)	2.06E7 (KR-85)	YES WHPF Ventilation Trips
RLM-RM 1	RLM Mechanical Equipment Room	RLM Exhaust System	900	7.04E4 CPM/μCi (SR-90)	----	----	NONE
HP-R-225	328' Elevation Auxiliary Building	Reactor Bldg Purge Exhaust Duct "A"	25,000	5.30E11 (SR-90)	3.89E12 (I-131)	7.81E7 (KR-85)	YES Closes D-5129A, 5128B. OPENS D-5129D, Trips AH-E-12A.
HP-R-226	328' Elevation Auxiliary Building	Reactor Bldg Purge Exhaust Duct "B"	25,000	5.30E11 (SR-90)	3.89E12 (I-131)	7.81E7 (KR-85)	YES Closes D-5129B, 5128C. OPENS D-5129C, Trips AH-E-12B.
PWD-RML-1	Near TMI-2 Air Intake Structure	TMI-2 Accident Generated Water Evaporator Stack	5.0 GPM	----	----	3.20E8 (Cs-137)	YES Closes Vaporizer Liquid Feed Valves.

TABLE 4.3

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radio-nuclide	Gamma Total Body Dose Factor(a) K_i (mrem/yr per $\mu Ci/m^3$)	Beta Skin Dose Factor(b) L_i (mrem/yr per $\mu Ci/m^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu Ci/m^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu Ci/m^3$)
Kr-83m	7.56E-02**	---	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

*Dose factors are for immersion exposure in uniform semi-infinite cloud of noble gas radionuclides that may be detected in gaseous effluents. Dose factor values are taken from Regulatory Guide 1.109 (Rev. 1), Table B-1.

**7.56E-02 = 7.56×10^{-2}.

(a) Total body dose factor for gamma penetration depth of 5 cm into the body.

(b) Skin dose factor at a tissue depth or tissue density thickness of 7 mg/cm^2.

TABLE 4.4

ATMOSPHERIC DISPERSION FACTORS FOR THREE MILE ISLAND

* STATION VENT
* SECTOR AVERAGE X/Q (IN SEC/M^3)

DISTANCE (IN METERS)

SEASON - ANNUAL

SECTOR	610	2413	4022	5631	7240	12067	24135	40225	56315	72405
N	1.18E-07	5.32E-07	2.95E-07	1.93E-07	1.39E-07	5.52E-08	1.91E-08	5.02E-09	1.88E-09	1.09E-09
NNE	1.70E-07	7.17E-07	3.45E-07	2.00E-07	1.39E-07	5.58E-08	1.70E-08	4.77E-09	1.8 09	9.69E-10
NE	1.12E-07	1.75E-07	3.26E-07	1.86E-07	1.21E-07	5.00E-08	1.67E-08	4.67E-09	1.85E-09	9.93E-10
ENE	1.09E-07	2.13E-07	2.67E-07	1.53E-07	1.05E-07	4.31E-08	1.42E-08	4.42E-09	1.59E-09	8.64E-10
E	2.31E-07	1.71E-07	1.52E-07	1.49E-07	1.06E-07	4.63E-08	1.52E-08	5.19E-09	2.48E-09	1.50E-09
ESE	3.50E-07	2.12E-07	2.50E-07	1.48E-07	9.48E-08	3.98E-08	1.50E-08	5.92E-09	2.92E-09	1.93E-09
SE	4.19E-07	3.79E-07	2.53E-07	1.55E-07	1.11E-07	4.82E-08	1.81E-08	6.84E-09	3.30E-09	2.22E-09
SSE	2.90E-07	3.62E-07	2.55E-07	1.49E-07	1.11E-07	5.02E-08	1.98E-08	6.97E-09	2.94E-09	1.70E-09
S	1.87E-07	6.47E-08	2.16E-07	1.30E-07	8.65E-08	4.09E-08	1.40E-08	4.96E-09	1.99E-09	1.04E-09
SSW	8.13E-08	4.16E-08	1.56E-07	1.03E-07	6.81E-08	2.74E-08	9.74E-09	3.01E-09	1.50E-09	8.23E-10
SW	5.76E-08	1.14E-07	1.70E-07	1.05E-07	6.93E-08	2.51E-08	9.34E-09	2.72E-09	1.33E-09	8.33E-10
WSW	8.52E-08	3.75E-07	2.14E-07	1.26E-07	7.74E-08	3.08E-08	1.02E-08	3.28E-09	1.38E-09	9.69E-10
W	1.15E-07	5.80E-07	2.88E-07	1.63E-07	1.18E-07	5.23E-08	1.72E-08	5.06E-09	1.98E-09	1.25E-09
WNW	1.41E-07	6.28E-07	3.30E-07	2.19E-07	1.48E-07	5.68E-08	1.95E-08	6.32E-09	2.16E-09	1.34E-09
NW	1.42E-07	5.67E-07	3.17E-07	1.93E-07	1.30E-07	5.67E-08	2.06E-08	5.90E-09	2.70E-09	1.45E-09
NNW	1.00E-07	5.77E-07	3.18E-07	1.80E-07	1.27E-07	5.20E-08	1.77E-08	4.82E-09	2.01E-09	1.22E-09

* STATION VENT
* SECTOR AVERAGE D/Q (IN M^{-2})

DISTANCE (IN METERS)

SEASON - ANNUAL

SECTOR	610	2413	4022	5631	7240	12067	24135	40225	56315	72405
N	2.51E-09	8.72E-10	4.64E-10	2.98E-10	2.50E-10	8.57E-11	2.51E-11	4.98E-12	1.57E-12	7.84E-13
NNE	3.89E-09	1.98E-09	9.54E-10	4.79E-10	3.38E-10	1.10E-10	2.89E-11	6.06E-12	2.10E-12	8.89E-13
NE	2.58E-09	6.70E-10	9.13E-10	4.91E-10	2.97E-10	1.04E-10	2.87E-11	6.01E-12	1.99E-12	9.23E-13
ENE	2.15E-09	5.85E-10	5.54E-10	3.06E-10	2.08E-10	8.30E-11	2.32E-11	5.41E-12	1.63E-12	7.64E-13
E	5.54E-09	1.23E-09	6.17E-10	4.59E-10	3.63E-10	1.34E-10	3.66E-11	9.44E-12	3.77E-12	1.97E-12
ESE	9.17E-09	2.05E-09	1.51E-09	8.66E-10	5.11E-10	1.82E-10	5.77E-11	1.72E-11	7.07E-12	4.07E-12
SE	1.22E-08	2.88E-09	1.84E-09	1.02E-09	6.85E-10	2.60E-10	8.30E-11	2.34E-11	9.42E-12	5.51E-12
SSE	7.50E-09	1.62E-09	1.08E-09	5.89E-10	4.49E-10	1.87E-10	6.16E-11	1.61E-11	5.67E-12	2.83E-12
S	3.86E-09	6.53E-10	6.27E-10	3.59E-10	2.32E-10	1.06E-10	3.05E-11	8.10E-12	2.73E-12	1.23E-12
SSW	1.13E-09	2.94E-10	4.19E-10	2.53E-10	1.56E-10	5.38E-11	1.68E-11	3.91E-12	1.64E-12	7.84E-13
SW	1.19E-09	3.84E-10	4.96E-10	2.80E-10	1.70E-10	5.24E-11	1.65E-11	3.62E-12	1.49E-12	8.12E-13
WSW	1.77E-09	8.31E-10	6.49E-10	3.50E-10	1.96E-10	6.73E-11	1.89E-11	4.58E-12	1.63E-12	9.90E-13
W	2.41E-09	1.29E-09	6.81E-10	3.65E-10	2.96E-10	1.12E-10	3.11E-11	6.90E-12	2.26E-12	1.25E-12
WNW	3.20E-09	1.39E-09	7.73E-10	5.91E-10	3.66E-10	1.19E-10	3.43E-11	8.36E-12	2.39E-12	1.29E-12
NW	3.25E-09	1.23E-09	7.39E-10	4.22E-10	2.77E-10	1.14E-10	7.28E-11	7.61E-12	2.92E-12	1.36E-12
NNW	1.98E-09	9.88E-10	5.71E-10	3.05E-10	2.23E-10	8.21E-11	2.41E-11	4.93E-12	1.72E-12	9.03E-13

DATA FROM 1/1/78 THROUGH 12/31/86 USED IN CALCULATIONS

TABLE 4.5

ATMOSPHERIC DISPERSION FACTORS FOR THREE MILE ISLAND

* GROUND RELEASE
* SECTOR AVERAGE X/Q (IN SEC/M^3)

DISTANCE (IN METERS)

SEASON - ANNUAL

SECTOR	610	2413	4022	5631	7240	12067	24135	40225	56315	72405
N	1.16E-05	1.13E-06	5.94E-07	3.80E-07	2.38E-07	9.74E-08	3.45E-08	9.26E-09	3.52E-09	2.05E-09
NNE	1.08E-05	1.10E-06	5.66E-07	3.41E-07	2.38E-07	9.55E-08	3.11E-08	8.94E-09	3.74E-09	1.84E-09
NE	7.02E-06	9.81E-07	5.42E-07	3.17E-07	2.10E-07	9.01E-08	3.10E-08	8.87E-09	3.54E-09	1.91E-09
ENE	7.14E-06	9.64E-07	4.92E-07	2.85E-07	1.97E-07	7.82E-08	2.64E-08	8.38E-09	3.04E-09	1.66E-09
E	8.49E-06	1.09E-06	5.48E-07	2.91E-07	1.87E-07	8.40E-08	2.82E-08	9.85E-09	4.75E-09	2.87E-09
ESE	6.51E-06	9.02E-07	4.49E-07	2.57E-07	1.67E-07	7.20E-08	2.77E-08	1.12E-08	5.54E-09	3.68E-09
SE	6.70E-06	9.06E-07	4.53E-07	2.81E-07	2.03E-07	8.94E-08	3.33E-08	1.28E-08	6.19E-09	4.18E-09
SSE	7.26E-06	9.25E-07	4.91E-07	2.87E-07	2.04E-07	9.18E-08	3.72E-08	1.32E-08	5.62E-09	3.26E-09
S	8.70E-06	9.08E-07	3.99E-07	2.41E-07	1.61E-07	7.31E-08	2.57E-08	9.23E-09	3.74E-09	1.95E-09
SSW	6.05E-06	7.01E-07	2.75E-07	1.86E-07	1.24E-07	5.06E-08	1.82E-08	5.71E-09	2.87E-09	1.58E-09
SW	5.94E-06	5.71E-07	2.86E-07	1.81E-07	1.22E-07	4.50E-08	1.72E-08	5.12E-09	2.53E-09	1.59E-09
WSW	6.00E-06	7.02E-07	3.60E-07	2.15E-07	1.34E-07	5.50E-08	1.87E-08	6.12E-09	2.62E-09	1.83E-09
W	1.02E-05	1.07E-06	5.30E-07	3.02E-07	2.05E-07	9.31E-08	3.15E-08	9.48E-09	3.74E-09	2.38E-09
WNW	1.16E-05	1.13E-06	5.98E-07	3.67E-07	2.53E-07	1.00E-07	3.56E-08	1.18E-08	4.07E-09	2.54E-09
NW	1.13E-05	1.06E-06	5.70E-07	3.53E-07	2.40E-07	1.02E-07	3.82E-08	1.11E-08	5.14E-09	2.78E-09
NNW	1.08E-05	1.04E-06	5.72E-07	3.27E-07	2.22E-07	9.06E-08	3.20E-08	8.89E-09	3.75E-09	2.29E-09

* GROUND RELEASE
* SECTOR AVERAGE D/Q (IN M^{-2})

DISTANCE (IN METERS)

SEASON - ANNUAL

SECTOR	610	2413	4022	5631	7240	12067	24135	40225	56315	72405
N	2.30E-08	1.88E-09	8.93E-10	4.82E-10	2.70E-10	8.96E-11	2.53E-11	4.98E-12	1.57E-12	7.84E-13
NNE	2.66E-08	2.25E-09	1.06E-09	5.42E-10	3.38E-10	1.10E-10	2.89E-11	6.06E-12	2.10E-12	8.89E-13
NE	1.75E-08	2.00E-09	1.01E-09	5.04E-10	2.98E-10	1.04E-10	2.88E-11	6.01E-12	1.99E-12	9.23E-13
ENE	1.68E-08	1.85E-09	8.65E-10	4.28E-10	2.65E-10	8.57E-11	2.33E-11	5.41E-12	1.63E-12	7.64E-13
E	2.08E-08	2.99E-09	1.39E-09	6.34E-10	3.67E-10	1.35E-10	3.68E-11	9.42E-12	3.77E-12	1.97E-12
ESE	3.55E-08	3.80E-09	1.77E-09	8.79E-10	5.15E-10	1.83E-10	5.78E-11	1.71E-11	7.06E-12	4.06E-12
SE	4.12E-08	4.55E-09	2.13E-09	1.15E-09	7.50E-10	2.72E-10	8.31E-11	2.34E-11	9.42E-12	5.50E-12
SSE	3.12E-08	3.23E-09	1.59E-09	8.00E-10	5.20E-10	1.88E-10	6.18E-11	1.61E-11	5.66E-12	2.83E-12
S	2.65E-08	2.21E-09	9.07E-10	4.75E-10	2.86E-10	1.07E-10	3.06E-11	8.10E-12	2.73E-12	1.23E-12
SSW	1.45E-08	1.30E-09	4.80E-10	2.82E-10	1.70E-10	5.71E-11	1.69E-11	3.91E-12	1.64E-12	7.84E-13
SW	1.42E-08	1.10E-09	5.15E-10	2.82E-10	1.71E-10	5.24E-11	1.65E-11	3.62E-12	1.49E-12	8.12E-13
WSW	2.01E-08	1.41E-09	6.82E-10	3.54E-10	2.00E-10	6.76E-11	1.89E-11	4.58E-12	1.63E-12	9.90E-13
W	2.55E-08	2.16E-09	1.00E-09	4.91E-10	3.01E-10	1.12E-10	3.11E-11	6.90E-12	2.27E-12	1.25E-12
WNW	2.88E-08	2.30E-09	1.13E-09	5.93E-10	3.67E-10	1.19E-10	3.43E-11	8.36E-12	2.39E-12	1.29E-12
NW	2.78E-08	2.15E-09	1.06E-09	5.58E-10	3.41E-10	1.19E-10	3.57E-11	7.61E-12	2.92E-12	1.36E-12
NNW	2.17E-08	1.75E-09	8.75E-10	4.24E-10	2.57E-10	8.55E-11	2.42E-11	4.93E-12	1.72E-12	9.03E-13

DATA FROM 1/1/76 THROUGH 12/31/86 USED IN CALCULATIONS

TABLE 4.6

DOSE PARAMETERS FOR RADIOIODINES AND RADIOACTIVE PARTICULATE IN GASEOUS EFFLUENTS*

NUCLIDE	CRITICAL ORGAN	ORGAN FACTOR	Pi***	NUCLIDE	CRITICAL ORGAN	ORGAN FACTOR	Pi***
H-3**	TOTAL BODY	4.62E-07	6.5E+02	Ru-105	GI-LLI	3.46E-05	4.8E+04
C-14	BONE	1.89E-05	2.6E+04	Ru-106	LUNG	8.26E-03	1.2E+07
Na-24	TOTAL BODY	7.54E-06	1.1E+04	Ag-110M	LUNG	2.62E-03	3.7E+06
Cr-51	LUNG	9.17E-06	1.3E+04	Sb-125	LUNG	1.17E-03	1.6E+06
Mn-54	LUNG	7.14E-04	1.0E+06	Te-125M	LUNG	3.19E-04	4.5E+05
Fe-55	LUNG	6.21E-05	8.7E+04	Te-132	LUNG	2.43E-04	3.4E+05
Fe-59	LUNG	7.25E-04	1.0E+06	I-131	THYROID	1.06E-02	1.5E+07
Co-58	LUNG	5.55E-04	7.8E+05	I-132	THYROID	1.21E-04	1.7E+05
Co-60	LUNG	3.22E-03	4.5E+06	I-133	THYROID	2.54E-03	3.6E+06
Ni-63	BONE	2.42E-04	3.4E+05	I-134	THYROID	3.18E-05	4.5E+04
Zn-65	LUNG	4.62E-04	6.5E+05	I-135	THYROID	4.97E-04	7.0E+05
Sr-89	LUNG	1.45E-03	2.0E+06	Cs-134	LIVER	5.02E-04	7.0E+05
Sr-90	BONE	2.92E-02	4.1E+07	Cs-136	LIVER	9.61E-05	1.3E+05
Y-90	LUNG	1.92E-04	2.7E+05	Cs-137	LIVER	4.37E-04	6.1E+05
Zr-95	LUNG	1.25E-03	1.8E+06	Ba-140	LUNG	1.14E-03	1.6E+06
Zr-97	GI-LLI	1.00E-04	1.3E+05	La-140	LUNG	1.20E-04	1.7E+05
Nb-95	LUNG	3.42E-04	4.8E+05	Ce-141	LUNG	3.69E-04	5.2E+05
Mo-99	LUNG	9.63E-05	1.3E+05	Ce-144	LUNG	7.03E-03	9.8E+06
Tc-99M	GI-LLI	1.45E-06	2.0E+03	Pr-144	GI-LLI	3.06E-06	4.3E+03
Ru-103	LUNG	3.94E-04	5.5E+05				

* The listed dose parameters are for radionuclides, other than noble gases that may be detected in gaseous effluents. Pi factors include all nonatmospheric pathway transport parameters, the receptor's usage of pathway media, and are based on the most restrictive age group (infant) critical organ, per TMI-1 Tech. Spec. Section 3.22.2.1. Additional dose parameters for nuclides not included in this Table may be calculated using the methodology described in NUREG-0133.

** Tritium dose factors include an increase of 50% to account for the additional amount of this nuclide absorbed through the skin.

*** mrem/year per $\mu Ci/m^3$.

FIGURE 4.1

TMI-1 GASEOUS EFFLUENT PATHWAYS

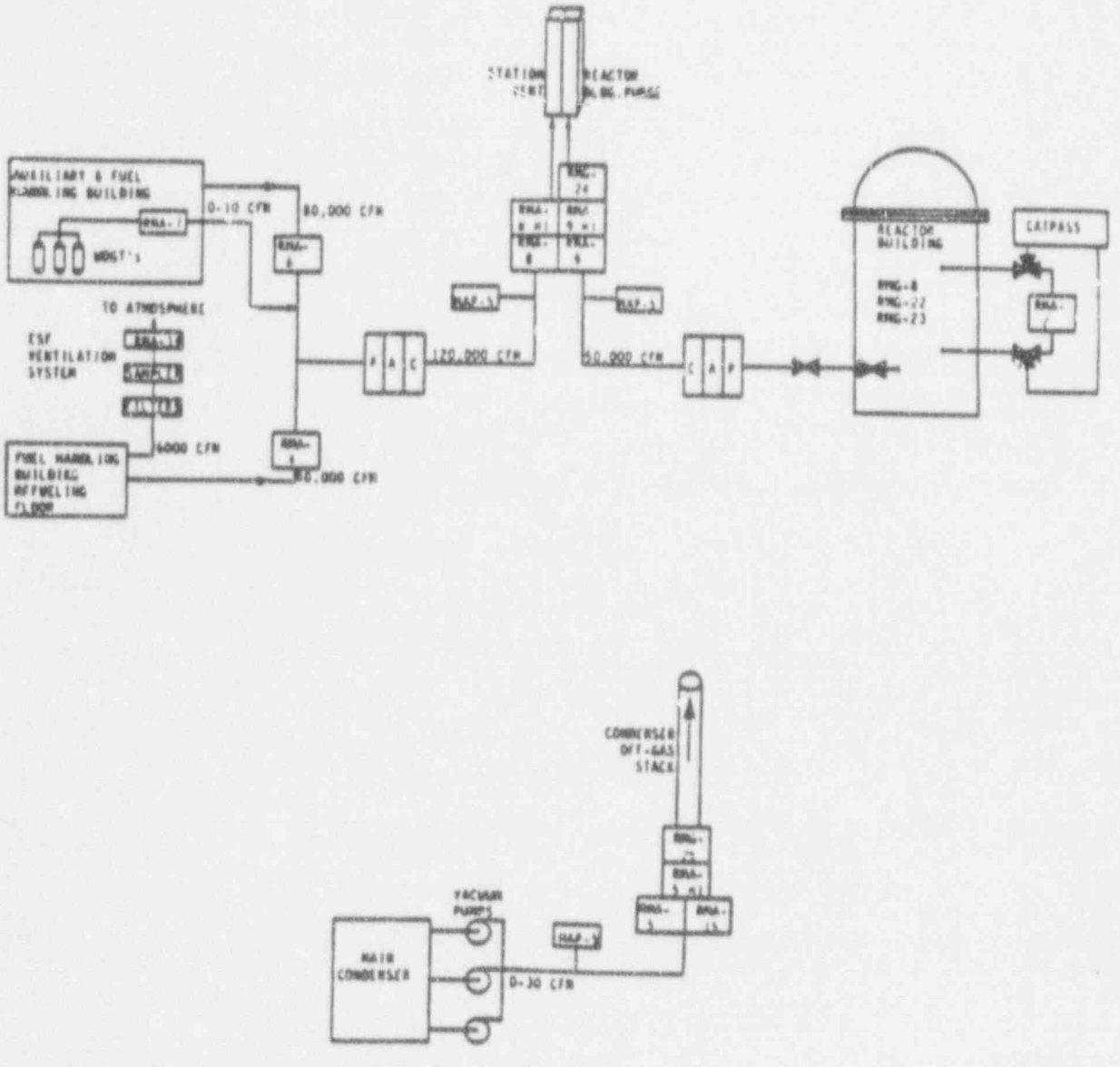


FIGURE 4.2

TMI-1 AUXILIARY AND FUEL HANDLING BUILDINGS EFFLUENT PATHWAYS

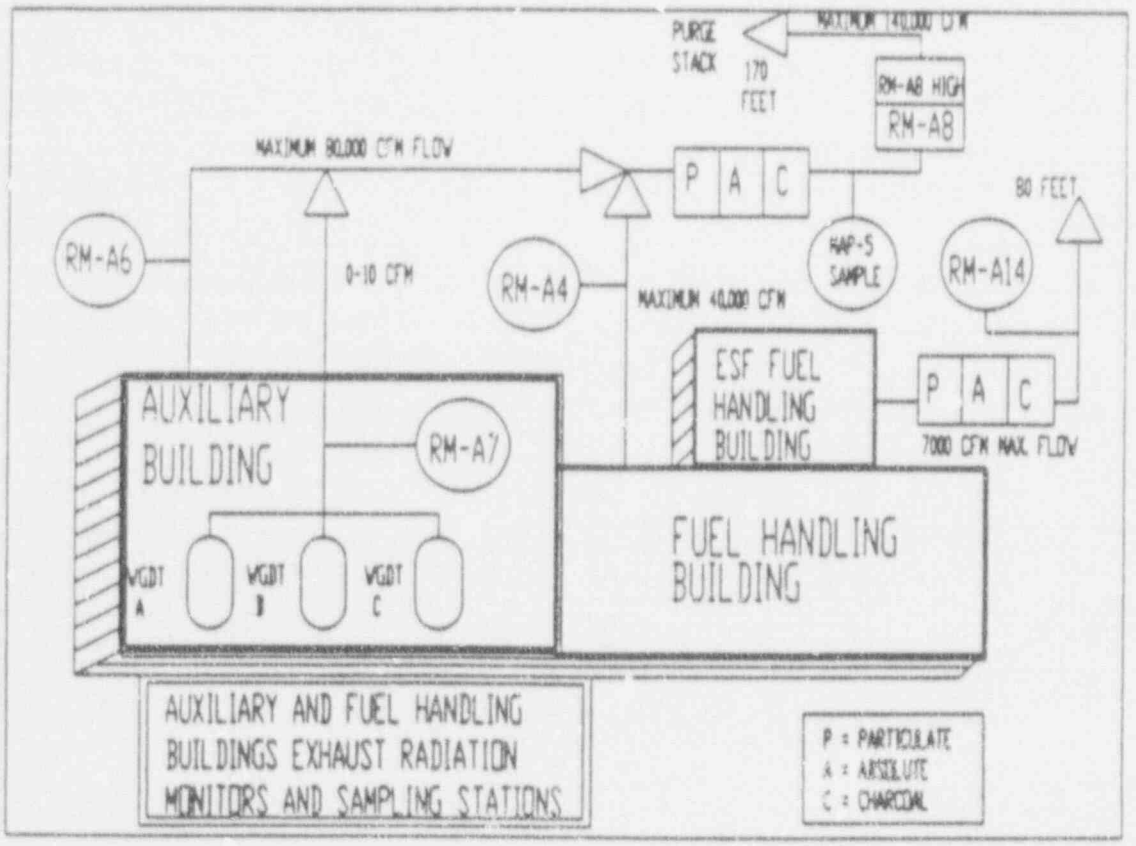


FIGURE 4.3

TMI-1 REACTOR BUILDING EFFLUENT PATHWAY

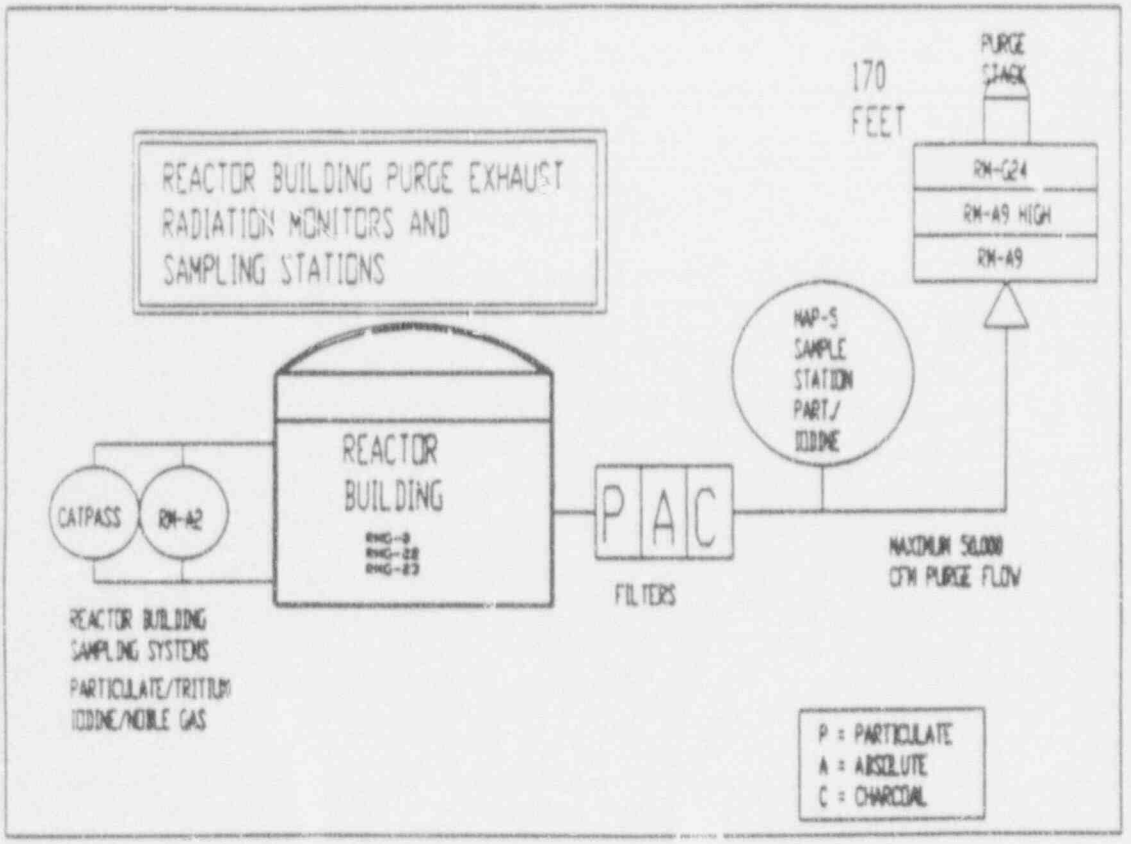


FIGURE 4.4

TMI-1 CONDENSER OFFGAS EFFLUENT PATHWAY

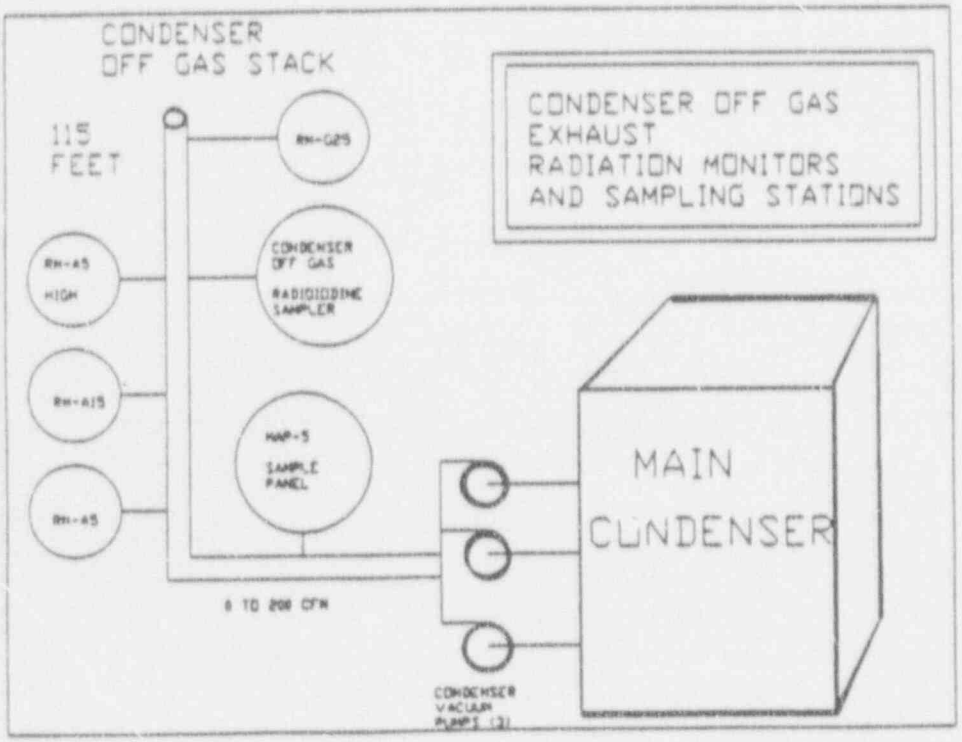
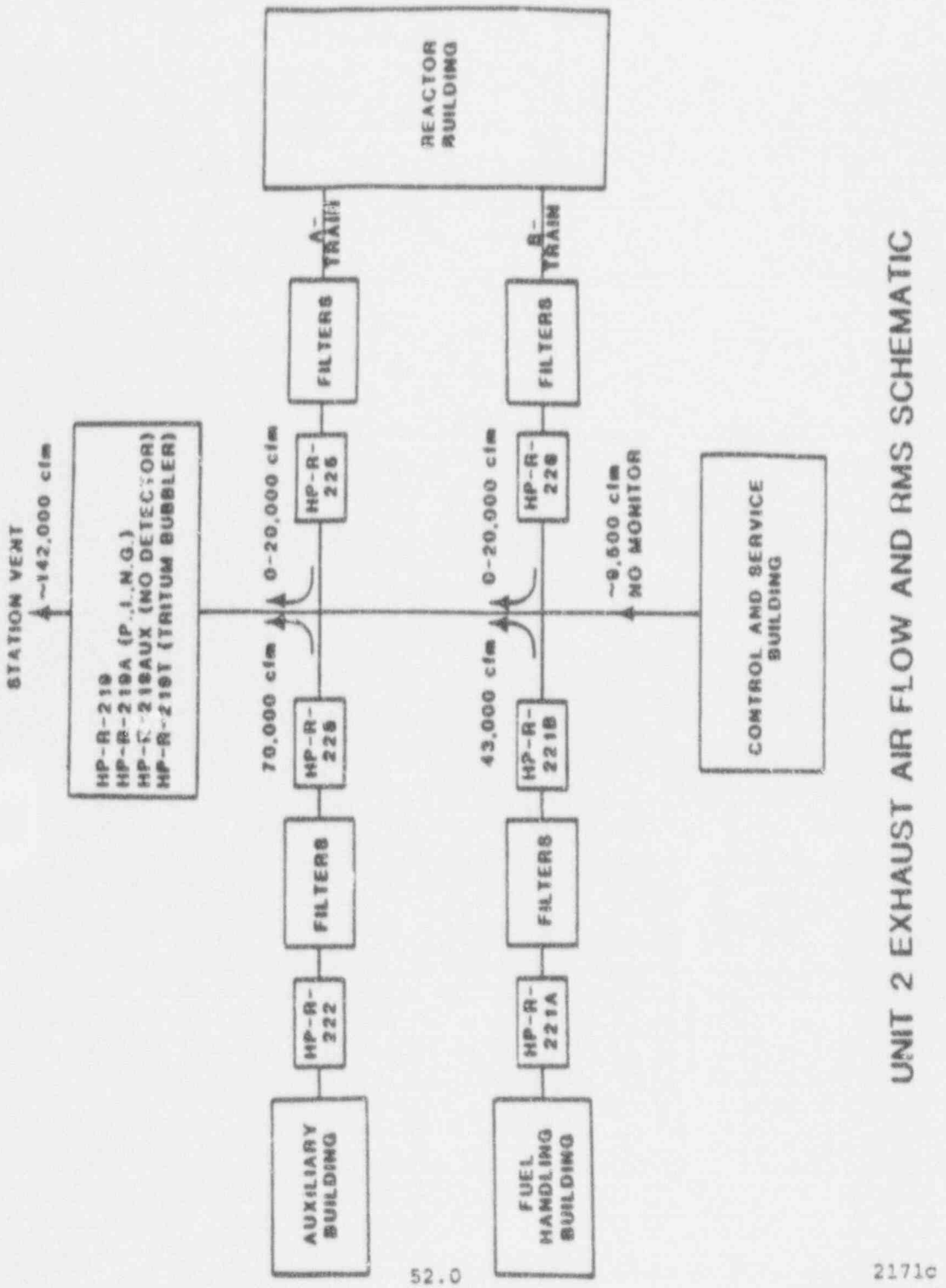


FIGURE 4.5

TMI-2 GASEOUS EFFLUENT PATHWAYS



5.0 GASEOUS EFFLUENT DOSE ASSESSMENT

5.1 Gaseous Effluents - 10 CFR 50 Limits (Instantaneous Release Limits)

5.1.1 Noble Gases

For noble gases, the following equations apply for total body and skin dose rate at the unrestricted area boundary:

5.1.1.1 Total Body

$$\text{Dose Rate}_{tb} = \sum_i (K_i) \times (Dv) \times (Q_i) \qquad \text{(eq 5.1.1.1)}$$

where:

Dose Rate_{tb} = instantaneous total body dose rate limit, at the site boundary, in mrem/yr.

K_i = total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 4.3.

Dv = average annual dispersion value X/Q at the site boundary for worst case sector, in sec/m^3. Values are obtained from Table 4.4 for releases from station vent; and Table 4.5 for all others (Condenser Off Gas, ESF FHB, and ground releases). Maximum values presently in use are 4.19E-7 sec/m^3 at sector SE for station vent, and 1.16E-5 sec/m^3 for all other releases, at sectors N and WNW.

Q_i = Release rate of radionuclide, i, in $\mu Ci/sec$. Calculated using the concentration of noble gas radionuclide, i, in $\mu Ci/cc$, times the release pathway flow rate, in cc/second.

5.2.1.2 Skin

$$\text{Dose Rate}_{sk} \leq \sum_i (L_i + 1.1\, M_i)\, \bar{X}\, (Dv)\, \dot{Q}_i \qquad \text{(eq 5.1.1.2)}$$

where:

Dose Rate_{sk} = instantaneous mrem/year skin dose rate limit, at the site boundary, in mrem/yr.

L_i = skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ from Table 4.3.

M_i = air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ from Table 4.3.

1.1 = mrem skin dose per mrad air dose. Converts air dose to skin dose.

Q_i = release rate of radionuclide, i, in $\mu Ci/sec$. Calculated using the concentration of noble gas radionuclide, i, times the release pathway flow rate, in cc/second.

Dv = average annual dispersion value X/Q at the site boundary for worst case sector, in sec/m^3. Values are obtained from Table 4.4 for releases from station vent; and Table 4.5 for all others (Condenser Off Gas, ESF FHB, and ground releases). Maximum values presently in use are 4.19E-7 sec/m^3 at sector SE for station vent, and 1.16E-5 sec/m^3 for all other releases, at sectors N and WNW.

5.1.2 Iodine-131, Iodine-133, Tritium and Radionuclides in Particulate Form, with Half-Lives Greater than 8 Days

For I-131, I-133, Tritium and Radionuclides in Particulate Form, with half-lives greater than 8 days, the following equation applies:

$$\text{Dose Rate}_{IP} = \sum_i (P_i)\ (Dv)\ (Q_i) \qquad \text{(eq 5.1.2)}$$

where:

Dose Rate_{IP} = mrem/year organ dose rate.

P_i = dose parameter for I-131, I-133, Tritium and Radionuclides in Particulate Form, with half-lives greater than 8 days, for the inhalation pathway, in mrem/yr per $\mu Ci/m^3$, from Table 4.6. The dose factors are based on the critical individual organ and most restrictive age group (infant).

Dv = the annual average atmospheric dispersion parameter, for the worst-case sector, for estimating the dose to the critical receptor; X/Q for the inhalation pathway, in sec/m^3. Dispersion factors may be read or interpolated from Table 4.4 for releases from the station vent and Table 4.5 for all other releases. Maximum values of X/Q presently used are 4.19E-7 sec/m^3 for station vent, at sector SE, and 1.16E-5 sec/m^3 for all other releases, at sectors N and WNW.

Q_i = release rate of each radionuclide, i, in $\mu Ci/sec$. Calculated using the concentration of each radionuclide, i, times the release pathway flow rate, in cc/second.

5.2 Gaseous Effluents - 10 CFR 50 Appendix I

5.2.1 Noble Gases

The air dose in an unrestricted area due to noble gases released in gaseous effluents from the site is determined using the following expressions:

$$\text{Dose } \Gamma = (3.17E\text{-}8) \times \sum_i (M_i) \times (Dv) \times (Qi) \qquad \text{(eq 5.2.1)}$$

and

$$\text{Dose } B = (3.17E\text{-}8) \times \sum_i (N_i) \times (Dv) \times (Qi) \qquad \text{(eq 5.2.2)}$$

where:

Dose Γ = mrad gamma air dose due to gamma emissions from noble gas radionuclides.

Dose B = mrad beta air dose due to beta emissions from noble gas radionuclides.

M_i = air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$, from Table 4.3.

N_i = air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$, from Table 4.3.

Dv = the maximum annual average atmospheric dispersion factor, Q/X, for the worst-case sector, for any area at or beyond the unrestricted area boundary, in sec/m^3. Values may be read or interpolated from Table 4.4 for releases from the station vent and Table 4.5 for all other releases. Maximum values of X/Q presently used are 4.19E-7 sec/m^3 for station vent at sector SE, and 1.16E-5 sec/m^3 for all other releases at sectors N or WNW.

Q_i = release of noble gas radionuclide, i, in μCi, over the specified time period, (μCi/second * seconds).

3.17E-8 = inverse of the number of seconds in a year.

NOTE: If the methodology in this section is used in determining dose to an individual, rather than air dose due to noble gases, substitute Ki, from Table 4.3, for Mi, and (Li + 1.1 Mi) for Ni.

5.2.2 Iodine-131, Iodine-133, Tritium and Radionuclides in Particulate Form, with Half-Lives Greater than 8 Days

The dose to an individual from I-131, I-133, Tritium and Radionuclides in Particulate Form with half-lives greater than 8 days in gaseous effluents released from the site to an unrestricted area is determined by solving the following expression:

$$Dose_o = (3.17E\text{-}8) \times \sum_i (R_i)\ (Dv)\ (Q_i) \qquad \text{(eq 5.2.2)}$$

where:

$Dose_o$ = dose to all real pathways, p, to organ, o, of an individual in age group, a, from I-131, I-133, Tritium and Radionuclides in Particulate Form, with half-lives greater than 8 days, in mrem, during any desired time period.

R_i = the dose factor for each identified radionuclide, i, pathway, p, age group, a, and organ, o, in mrem/yr per $\mu Ci/m^3$ for the inhalation pathway and m^2 - mrem/yr per $\mu Ci/sec$ for other pathways, from Tables 5.2 to 5.7.

NOTE: Since there is minimal or no elemental iodine released from the condenser off-gas air ejector (see NUREG-0017) all iodine R_i values for all pathways, except the inhalation pathway are considered to be zero when performing dose calculations for releases from the condenser off-gas air ejector. Only calculate the dose due to the inhalation pathway for condenser off-gas air ejector iodines.

NOTE: Tritium, H-3, dose factor is mrem/year per $\mu Ci/m^3$ for all pathways.

Dv = the annual average atmospheric dispersion parameter, for the worst case sector, for estimating the dose to an individual at the critical location; X/Q, in sec/m^3, for the inhalation pathway, and D/Q, in m^{-2}, for other pathways. Maximum values of X/Q in sec/m^3 for station vent and all other releases are 4.19E-7 and 1.16E-5 for sectors SE and N, WNW respectively. Maximum values of D/Q in m^{-2} for station vent and all other releases are 1.22E-8 and 4.12E-8 for sector SE.

Dv(H-3) = In the case of H-3 only X/Q's are used for all pathways. Dispersion factors may be read or interpolated from Table 4.4 for station vent releases and Table 4.5 for all other releases.

Q_i = release of I-131, I-133, Tritium and Radionuclides, i, in Particulate Form with half-lives greater than 8 days, in μCi, cumulative over the specified time period (μCi/second * seconds).

3.17E-8 = inverse of the number of seconds in a year.

5.3 Gaseous Radioactive System Dose Calculations Once per Month

TMI-1 Tech. Spec. Section 3.22.2.4 requires that appropriate subsystem of the Gaseous Radwaste Treatment System shall be used to reduce the radioactive materials in gaseous waste prior to their discharge. When the monthly projected doses due to the gaseous effluent releases from the site would exceed:

0.2 mrad to air from gamma radiation; or
0.4 mrad to air from beta radiation; or
0.3 mrem to any organ.

The following calculational method is provided for performing this dose projection.

At least once a calendar month the gamma air dose, beta air dose and the maximum organ dose for the month will be integrated. An estimated projected gamma air dose, beta air dose, and the maximum organ dose for the next month will be determined based on plant operation and the integrated dose for the previous month. If these estimated projected doses exceed any of the values listed above, appropriate portions of the Gaseous Waste Processing System shall be used to reduce radioactivity levels prior to release.

5.4 Alternative Dose Calculational Methodologies for Gaseous Effluents

As an alternative to the methods described above, the models in/or based upon, those presented in Regulatory Guide 1.109 (Rev. 1) may be used to make a comprehensive dose assessment. Default parameter values from Regulatory Guide 1.109 (Rev. 1) and/or actual site specific data can be used where applicable. Dispersion parameter values for such analyses may be drawn from Tables 4.4 and 4.5 or may be computed from site meteorological data for the specified time period using acceptable models such as those presented in Regulatory Guide 1.111 (Rev. 1).

TABLE 5.2.1

PATHWAY DOSE FACTORS, Ri

AGE GROUP: INFANT PATHWAY: INHALATION

NUCLIDE	ORGAN DOSE FACTORS; mrem/year per $\mu Ci/m^3$						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
C-14	2.65E+04	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03
CR-51	0.00E+00	0.00E+00	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02
MN-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	1.00E+06	7.06E+03
FE-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03
FE-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
CO-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
CO-60	0.00E+00	8.02E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
NI-63	3.39E+05	2.04E+04	1.16E+04	0.00E+00	0.00E+00	2.09E+05	2.42E+03
ZN-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
RB-86	0.00E+00	1.90E+05	8.82E+04	0.00E+00	0.00E+00	0.00E+00	3.04E+03
SR-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
SR-90	4.09E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05
Y-91	5.88E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.03E+04
ZR-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
NB-95	1.57E+04	6.43E+03	3.78E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04
RU-103	2.02E+03	0.00E+00	6.79E+02	0.00E+00	4.24E+03	5.52E+05	1.61E+04
RU-106	8.68E+04	0.00E+00	1.09E+04	0.00E+00	1.07E+05	1.16E+07	1.64E+05
AG-110M	9.98E+03	7.22E+03	5.00E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04
TE-125M	4.76E+03	1.99E+03	6.58E+02	1.62E+03	0.00E+00	4.47E+05	1.29E+04
TE-127M	1.67E+04	6.90E+03	2.07E+03	4.87E+03	3.75E+04	1.31E+06	2.73E+04
TE-129M	[illegible]+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04
I-131	[illegible]04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-133	[illegible]+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03
CS-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
CS-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
CS-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
BA-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
CE-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
CE-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.84E+06	1.48E+05
PR-143	1.40E+04	5.24E+03	6.99E+02	0.00E+00	1.97E+03	4.33E+05	3.72E+04
ND-147	7.94E+03	8.13E+03	5.00E+02	0.00E+00	3.15E+03	3.22E+05	3.12E+04

TABLE 5.2.2

PATHWAY DOSE FACTORS, Ri

AGE GROUP: CHILD PATHWAY: INHALATION

NUCLIDE	ORGAN DOSE FACTORS; mrem/year per µCi/m³						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
C-14	3.59E+04	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03
CR-51	0.00E+00	0.00E+00	1.54E+02	55E+01	2.43E+01	1.70E+04	1.08E+03
MN-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
FE-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
FE-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
CO-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
CO-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
NI-63	8.21E+05	4.63E+04	2.80E+04	0.00E+00	0.00E+00	2.75E+05	6.33E+03
ZN-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04
RB-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.99E+03
SR-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
SR-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.43E+05
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05
ZR-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
NB-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04
RU-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04
RU-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
AG-110M	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	2.00E+05
TE-125M	6.73E+03	2.33E+03	9.14E+02	1.92E+03	0.00E+00	4.77E+05	3.38E+04
TE-127M	2.49E+04	8.55E+03	3.02E+03	6.07E+03	6.36E+04	1.48E+06	7.14E+04
TE-129M	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.33E+06	2.33E+04	0.00E+00	5.48E+03
CS-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03
CS-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
CS-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
BA-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
CE-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
CE-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05
PR-143	1.85E+04	5.55E+03	9.14E+02	0.00E+00	3.00E+03	4.33E+05	9.73E+04
ND-147	1.08E+04	8.73E+03	6.81E+02	0.00E+00	4.81E+03	3.28E+05	8.21E+04

TABLE 5.2.3

PATHWAY DOSE FACTORS, Ri

AGE GROUP: TEEN PATHWAY: INHALATION

NUCLIDE	ORGAN DOSE FACTORS; mrem/year per $\mu Ci/m^3$						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
C-14	2.60E+04	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03
CR-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
MN-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
FE-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
FE-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
CO-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
CO-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
NI-63	5.80E+05	4.34E+04	1.98E+04	0.00E+00	0.00E+00	3.07E+05	1.42E+04
ZN-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.66E+04
RB-86	0.00E+00	1.90E+05	8.40E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04
SR-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
SR-90	1.08E+08	0.00E+00	6.68E+06	0.00E+00	0.00E+00	1.65E+07	7.65E+05
Y-91	6.61E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.94E+06	4.09E+05
ZR-95	1.46E+05	4.58E+04	3.15E+04	0.00E+00	6.74E+04	2.59E+06	1.49E+05
NB-95	1.86E+04	1.03E+04	5.66E+03	0.00E+00	1.00E+04	7.51E+05	9.68E+04
RU-103	2.10E+03	0.00E+00	8.95E+02	0.00E+00	7.43E+03	7.83E+05	1.09E+05
RU-106	9.84E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.60E+05
AG-110M	1.38E+04	1.31E+04	7.99E+03	0.00E+00	2.50E+04	6.75E+06	2.73E+05
TE-125M	4.88E+03	2.24E+03	6.67E+02	1.40E+03	0.00E+00	5.36E+05	7.50E+04
TE-127M	1.80E+04	8.16E+03	2.18E+03	4.38E+03	6.54E+04	1.66E+06	1.59E+05
TE-129M	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
CS-134	5.02E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
CS-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
CS-137	6.70E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
BA-140	5.47E+04	6.70E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
CE-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
CE-144	4.89E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05
PR-143	1.34E+04	5.31E+03	6.62E+02	0.00E+00	3.09E+03	4.83E+05	2.14E+05
ND-147	7.86E+03	8.56E+03	5.13E+02	0.00E+00	5.02E+03	3.72E+05	1.82E+05

TABLE 5.2.4

PATHWAY DOSE FACTORS, Ri

AGE GROUP: ADULT PATHWAY: INHALATION

NUCLIDE	ORGAN DOSE FACTORS; mrem/year per $\mu Ci/m^3$						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
C-14	1.82E+04	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03
CR-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
MN-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
FE-55	2.46E+04	1.70E+04	3.94E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
FE-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
CO-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
CO-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
NI-63	4.32E+05	3.14E+04	1.65E+04	0.00E+00	0.00E+00	1.78E+06	1.34E+04
ZN-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.34E+04
RB-86	0.00E+00	1.35E+05	5.90E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04
SR-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
SR-90	5.92E+07	0.00E+00	6.10E+06	0.00E+00	0.00E+00	9.60E+06	7.22E+05
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.85E+05
ZR-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
NB-95	1.41E+04	7.82E+03	4.21E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05
RU-103	1.53E+03	0.00E+00	6.58E+02	0.00E+00	5.83E+03	5.05E+05	1.10E+05
RU-106	6.91E+04	0.00E+00	8.72E+03	0.00E+00	1.34E+05	9.36E+06	9.12E+05
AG-110M	1.08E+04	1.00E+04	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05
TE-125M	3.42E+03	1.58E+03	4.67E+02	1.05E+03	1.24E+04	3.14E+05	7.06E+04
TE-127M	1.26E+04	5.77E+03	1.57E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05
TE-129M	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	0.00E+00	8.88E+03
CS-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
CS-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
CS-137	4.78E+05	6.21E+05	4.28E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03
BA-140	3.90E+04	4.90E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
CE-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.26E+03	3.62E+05	1.20E+05
CE-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05
PR-143	9.36E+03	3.75E+03	4.64E+02	0.00E+00	2.16E+03	2.81E+05	2.00E+05
ND-147	5.27E+03	6.10E+03	3.65E+02	0.00E+00	3.56E+03	2.21E+05	1.73E+05

TABLE 5.3.1

PATHWAY DOSE FACTORS, Ri

AGE GROUP: ALL PATHWAY: GROUND PLANE

NUCLIDE	ORGAN DOSE FACTORS*	
	T.BODY	SKIN
H-3	0.00E+00	0.00E+00
C-14	0.00E+00	0.00E+00
CR-51	4.65E+06	5.50E+06
MN-54	1.39E+09	1.62E+09
FE-55	0.00E+00	0.00E+00
FE-59	2.73E+08	3.21E+08
CO-58	3.79E+08	4.44E+08
CO-60	2.15E+10	2.53E+10
NI-63	0.00E+00	0.00E+00
ZN-65	7.47E+08	8.59E+08
RB-86	8.97E+06	1.03E+07
SR-89	2.16E+04	2.51E+04
SR-90	0.00E+00	0.00E+00
Y-91	1.07E+06	1.21E+06
ZR-95	2.45E+08	2.84E+08
NB-95	1.37E+08	1.61E+08
RU-103	1.08E+08	1.26E+08
RU-106	4.28E+08	5.06E+08
AG-110M	3.44E+09	4.01E+09
TE-125M	1.55E+06	2.13E+06
TE-127M	9.17E+04	1.08E+05
TE-129M	1.98E+07	2.31E+07
I-131	1.72E+07	2.09E+07
I-133	2.45E+06	2.98E+06
CS-134	6.86E+09	8.00E+09
CS-136	1.51E+08	1.71E+08
CS-137	1.03E+10	1.20E+10
BA-140	2.06E+07	2.36E+07
CE-141	1.37E+07	1.54E+07
CE-144	6.96E+07	8.05E+07
PR-143	0.00E+00	0.00E+00
ND-147	8.39E+06	1.01E+07

* m^2 - mrem/year per µCi/sec.

TABLE 5.4.1

PATHWAY DOSE FACTORS, Ri

AGE GROUP: INFANT PATHWAY: GRASS-COW-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03
C-14	2.34E+09	5.00E+08	5.00E+08	5.00E+08	5.00E+08	5.00E+08	5.00E+08
CR-51	0.00E+00	0.00E+00	1.61E+05	1.05E+05	2.30E+04	2.05E+05	4.70E+06
MN-54	0.00E+00	3.91E+07	8.85E+06	0.00E+00	8.65E+06	0.00E+00	1.43E+07
FE-55	1.35E+08	8.74E+07	2.34E+07	0.00E+00	0.00E+00	4.27E+07	1.11E+07
FE-59	2.25E+08	3.93E+08	1.55E+08	0.00E+00	0.00E+00	1.16E+08	1.88E+08
CO-58	0.00E+00	2.43E+07	6.06E+07	0.00E+00	0.00E+00	0.00E+00	6.05E+07
CO-60	0.00E+00	8.83E+07	2.08E+08	0.00E+00	0.00E+00	0.00E+00	2.10E+08
NI-63	3.50E+10	2.16E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	1.08E+08
ZN-65	5.56E+09	1.91E+10	8.79E+09	0.00E+00	9.24E+09	0.00E+00	1.61E+10
RB-86	0.00E+00	2.23E+10	1.10E+10	0.00E+00	0.00E+00	0.00E+00	5.70E+08
SR-89	1.26E+10	0.00E+00	3.62E+08	0.00E+00	0.00E+00	0.00E+00	2.59E+08
SR-90	1.22E+11	0.00E+00	3.10E+10	0.00E+00	0.00E+00	0.00E+00	1.52E+09
Y-91	7.34E+04	0.00E+00	1.95E+03	0.00E+00	0.00E+00	0.00E+00	5.26E+06
ZR-95	6.81E+03	1.66E+03	1.18E+03	0.00E+00	1.79E+03	0.00E+00	8.27E+05
NB-95	5.94E+05	2.45E+05	1.41E+05	0.00E+00	1.75E+05	0.00E+00	2.07E+08
RU-103	8.68E+03	0.00E+00	2.90E+03	0.00E+00	1.81E+04	0.00E+00	1.06E+05
RU-106	1.91E+05	0.00E+00	2.38E+04	0.00E+00	2.25E+05	0.00E+00	1.45E+06
AG-110M	3.86E+08	2.82E+08	1.87E+08	0.00E+00	4.03E+08	0.00E+00	1.46E+10
TE-125M	1.51E+08	5.05E+07	2.04E+07	5.08E+07	0.00E+00	0.00E+00	7.19E+07
TE-127M	4.22E+08	1.40E+08	5.10E+07	1.22E+08	1.04E+09	0.00E+00	1.70E+08
TE-129M	5.58E+08	1.91E+08	8.59E+07	2.14E+08	1.39E+09	0.00E+00	3.33E+08
I-131	2.72E+09	3.21E+09	1.41E+09	1.05E+12	3.75E+09	0.00E+00	1.15E+08
I-133	3.63E+07	5.29E+07	1.55E+07	9.62E+09	6.22E+07	0.00E+00	8.96E+06
CS-134	3.65E+10	6.81E+10	6.88E+09	0.00E+00	1.75E+10	7.19E+09	1.85E+08
CS-136	1.98E+09	5.83E+09	2.18E+09	0.00E+00	2.32E+09	4.75E+08	8.85E+07
CS-137	5.15E+10	6.03E+10	4.27E+09	0.00E+00	1.62E+10	6.55E+09	1.89E+08
BA-140	2.42E+08	2.42E+05	1.25E+07	0.00E+00	5.75E+04	1.49E+05	5.94E+07
CE-141	4.34E+04	2.65E+04	3.12E+03	0.00E+00	8.17E+03	0.00E+00	1.37E+07
CE-144	2.33E+06	9.53E+05	1.30E+05	0.00E+00	3.85E+05	0.00E+00	1.34E+08
PR-143	1.40E+03	5.56E+02	7.37E+01	0.00E+00	2.07E+02	0.00E+00	7.84E+05
ND-147	8.83E+02	9.07E+02	5.55E+01	0.00E+00	3.50E+02	0.00E+00	5.75E+05

TABLE 5.4.2

PATHWAY DOSE FACTORS, Ri

AGE GROUP: CHILD PATHWAY: GRASS-COW-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03
C-14	1.20E+09	2.39E+08	2.39E+08	2.39E+08	2.39E+08	2.39E+08	2.39E+08
CR-51	0.00E+00	0.00E+00	1.02E+05	5.65E+04	1.54E+04	1.03E+05	5.40E+06
MN-54	0.00E+00	2.10E+07	5.59E+06	0.00E+00	5.89E+06	0.00E+00	1.76E+07
FE-55	1.12E+08	5.94E+07	1.84E+07	0.00E+00	0.00E+00	3.36E+07	1.10E+07
FE-59	1.20E+08	1.95E+08	9.70E+07	0.00E+00	0.00E+00	5.65E+07	2.03E+08
CO-58	0.00E+00	1.21E+07	3.72E+07	0.00E+00	0.00E+00	0.00E+00	7.08E+07
CO-60	0.00E+00	4.32E+07	1.27E+08	0.00E+00	0.00E+00	0.00E+00	2.39E+08
NI-63	2.97E+10	1.59E+09	1.01E+09	0.00E+00	0.00E+00	0.00E+00	1.07E+08
ZN-65	4.14E+09	1.10E+10	6.86E+09	0.00E+00	6.95E+09	0.00E+00	1.94E+09
RB-86	0.00E+00	8.78E+09	5.40E+09	0.00E+00	0.00E+00	0.00E+00	5.65E+08
SR-89	6.63E+09	0.00E+00	1.89E+08	0.00E+00	0.00E+00	0.00E+00	2.57E+03
SR-90	1.12E+11	0.00E+00	2.84E+10	0.00E+00	0.00E+00	0.00E+00	1.51E+09
Y-91	3.91E+04	0.00E+00	1.05E+03	0.00E+00	0.00E+00	0.00E+00	5.21E+06
ZR-95	3.84E+03	8.43E+02	7.51E+02	0.00E+00	1.21E+03	0.00E+00	8.80E+05
NB-95	3.18E+05	1.24E+05	8.86E+04	0.00E+00	1.15E+05	0.00E+00	2.29E+08
RU-103	4.29E+03	0.00E+00	1.65E+03	0.00E+00	1.08E+04	0.00E+00	1.11E+05
RU-106	9.25E+04	0.00E+00	1.15E+04	0.00E+00	1.25E+05	0.00E+00	1.44E+06
AG-110M	2.09E+08	1.41E+08	1.13E+08	0.00E+00	2.63E+08	0.00E+00	1.68E+10
TE-125M	7.39E+07	2.00E+07	9.85E+06	2.07E+07	0.00E+00	0.00E+00	7.13E+07
TE-127M	2.08E+08	5.61E+07	2.47E+07	4.98E+07	5.94E+08	0.00E+00	1.69E+08
TE-129M	2.72E+08	7.59E+07	4.22E+07	8.76E+07	7.98E+08	0.00E+00	3.31E+08
I-131	1.31E+09	1.31E+09	7.46E+08	4.34E+11	2.16E+09	0.00E+00	1.17E+08
I-133	1.72E+07	2.13E+07	8.05E+06	3.95E+09	3.55E+07	0.00E+00	8.58E+06
CS-134	2.27E+10	3.72E+10	7.85E+09	0.00E+00	1.15E+10	4.14E+09	2.01E+08
CS-136	1.01E+09	2.79E+09	1.80E+09	0.00E+00	1.49E+09	2.21E+08	9.80E+07
CS-137	3.23E+10	3.09E+10	4.56E+09	0.00E+00	1.01E+10	3.62E+09	1.93E+08
BA-140	1.18E+08	1.03E+05	6.86E+06	0.00E+00	3.35E+04	6.14E+04	5.96E+07
CE-141	2.19E+04	1.09E+04	1.62E+03	0.00E+00	4.79E+03	0.00E+00	1.36E+07
CE-144	1.63E+06	5.09E+05	8.67E+04	0.00E+00	2.82E+05	0.00E+00	1.33E+08
PR-143	7.18E+02	2.16E+02	3.56E+01	0.00E+00	1.17E+02	0.00E+00	7.75E+05
ND-147	4.45E+02	3.61E+02	2.79E+01	0.00E+00	1.98E+02	0.00E+00	5.71E+05

TABLE 5.4.3

PATHWAY DOSE FACTORS, Ri

AGE GROUP: TEEN PATHWAY: GRASS-COW-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	9.93E+02	9.93E+02	9.93E+02	9.93E+02	9.93E+02	9.93E+02
C-14	4.86E+08	9.73E+07	9.73E+07	9.73E+07	9.73E+07	9.73E+07	9.73E+07
CR-51	0.00E+00	0.00E+00	4.99E+04	2.77E+04	1.09E+04	7.13E+04	8.39E+06
MN-54	0.00E+00	1.40E+07	2.78E+06	0.00E+00	4.19E+06	0.00E+00	2.88E+07
FE-55	4.46E+07	3.10E+07	7.37E+06	0.00E+00	0.00E+00	2.01E+07	1.37E+07
FE-59	5.19E+07	1.21E+08	4.60E+07	0.00E+00	0.00E+00	3.82E+07	2.86E+08
CO-58	0.00E+00	7.94E+06	1.83E+07	0.00E+00	0.00E+00	0.00E+00	1.10E+08
CO-60	0.00E+00	2.78E+07	6.27E+07	0.00E+00	0.00E+00	0.00E+00	3.62E+08
NI-63	1.18E+10	8.36E+08	4.01E+08	0.00E+00	0.00E+00	0.00E+00	1.33E+08
ZN-65	2.11E+09	7.32E+09	3.42E+09	0.00E+00	4.69E+09	0.00E+00	3.10E+09
RB-86	0.00E+00	4.73E+09	2.22E+09	0.00E+00	0.00E+00	0.00E+00	7.00E+08
SR-89	2.89E+09	0.00E+00	7.67E+07	0.00E+00	0.00E+00	0.00E+00	3.19E+08
SR-90	6.62E+10	0.00E+00	1.63E+10	0.00E+00	0.00E+00	0.00E+00	1.86E+09
Y-91	1.58E+04	0.00E+00	4.24E+02	0.00E+00	0.00E+00	0.00E+00	6.48E+06
ZR-95	1.65E+03	5.21E+02	3.58E+02	0.00E+00	7.65E+02	0.00E+00	1.20E+06
NB-95	1.41E+05	7.82E+04	4.30E+04	0.00E+00	7.58E+04	0.00E+00	3.34E+08
RU-103	1.81E+03	0.00E+00	7.75E+02	0.00E+00	6.39E+03	0.00E+00	1.51E+05
RU-106	3.76E+04	0.00E+00	4.73E+03	0.00E+00	7.24E+04	0.00E+00	1.80E+06
AG-110M	9.64E+07	9.12E+07	5.55E+07	0.00E+00	1.74E+08	0.00E+00	2.56E+10
TE-125M	3.01E+07	1.08E+07	4.02E+06	8.40E+06	0.00E+00	0.00E+00	8.87E+07
TE-127M	8.45E+07	3.00E+07	1.00E+07	2.01E+07	3.42E+08	0.00E+00	2.11E+08
TE-129M	1.10E+08	4.09E+07	1.74E+07	3.56E+07	4.61E+08	0.00E+00	4.14E+08
I-131	5.38E+08	7.53E+08	4.05E+08	2.20E+11	1.30E+09	0.00E+00	1.49E+08
I-133	7.08E+06	1.20E+07	3.66E+06	1.68E+09	2.11E+07	0.00E+00	9.09E+06
CS-134	9.83E+09	2.31E+10	1.07E+10	0.00E+00	7.35E+09	2.81E+09	2.88E+08
CS-136	4.49E+08	1.77E+09	1.19E+09	0.00E+00	9.63E+08	1.52E+08	1.42E+08
CS-137	1.34E+10	1.78E+10	6.21E+09	0.00E+00	6.06E+09	2.36E+09	2.54E+08
BA-140	4.87E+07	5.97E+04	3.14E+06	0.00E+00	2.02E+04	4.01E+04	7.51E+07
CE-141	8.89E+03	5.94E+03	6.82E+02	0.00E+00	2.80E+03	0.00E+00	1.70E+07
CE-144	6.59E+05	2.73E+05	3.54E+04	0.00E+00	1.63E+05	0.00E+00	1.66E+08
PR-143	2.90E+02	1.16E+02	1.44E+01	0.00E+00	6.73E+01	0.00E+00	9.55E+05
ND-147	1.81E+02	1.07E+02	1.18E+01	0.00E+00	1.16E+02	0.00E+00	7.12E+05

TABLE 5.4.4

PATHWAY DOSE FACTORS, Ri

AGE GROUP: ADULT PATHWAY: GRASS-COW-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	7.62E+02	7.62E+02	7.62E+02	7.62E+02	7.62E+02	7.62E+02
C-14	2.63E+08	5.26E+07	5.26E+07	5.26E+07	5.26E+07	5.26E+07	5.26E+07
CR-51	0.00E+00	0.00E+00	2.85E+04	1.70E+04	6.28E+03	3.78E+04	7.17E+06
MN-54	0.00E+00	8.40E+06	1.60E+06	0.00E+00	2.50E+06	0.00E+00	2.57E+07
FE-55	2.51E+07	1.73E+07	4.04E+06	0.00E+00	0.00E+00	9.66E+06	9.93E+06
FE-59	2.97E+07	6.97E+07	2.67E+07	0.00E+00	0.00E+00	1.95E+07	2.32E+08
CO-58	0.00E+00	4.71E+06	1.05E+07	0.00E+00	0.00E+00	0.00E+00	9.54E+07
CO-60	0.00E+00	1.64E+07	3.61E+07	0.00E+00	0.00E+00	0.00E+00	3.08E+08
NI-63	6.72E+09	4.65E+08	2.25E+08	0.00E+00	0.00E+00	0.00E+00	9.71E+07
ZN-65	1.37E+09	4.36E+09	1.97E+09	0.00E+00	2.91E+09	0.00E+00	2.74E+09
RB-86	0.00E+00	2.59E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	5.10E+08
SR-89	1.45E+09	0.00E+00	4.16E+07	0.00E+00	0.00E+00	0.00E+00	2.32E+08
SR-90	4.67E+10	0.00E+00	1.15E+10	0.00E+00	0.00E+00	0.00E+00	1.35E+09
Y-91	8.57E+03	0.00E+00	2.29E+02	0.00E+00	0.00E+00	0.00E+00	4.72E+06
ZR-95	9.41E+02	3.02E+02	2.04E+02	0.00E+00	4.74E+02	0.00E+00	9.57E+05
NB-95	8.24E+04	4.58E+04	2.46E+04	0.00E+00	4.53E+04	0.00E+00	2.78E+08
RU-103	1.02E+03	0.00E+00	4.38E+02	0.00E+00	3.88E+03	0.00E+00	1.19E+05
RU-106	2.04E+04	0.00E+00	2.59E+03	0.00E+00	3.93E+04	0.00E+00	1.32E+06
AG-110M	5.81E+07	5.38E+07	3.19E+07	0.00E+00	1.06E+08	0.00E+00	2.19E+10
TE-125M	1.63E+07	5.89E+06	2.18E+06	4.89E+06	6.61E+07	0.00E+00	6.49E+07
TE-127M	4.57E+07	1.63E+07	5.57E+06	1.17E+07	1.86E+08	0.00E+00	1.53E+08
TE-129M	6.01E+07	2.24E+07	9.51E+06	2.06E+07	2.51E+08	0.00E+00	3.02E+08
I-131	2.96E+08	4.23E+08	2.62E+08	1.39E+11	7.25E+08	0.00E+00	1.12E+08
I-133	3.87E+06	6.73E+06	2.05E+06	9.88E+08	1.17E+07	0.00E+00	6.04E+06
CS-134	5.64E+09	1.34E+10	1.10E+10	0.00E+00	4.34E+09	1.44E+09	2.35E+08
CS-136	2.63E+08	1.04E+09	7.48E+08	0.00E+00	5.78E+08	7.92E+07	1.18E+08
CS-137	7.37E+09	1.01E+10	6.60E+09	0.00E+00	3.42E+09	1.14E+09	1.95E+08
BA-140	2.69E+07	3.38E+04	1.76E+06	0.00E+00	1.15E+04	1.94E+04	5.54E+07
CE-141	4.84E+03	3.27E+03	3.71E+02	0.00E+00	1.52E+03	0.00E+00	1.25E+07
CE-144	3.57E+05	1.49E+05	1.92E+04	0.00E+00	8.85E+04	0.00E+00	1.21E+08
PR-143	1.57E+02	6.32E+01	7.81E+00	0.00E+00	3.65E+01	0.00E+00	6.90E+05
ND-147	9.40E+01	1.09E+02	6.50E+00	0.00E+00	6.35E+01	0.00E+00	5.22E+05

TABLE 5.5.1

PATHWAY DOSE FACTORS, Ri

AGE GROUP: INFANT PATHWAY: GRASS-GOAT-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	4.86E+03	4.86E+03	4.86E+03	4.86E+03	4.86E+03	4.86E+03
C-14	2.34E+09	5.00E+08	5.00E+08	5.00E+08	5.00E+08	5.00E+08	5.00E+08
CR-51	0.00E+00	0.00E+00	1.94E+04	1.26E+04	2.76E+03	2.46E+04	5.64E+05
MN-54	0.00E+00	4.68E+06	1.05E+06	0.00E+00	1.04E+06	0.00E+00	1.72E+06
FE-55	1.76E+06	1.14E+06	3.03E+05	0.00E+00	0.00E+00	5.55E+05	1.44E+05
FE-59	2.92E+06	5.10E+06	2.01E+06	0.00E+00	0.00E+00	1.51E+06	2.44E+06
CO-58	0.00E+00	2.91E+06	7.26E+06	0.00E+00	0.00E+00	0.00E+00	7.25E+05
CO-60	0.00E+00	1.06E+07	2.50E+07	0.00E+00	0.00E+00	0.00E+00	2.52E+07
NI-63	4.19E+09	2.59E+08	1.46E+08	0.00E+00	0.00E+00	0.00E+00	1.29E+07
ZN-65	6.67E+08	2.29E+09	1.05E+09	0.00E+00	1.11E+09	0.00E+00	1.93E+09
RB-86	0.00E+00	2.67E+09	1.32E+09	0.00E+00	0.00E+00	0.00E+00	6.83E+07
SR-89	2.65E+10	0.00E+00	7.59E+08	0.00E+00	0.00E+00	0.00E+00	5.44E+08
SR-90	2.55E+11	0.00E+00	6.50E+10	0.00E+00	0.00E+00	0.00E+00	3.19E+09
Y-91	8.80E+03	0.00E+00	2.34E+02	0.00E+00	0.00E+00	0.00E+00	6.31E+05
ZR-95	8.17E+02	1.99E+02	1.41E+02	0.00E+00	2.15E+02	0.00E+00	9.91E+04
NB-95	7.13E+04	2.93E+04	1.70E+04	0.00E+00	2.10E+04	0.00E+00	2.48E+07
RU-103	1.04E+03	0.00E+00	3.48E+02	0.00E+00	2.17E+03	0.00E+00	1.27E+04
RU-106	2.28E+04	0.00E+00	2.85E+03	0.00E+00	2.70E+04	0.00E+00	1.73E+05
AG-110M	4.63E+07	3.38E+07	2.24E+07	0.00E+00	4.84E+07	0.00E+00	1.75E+09
TE-125M	1.81E+07	6.05E+06	2.45E+06	6.09E+06	0.00E+00	0.00E+00	8.62E+06
TE-127M	5.06E+07	1.68E+07	6.12E+06	1.46E+07	1.24E+08	0.00E+00	2.04E+07
TE-129M	6.69E+07	2.29E+07	1.03E+07	2.57E+07	1.67E+08	0.00E+00	3.99E+07
I-131	3.27E+09	3.85E+09	1.69E+09	1.27E+12	4.50E+09	0.00E+00	1.37E+08
I-133	4.36E+07	6.35E+07	1.86E+07	1.15E+10	7.46E+07	0.00E+00	1.07E+07
CS-134	1.09E+11	2.04E+11	2.06E+10	0.00E+00	5.26E+10	2.15E+10	5.55E+08
CS-136	5.94E+09	1.75E+10	6.52E+09	0.00E+00	6.96E+09	1.42E+09	2.65E+08
CS-137	1.54E+11	1.81E+11	1.28E+10	0.00E+00	4.85E+10	1.96E+10	5.65E+08
BA-140	2.90E+07	2.90E+04	1.50E+06	0.00E+00	6.89E+03	1.78E+04	7.13E+06
CE-141	5.21E+03	3.16E+03	3.74E+02	0.00E+00	9.79E+02	0.00E+00	1.64E+06
CE-144	2.79E+05	1.14E+05	1.56E+04	0.00E+00	4.62E+04	0.00E+00	1.60E+07
PR-143	1.78E+02	6.66E+01	3.83E+00	0.00E+00	2.48E+01	0.00E+00	9.40E+04
ND-147	1.06E+02	1.09E+02	6.66E+00	0.00E+00	4.19E+01	0.00E+00	6.89E+04

TABLE 5.5.2

PATHWAY DOSE FACTORS, Ri

AGE GROUP: CHIL PATHWAY: GRASS-GOAT-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	3.20E+03	3.20E+03	3.20E+03	3.20E+03	3.20E+03	3.20E+03
C-14	1.20E+09	2.39E+08	2.39E+08	2.39E+08	2.39E+08	2.39E+08	2.39E+08
CR-51	0.00E+00	0.00E+00	1.22E+04	6.78E+03	1.85E+03	1.24E+04	6.48E+05
MN-54	0.00E+00	2.52E+06	6.71E+05	0.00E+00	7.06E+05	0.00E+00	2.11E+06
FE-55	1.48E+06	7.71E+05	2.39E+05	0.00E+00	0.00E+00	4.36E+05	1.43E+05
FE-59	1.56E+06	2.53E+06	1.26E+06	0.00E+00	0.00E+00	7.34E+05	2.64E+06
CO-58	0.00E+00	1.46E+06	4.46E+06	0.00E+00	0.00E+00	0.00E+00	8.49E+06
CO-60	0.00E+00	5.18E+06	1.53E+07	0.00E+00	0.00E+00	0.00E+00	2.87E+07
NI-63	3.56E+09	1.91E+08	1.21E+08	0.00E+00	0.00E+00	0.00E+00	1.28E+07
ZN-65	4.96E+08	1.32E+09	8.22E+08	0.00E+00	8.33E+08	0.00E+00	2.32E+08
RB-86	0.00E+00	1.05E+09	6.47E+08	0.00E+00	0.00E+00	0.00E+00	6.77E+07
SR-89	1.39E+10	0.00E+00	3.97E+08	0.00E+00	0.00E+00	0.00E+00	5.39E+08
SR-90	2.35E+11	0.00E+00	5.95E+10	0.00E+00	0.00E+00	0.00E+00	3.16E+09
Y-91	4.69E+03	0.00E+00	1.25E+02	0.00E+00	0.00E+00	0.00E+00	6.24E+05
ZR-95	4.60E+02	1.01E+02	9.00E+01	0.00E+00	1.15E+02	0.00E+00	1.05E+05
NB-95	3.62E+04	1.49E+04	1.06E+04	0.00E+00	1.40E+04	0.00E+00	2.75E+07
RU-103	5.14E+02	0.00E+00	1.98E+02	0.00E+00	1.29E+03	0.00E+00	1.33E+04
RU-106	1.11E+04	0.00E+00	1.38E+03	0.00E+00	1.50E+04	0.00E+00	1.73E+05
AG-110M	2.51E+07	1.69E+07	1.35E+07	0.00E+00	3.15E+07	0.00E+00	2.01E+09
TE-125M	8.86E+06	2.40E+06	1.18E+06	2.49E+06	0.00E+00	0.00E+00	8.55E+06
TE-127M	2.50E+07	6.72E+06	2.96E+06	5.97E+06	7.12E+07	0.00E+00	2.02E+07
TE-129M	3.26E+07	9.10E+06	5.06E+06	1.05E+07	9.56E+07	0.00E+00	3.97E+07
I-131	1.57E+09	1.57E+09	8.95E+08	5.21E+11	2.58E+09	0.00E+00	1.40E+08
I-133	2.06E+07	2.55E+07	9.66E+06	4.74E+09	4.25E+07	0.00E+00	1.03E+07
CS-134	6.80E+10	1.12E+11	2.35E+10	0.00E+00	3.46E+10	1.24E+10	6.01E+08
CS-136	3.04E+09	8.36E+09	5.41E+09	0.00E+00	4.45E+09	6.64E+08	2.94E+08
CS-137	9.68E+10	9.26E+10	1.37E+10	0.00E+00	3.02E+10	1.09E+10	5.80E+08
BA-140	1.41E+07	1.24E+04	8.23E+05	0.00E+00	4.02E+03	7.37E+03	7.15E+06
CE-141	2.63E+03	1.31E+03	1.95E+02	0.00E+00	5.74E+02	0.00E+00	1.63E+06
CE-144	1.95E+05	6.11E+04	1.04E+04	0.00E+00	3.38E+04	0.00E+00	1.59E+07
PR-143	8.01E+01	2.59E+01	4.27E+00	0.00E+00	1.40E+01	0.00E+00	9.29E+04
ND-147	5.34E+01	4.33E+01	3.35E+00	0.00E+00	2.37E+01	0.00E+00	6.95E+04

TABLE 5.5.3

PATHWAY DOSE FACTORS, Ri

AGE GROUP: TEEN PATHWAY: GRASS-GOAT-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.04E+03	2.04E+03	2.04E+03	2.04E+03	2.04E+03	2.04E+03
C-14	4.86E+08	9.72E+07	9.72E+07	9.72E+07	9.72E+07	9.72E+07	9.72E+07
CR-51	0.00E+00	0.00E+00	5.99E+03	3.33E+03	1.31E+03	8.55E+03	1.01E+06
MN-54	0.00E+00	1.68E+06	3.34E+05	0.00E+00	5.02E+05	0.00E+00	3.45E+06
FE-55	5.79E+05	4.11E+05	9.58E+04	0.00E+00	0.00E+00	2.61E+05	1.78E+05
FE-59	6.74E+05	1.57E+06	6.08E+05	0.00E+00	0.00E+00	4.96E+05	3.72E+06
CO-58	0.00E+00	9.53E+05	2.20E+06	0.00E+00	0.00E+00	0.00E+00	1.31E+07
CO-60	0.00E+00	3.34E+06	7.52E+06	0.00E+00	0.00E+00	0.00E+00	4.35E+07
NI-63	1.42E+09	1.00E+08	4.81E+07	0.00E+00	0.00E+00	0.00E+00	1.60E+07
ZN-65	2.53E+08	8.78E+08	4.10E+08	0.00E+00	5.62E+08	0.00E+00	3.72E+08
RB-86	0.00E+00	5.67E+08	2.67E+08	0.00E+00	0.00E+00	0.00E+00	8.40E+07
SR-89	5.62E+09	0.00E+00	1.61E+08	0.00E+00	0.00E+00	0.00E+00	6.69E+08
SR-90	1.39E+11	0.00E+00	3.43E+10	0.00E+00	0.00E+00	0.00E+00	3.90E+09
Y-91	1.90E+03	0.00E+00	5.09E+01	0.00E+00	0.00E+00	0.00E+00	7.78E+05
ZR-95	1.98E+02	6.25E+01	4.30E+01	0.00E+00	9.18E+01	0.00E+00	1.44E+05
NB-95	1.69E+04	9.38E+03	5.16E+03	0.00E+00	9.09E+03	0.00E+00	4.01E+07
RU-103	2.17E+02	0.00E+00	9.29E+01	0.00E+00	7.66E+02	0.00E+00	1.82E+04
RU-106	4.50E+03	0.00E+00	5.68E+02	0.00E+00	8.69E+03	0.00E+00	2.16E+05
AG-110M	1.16E+07	1.09E+07	6.65E+06	0.00E+00	2.09E+07	0.00E+00	3.07E+09
TE-125M	3.61E+06	1.30E+06	4.82E+05	1.01E+06	0.00E+00	0.00E+00	1.06E+07
TE-127M	1.01E+07	3.59E+06	1.20E+06	2.41E+06	4.11E+07	0.00E+00	2.57E+07
TE-129M	1.32E+07	4.90E+06	2.09E+06	4.26E+06	5.53E+07	0.00E+00	4.96E+07
I-131	6.45E+08	9.03E+08	4.85E+08	2.64E+11	1.56E+09	0.00E+00	1.79E+08
I-133	8.49E+06	1.44E+07	4.40E+06	2.01E+09	2.53E+07	0.00E+00	1.09E+07
CS-134	2.95E+10	6.93E+10	3.22E+10	0.00E+00	2.20E+10	8.41E+09	8.62E+08
CS-136	1.35E+09	5.30E+09	3.56E+09	0.00E+00	2.89E+09	4.55E+08	4.27E+08
CS-137	4.02E+10	5.34E+10	1.86E+10	0.00E+00	1.82E+10	7.07E+09	7.60E+08
BA-140	5.84E+06	7.16E+03	3.76E+05	0.00E+00	2.43E+03	4.81E+03	9.01E+06
CE-141	1.07E+03	7.12E+02	8.18E+01	0.00E+00	3.35E+02	0.00E+00	2.04E+06
CE-144	7.90E+04	3.27E+04	4.25E+03	0.00E+00	1.95E+04	0.00E+00	1.99E+07
PR-143	3.48E+01	1.39E+01	1.73E+00	0.00E+00	8.08E+00	0.00E+00	1.15E+05
ND-147	2.18E+01	2.37E+01	1.42E+00	0.00E+00	1.39E+01	0.00E+00	8.54E+04

TABLE 5.5.4

PATHWAY DOSE FACTORS, Ri

AGE GROUP: ADULT PATHWAY: GRASS-GOAT-MILK

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03
C-14	2.64E+08	5.27E+07	5.27E+07	5.27E+07	5.27E+07	5.27E+07	5.27E+07
CR-51	0.00E+00	0.00E+00	3.43E+03	2.05E+03	7.56E+02	4.55E+03	8.63E+05
MN-54	0.00E+0	1.01E+06	1.93E+05	0.00E+00	3.01E+05	0.00E+00	3.10E+06
FE-55	3.27E+05	2.26E+05	5.26E+04	0.00E+00	0.00E+00	1.26E+05	1.30E+05
FE-59	3.87E+05	9.09E+05	3.48E+05	0.00E+00	0.00E+00	2.54E+05	3.03E+06
CO-58	0.00E+00	5.66E+05	1.27E+06	0.00E+00	0.00E+00	0.00E+00	1.15E+07
CO-60	0.00E+00	1.97E+06	4.35E+06	0.00E+00	0.00E+00	0.00E+00	3.70E+07
NI-63	8.08E+08	5.60E+07	2.71E+07	0.00E+00	0.00E+00	0.00E+00	1.17E+07
ZN-65	1.65E+08	5.24E+08	2.37E+08	0.00E+00	3.51E+08	0.00E+00	3.30E+08
RB-86	0.00E+00	3.12E+08	1.45E+08	0.00E+00	0.00E+00	0.00E+00	6.14E+07
SR-89	3.05E+09	0.00E+00	8.76E+07	0.00E+00	0.00E+00	0.00E+00	4.89E+08
SR-90	9.84E+10	0.00E+00	2.41E+10	0.00E+00	0.00E+00	0.00E+00	2.84E+09
Y-91	1.03E+03	0.00E+00	2.76E+01	0.00E+00	0.00E+00	0.00E+00	5.68E+05
ZR-95	2.13E+02	3.63E+01	2.46E+01	0.00E+00	5.70E+01	0.00E+00	1.15E+05
NB-95	9.92E+03	5.52E+03	2.97E+03	0.00E+00	5.45E+03	0.00E+00	3.35E+07
RU-103	1.22E+02	0.00E+00	5.27E+01	0.00E+00	4.67E+02	0.00E+00	1.43E+04
RU-106	2.45E+03	0.00E+00	3.10E+02	0.00E+00	4.73E+03	0.00E+00	1.59E+05
AG-110M	6.99E+06	6.47E+06	3.84E+06	0.00E+00	1.27E+07	0.00E+00	2.64E+09
TE-125M	1.96E+06	7.09E+05	2.62E+05	5.89E+05	7.96E+06	0.00E+00	7.81E+06
TE-127M	5.50E+06	1.97E+06	6.70E+05	1.41E+06	2.23E+07	0.00E+00	1.84E+07
TE-129M	7.23E+06	2.70E+06	1.14E+06	2.48E+06	3.02E+07	0.00E+00	3.64E+07
I-131	3.56E+08	5.09E+08	2.92E+08	1.67E+11	8.73E+08	0.00E+00	1.34E+08
I-133	4.65E+06	8.10E+06	2.47E+06	1.19E+09	1.41E+07	0.00E+00	7.28E+06
CS-134	1.70E+10	4.04E+10	3.30E+10	0.00E+00	1.31E+10	4.34E+09	7.07E+08
CS-136	7.92E+08	3.13E+09	2.25E+09	0.00E+00	1.74E+09	2.38E+08	3.55E+08
CS-137	2.22E+10	3.03E+10	1.99E+10	0.00E+00	1.03E+10	3.42E+09	5.87E+08
BA-140	3.24E+06	4.07E+03	2.12E+05	0.00E+00	1.28E+03	2.33E+03	6.67E+06
CE-141	5.82E+02	3.94E+02	4.47E+01	0.00E+00	1.83E+02	0.00E+00	1.51E+06
CE-144	4.30E+04	1.80E+04	2.31E+03	0.00E+00	1.07E+04	0.00E+00	1.45E+07
PR-143	1.90E+01	7.60E+00	9.40e-01	0.00E+00	4.39E+00	0.00E+00	8.30E+04
ND-147	1.13E+01	1.31E+01	7.82e-01	0.00E+00	7.65E+00	0.00E+00	6.28E+04

TABLE 5.6.1

PATHWAY DOSE FACTORS, Ri

AGE GROUP: INFANT PATHWAY: GRASS-COW-MEAT

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MN-54	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-95	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG-110M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-125M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-127M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-129M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-136	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-140	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CE-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CE-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PR-143	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 5.6.2

PATHWAY DOSE FACTORS, Ri

AGE GROUP: CHILD PATHWAY: GRASS-COW-MEAT

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.34E+02	2.34E+02	2.34E+02	2.34E+02	2.34E+02	2.34E+02
C-14	3.84E+08	7.67E+07	7.67E+07	7.67E+07	7.67E+07	7.67E+07	7.67E+07
CR-51	0.00E+00	0.00E+00	8.78E+03	4.88E+03	1.33E+03	8.90E+03	4.66E+05
MN-54	0.00E+00	8.01E+06	2.13E+06	0.00E+00	2.25E+06	0.00E+00	6.73E+06
FE-55	4.57E+08	2.43E+08	7.52E+07	0.00E+00	0.00E+00	1.37E+08	4.49E+07
FE-59	3.77E+08	6.10E+08	3.04E+08	0.00E+00	0.00E+00	1.77E+08	6.35E+08
CO-58	0.00E+00	1.64E+07	5.03E+07	0.00E+00	0.00E+00	0.00E+00	9.58E+07
CO-60	0.00E+00	6.93E+07	2.04E+08	0.00E+00	0.00E+00	0.00E+00	3.84E+08
NI-63	2.91E+10	1.56E+09	9.91E+08	0.00E+00	0.00E+00	0.00E+00	1.05E+08
ZN-65	3.76E+08	1.00E+09	6.22E+08	0.00E+00	6.31E+08	0.00E+00	1.76E+08
RB-86	0.00E+00	5.76E+08	3.54E+08	0.00E+00	0.00E+00	0.00E+00	3.71E+07
SR-89	4.82E+08	0.00E+00	1.38E+07	0.00E+00	0.00E+00	0.00E+00	1.87E+07
SR-90	1.04E+10	0.00E+00	2.64E+09	0.00E+00	0.00E+00	0.00E+00	1.40E+08
Y-91	1.00E+06	0.00E+00	4.82E+04	0.00E+00	0.00E+00	0.00E+00	2.40E+08
ZR-95	2.66E+06	5.86E+05	5.21E+05	0.00E+00	8.38E+05	0.00E+00	6.11E+08
NB-95	3.10E+06	1.21E+06	8.63E+05	0.00E+00	1.13E+06	0.00E+00	2.23E+09
RU-103	1.55E+08	0.00E+00	5.96E+07	0.00E+00	3.90E+08	0.00E+00	4.01E+09
RU-106	4.44E+09	0.00E+00	5.54E+08	0.00E+00	6.00E+09	0.00E+00	6.31E+10
AG-110M	8.39E+06	5.67E+06	4.53E+06	0.00E+00	1.06E+07	0.00E+00	6.74E+08
TE-125M	5.69E+08	1.54E+08	7.59E+07	1.60E+08	0.00E+00	0.00E+00	5.69E+08
TE-127M	1.78E+09	4.78E+08	2.11E+08	4.25E+08	5.06E+09	0.00E+00	1.44E+09
TE-129M	1.79E+09	5.00E+08	2.78E+08	5.77E+08	5.26E+09	0.00E+00	2.18E+09
I-131	1.66E+07	1.67E+07	9.48E+06	5.52E+09	2.74E+07	0.00E+00	1.48E+06
I-133	5.72e-01	7.08e-01	2.68e-01	1.31E+02	1.18E+00	0.00E+00	2.85e-01
CS-134	9.23E+08	1.51E+09	3.19E+08	0.00E+00	4.69E+08	1.68E+08	8.16E+06
CS-136	1.63E+07	4.48E+07	2.90E+07	0.00E+00	2.39E+07	3.55E+06	1.57E+06
CS-137	1.33E+09	1.28E+09	1.89E+08	0.00E+00	4.16E+08	1.50E+08	8.00E+06
BA-140	4.42E+07	3.87E+04	2.58E+06	0.00E+00	1.26E+04	2.31E+04	2.24E+07
CE-141	2.22E+04	1.11E+04	1.65E+03	0.00E+00	4.86E+03	0.00E+00	1.38E+07
CE-144	2.32E+06	7.26E+05	1.24E+05	0.00E+00	4.02E+05	0.00E+00	1.89E+08
PR-143	3.33E+04	1.00E+04	1.65E+03	0.00E+00	5.42E+03	0.00E+00	3.60E+07
ND-147	1.17E+04	9.48E+03	7.34E+02	0.00E+00	5.20E+03	0.00E+00	1.50E+07

TABLE 5.6.3

PATHWAY DOSE FACTORS, Ri

AGE GROUP: TEEN PATHWAY: GRASS-COW-MEAT

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.93E+02	1.93E+02	1.93E+02	1.93E+02	1.93E+02	1.93E+02
C-14	2.04E+08	4.08E+07	4.08E+07	4.08E+07	4.08E+07	4.08E+07	4.08E+07
CR-51	0.00E+00	0.00E+00	5.63E+03	3.13E+03	1.23E+03	8.03E+03	9.46E+05
MN-54	0.00E+00	7.00E+06	1.39E+06	0.00E+00	2.09E+06	0.00E+00	1.44E+07
FE-55	2.38E+08	1.69E+08	3.94E+07	0.00E+00	0.00E+00	1.07E+08	7.31E+07
FE-59	2.12E+08	4.95E+08	1.91E+08	0.00E+00	0.00E+00	1.56E+08	1.17E+09
CO-58	0.00E+00	1.40E+07	3.24E+07	0.00E+00	0.00E+00	0.00E+00	1.94E+08
CO-60	0.00E+00	5.83E+07	1.31E+08	0.00E+00	0.00E+00	0.00E+00	7.60E+08
NI-63	1.52E+10	1.07E+09	5.15E+08	0.00E+00	0.00E+00	0.00E+00	1.71E+08
ZN-65	2.50E+08	8.68E+08	4.05E+08	0.00E+00	5.56E+08	0.00E+00	3.68E+08
RB-86	0.00E+00	4.06E+08	1.91E+08	0.00E+00	0.00E+00	0.00E+00	6.00E+07
SR-89	2.55E+08	0.00E+00	7.29E+06	0.00E+00	0.00E+00	0.00E+00	3.03E+07
SR-90	8.04E+09	0.00E+00	1.99E+09	0.00E+00	0.00E+00	0.00E+00	2.26E+08
Y-91	9.54E+05	0.00E+00	2.56E+04	0.00E+00	0.00E+00	0.00E+00	3.91E+08
ZR-95	1.50E+06	4.73E+05	3.25E+05	0.00E+00	6.95E+05	0.00E+00	1.09E+09
NB-95	1.79E+06	9.95E+05	5.43E+05	0.00E+00	9.64E+05	0.00E+00	4.25E+09
RU-103	8.56E+07	0.00E+00	3.66E+07	0.00E+00	3.02E+08	0.00E+00	7.13E+09
RU-106	2.36E+09	0.00E+00	2.97E+08	0.00E+00	4.54E+09	0.00E+00	1.13E+11
AG-110M	5.06E+06	4.78E+06	2.91E+06	0.00E+00	9.13E+06	0.00E+00	1.34E+09
TE-125M	3.03E+08	1.09E+08	4.05E+07	8.46E+07	0.00E+00	0.00E+00	8.94E+08
TE-127M	9.41E+08	3.34E+08	1.12E+08	2.24E+08	3.81E+09	0.00E+00	2.35E+09
TE-129M	9.49E+08	3.52E+08	1.50E+08	3.06E+08	3.97E+09	0.00E+00	3.56E+09
I-131	8.93E+06	1.25E+07	6.72E+06	3.65E+09	2.15E+07	0.00E+00	2.47E+06
I-133	3.08e-01	5.22e-01	1.59e-01	7.29E+01	9.16e-01	0.00E+00	3.95e-01
CS-134	5.23E+08	1.23E+09	5.71E+08	0.00E+00	3.91E+08	1.49E+08	1.53E+07
CS-136	9.43E+06	3.71E+07	2.49E+07	0.00E+00	2.02E+07	3.18E+06	2.99E+06
CS-137	7.24E+08	9.63E+08	3.35E+08	0.00E+00	3.28E+08	1.27E+08	1.37E+07
BA-140	2.39E+07	2.93E+07	1.54E+06	0.00E+00	9.94E+03	1.97E+04	3.69E+07
CE-141	1.18E+04	7.87E+03	9.05E+02	0.00E+00	3.71E+03	0.00E+00	2.25E+07
CE-144	1.23E+06	5.08E+05	6.60E+04	0.00E+00	3.03E+05	0.00E+00	3.09E+08
PR-143	1.76E+04	7.03E+03	8.76E+02	0.00E+00	4.08E+03	0.00E+00	5.79E+07
ND-147	6.23E+03	6.78E+03	4.06E+02	0.00E+00	3.98E+03	0.00E+00	2.44E+07

TABLE 5.6.4

PATHWAY DOSE FACTORS, Ri

AGE GROUP: ADULT PATHWAY: GRASS-COW-MEAT

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per μCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	3.24E+02	3.24E+02	3.24E+02	3.24E+02	3.24E+02	3.24E+02
C-14	2.42E+08	4.83E+07	4.83E+07	4.83E+07	4.83E+07	4.83E+07	4.83E+07
CR-51	0.00E+00	0.00E+00	7.04E+03	4.21E+03	1.55E+03	9.35E+03	1.77E+06
MN-54	0.00E+00	9.18E+06	1.75E+06	0.00E+00	2.73E+06	0.00E+00	2.81E+07
FE-55	2.93E+08	2.03E+08	4.73E+07	0.00E+00	0.00E+00	1.13E+08	1.16E+08
FE-59	2.66E+08	6.25E+08	2.39E+08	0.00E+00	0.00E+00	1.75E+08	2.08E+09
CO-58	0.00E+00	1.82E+07	4.09E+07	0.00E+00	0.00E+00	0.00E+00	3.70E+08
CO-60	0.00E+00	7.52E+07	1.66E+08	0.00E+00	0.00E+00	0.00E+00	1.41E+09
NI-63	1.89E+10	1.31E+09	6.33E+08	0.00E+00	0.00E+00	0.00E+00	2.73E+08
ZN-65	3.56E+08	1.13E+09	5.12E+08	0.00E+00	7.57E+08	0.00E+00	7.13E+08
RB-86	0.00E+00	4.87E+08	2.27E+08	0.00E+00	0.00E+00	0.00E+00	9.59E+07
SR-89	3.02E+08	0.00E+00	8.66E+06	0.00E+00	0.00E+00	0.00E+00	4.84E+07
SR-90	1.24E+10	0.00E+00	3.05E+09	0.00E+00	0.00E+00	0.00E+00	3.60E+08
Y-91	1.13E+06	0.00E+00	3.03E+04	0.00E+00	0.00E+00	0.00E+00	6.24E+08
ZR-95	1.87E+06	6.0[illegible]E+05	4.07E+05	0.00E+00	9.4[illegible]E+05	0.00E+00	1.90E+09
NB-95	2.30E+06	1.28E+06	6.87E+05	0.00E+00	1.26E+06	0.00E+00	7.76E+09
RU-103	1.05E+08	0.00E+00	4.53E+07	0.00E+00	4.02E+08	0.00E+00	1.23E+10
RU-106	2.80E+09	0.00E+00	3.54E+08	0.00E+00	5.41E+09	0.00E+00	1.81E+11
AG-110M	6.68E+06	6.18E+06	3.67E+06	0.00E+00	1.22E+07	0.00E+00	2.52E+09
TE-125M	3.59E+08	1.30E+08	4.81E+07	1.08E+08	1.46E+09	0.00E+00	1.43E+09
TE-127M	1.12E+09	3.99E+08	1.36E+08	2.85E+08	4.53E+09	0.00E+00	3.74E+09
TE-129M	1.13E+09	4.23E+08	1.79E+08	3.89E+08	4.73E+09	0.00E+00	5.71E+09
I-131	1.08E+07	1.54E+07	8.82E+06	5.04E+09	2.64E+07	0.00E+00	4.06E+06
I-133	3.68e-01	6.41e-01	1.95e-01	9.42E+01	1.12E+00	0.00E+00	5.76e-01
CS-134	6.58E+08	1.57E+09	1.28E+09	0.00E+00	5.07E+08	1.68E+08	2.74E+07
CS-136	1.21E+07	4.78E+07	3.44E+07	0.00E+00	2.66E+07	3.65E+06	5.43E+06
CS-137	8.72E+08	1.19E+09	7.82E+08	0.00E+00	4.05E+08	1.35E+08	2.31E+07
BA-140	2.90E+07	3.64E+04	1.90E+06	0.00E+00	1.24E+04	2.08E+04	5.96E+07
CE-141	1.41E+04	9.51E+03	1.08E+03	0.00E+00	4.42E+03	0.00E+00	3.64E+07
CE-144	1.46E+06	6.10E+05	7.83E+04	0.00E+00	3.62E+05	0.00E+00	4.93E+08
PR-143	2.09E+04	8.40E+03	1.04E+03	0.00E+00	4.85E+03	0.00E+00	9.17E+07
ND-147	7.08E+03	8.18E+03	4.90E+02	0.00E+00	4.79E+03	0.00E+00	3.93E+07

TABLE 5.7.1

PATHWAY DOSE FACTORS, Ri

AGE GROUP: INFANT PATHWAY: VEGETATION

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CR-51	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MN-54	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZN-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZR-95	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-95	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG-110M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-125M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-127M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-129M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-136	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-140	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CE-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CE-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PR-143	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 3.7.2

PATHWAY DOSE FACTORS, Ri

AGE GROUP: CHILD PATHWAY: VEGETATION

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per μCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	4.02E+03	4.02E+03	4.02E+03	4.02E+03	4.02E+03	4.02E+03
C-14	8.89E+08	1.78E+08	1.78E+08	1.78E+08	1.78E+08	1.78E+08	1.78E+08
CR-51	0.00E+00	0.00E+00	1.17E+05	6.49E+04	1.77E+04	1.18E+05	6.20E+05
MN-54	0.00E+00	6.65E+08	1.77E+08	0.00E+00	1.86E+08	0.00E+00	5.58E+08
FE-55	8.01E+08	4.25E+08	1.32E+08	0.00E+00	0.00E+00	2.40E+08	7.87E+07
FE-59	3.98E+08	6.44E+08	3.21E+08	0.00E+00	0.00E+00	1.87E+08	6.71E+08
CO-58	0.00E+00	6.44E+07	1.97E+08	0.00E+00	0.00E+00	0.00E+00	3.76E+08
CO-60	0.00E+00	3.78E+08	1.12E+09	0.00E+00	0.00E+00	0.00E+00	2.10E+09
NI-63	3.95E+10	2.11E+09	1.34E+09	0.00E+00	0.00E+00	0.00E+00	1.42E+08
ZN-65	8.12E+08	2.16E+09	1.35E+09	0.00E+00	1.36E+09	0.00E+00	3.80E+08
RB-86	0.00E+00	4.51E+08	2.77E+08	0.00E+00	0.00E+00	0.00E+00	2.90E+07
SR-89	3.60E+10	0.00E+00	1.03E+09	0.00E+00	0.00E+00	0.00E+00	1.39E+09
SR-90	1.24E+12	0.00E+00	3.15E+11	0.00E+00	0.00E+00	0.00E+00	1.67E+10
Y-91	1.87E+07	0.00E+00	4.99E+05	0.00E+00	0.00E+00	0.00E+00	2.49E+09
ZR-95	3.86E+06	8.48E+05	7.55E+05	0.00E+00	1.21E+06	0.00E+00	8.85E+08
NB-95	4.11E+05	1.60E+05	1.14E+05	0.00E+00	1.50E+05	0.00E+00	2.96E+08
RU-103	1.53E+07	0.00E+00	5.90E+06	0.00E+00	3.86E+07	0.00E+00	3.97E+08
RU-106	7.45E+08	0.00E+00	9.30E+07	0.00E+00	1.01E+09	0.00E+00	1.16E+10
AG-110M	3.21E+07	2.17E+07	1.73E+07	0.00E+00	4.04E+07	0.00E+00	2.58E+09
TE-125M	3.51E+08	9.50E+07	4.67E+07	9.84E+07	0.00E+00	0.00E+00	3.38E+08
TE-127M	1.32E+09	3.56E+08	1.57E+08	3.16E+08	3.77E+09	0.00E+00	1.07E+09
TE-129M	8.40E+08	2.35E+08	1.30E+08	2.71E+08	2.47E+09	0.00E+00	1.02E+09
I-131	1.43E+08	1.44E+08	8.18E+07	4.76E+10	2.36E+08	0.00E+00	1.28E+07
I-133	3.53E+06	4.37E+06	1.65E+06	8.12E+08	7.28E+06	0.00E+00	1.76E+06
CS-134	1.60E+10	2.63E+10	5.55E+09	0.00E+00	8.15E+09	2.93E+09	1.42E+08
CS-136	8.28E+07	2.28E+08	1.47E+08	0.00E+00	1.21E+08	1.81E+07	8.00E+06
CS-137	2.39E+10	2.29E+10	3.38E+09	0.00E+00	7.46E+09	2.68E+09	1.43E+08
BA-140	2.79E+08	2.44E+05	1.63E+07	0.00E+00	7.96E+04	1.46E+05	1.41E+08
CE-141	6.57E+05	3.28E+05	4.86E+04	0.00E+00	1.44E+05	0.00E+00	4.09E+08
CE-144	1.27E+08	3.99E+07	6.79E+06	0.00E+00	2.21E+07	0.00E+00	1.04E+10
PR-143	1.45E+05	4.36E+04	7.21E+03	0.00E+00	2.36E+04	0.00E+00	1.57E+08
ND-147	7.15E+04	5.79E+04	4.49E+03	0.00E+00	3.18E+04	0.00E+00	9.18E+07

TABLE 5.7.3

PATHWAY DOSE FACTORS, Ri

AGE GROUP: TEEN PATHWAY: VEGETATION

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per μCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
C-14	3.69E+08	7.38E+07	7.38E+07	7.38E+07	7.38E+07	7.38E+07	7.38E+07
CR-51	0.00E+00	0.00E+00	6.16E+04	3.42E+04	1.35E+04	8.79E+04	1.03E+07
MN-54	0.00E+00	4.54E+08	9.01E+07	0.00E+00	1.36E+08	0.00E+00	9.32E+08
FE-55	3.26E+08	2.31E+08	5.39E+07	0.00E+00	0.00E+00	1.47E+08	1.00E+08
FE-59	1.80E+08	4.19E+08	1.62E+08	0.00E+00	0.00E+00	1.32E+08	9.91E+08
CO-58	0.00E+00	4.36E+07	1.01E+08	0.00E+00	0.00E+00	0.00E+00	6.01E+08
CO-60	0.00E+00	2.49E+08	5.60E+08	0.00E+00	0.00E+00	0.00E+00	3.24E+09
NI-63	1.61E+10	1.13E+09	5.45E+08	0.00E+00	0.00E+00	0.00E+00	1.81E+08
ZN-65	4.24E+08	1.47E+09	6.86E+08	0.00E+00	9.42E+08	0.00E+00	6.23E+08
RB-86	0.00E+00	2.73E+08	1.28E+08	0.00E+00	0.00E+00	0.00E+00	4.04E+07
SR-89	1.52E+10	0.00E+00	4.34E+08	0.00E+00	0.00E+00	0.00E+00	1.80E+09
SR-90	7.51E+11	0.00E+00	1.85E+11	0.00E+00	0.00E+00	0.00E+00	2.11E+10
Y-91	7.84E+06	0.00E+00	2.10E+05	0.00E+00	0.00E+00	0.00E+00	3.22E+09
ZR-95	1.72E+06	5.43E+05	3.73E+05	0.00E+00	7.98E+05	0.00E+00	1.25E+09
NB-95	1.92E+05	1.07E+05	5.87E+04	0.00E+00	1.03E+05	0.00E+00	4.56E+08
RU-103	6.82E+06	0.00E+00	2.92E+06	0.00E+00	2.41E+07	0.00E+00	5.70E+08
RU-106	3.09E+08	0.00E+00	3.90E+07	0.00E+00	5.97E+08	0.00E+00	1.48E+10
AG-110M	1.52E+07	1.43E+07	8.72E+06	0.00E+00	2.74E+07	0.00E+00	4.03E+09
TE-125M	1.48E+08	5.34E+07	1.98E+07	4.14E+07	0.00E+00	0.00E+00	4.37E+08
TE-127M	5.52E+08	1.96E+08	6.56E+07	1.31E+08	2.24E+09	0.00E+00	1.37E+09
TE-129M	3.61E+08	1.34E+08	5.72E+07	1.17E+08	1.51E+09	0.00E+00	1.36E+09
I-131	7.69E+07	1.08E+08	5.78E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07
I-133	1.94E+06	3.29E+06	1.00E+06	4.59E+08	5.77E+06	0.00E+00	2.49E+06
CS-134	7.10E+09	1.57E+10	7.75E+09	0.00E+00	5.31E+09	2.03E+09	2.08E+08
CS-136	4.39E+07	1.73E+08	1.16E+08	0.00E+00	9.41E+07	1.48E+07	1.39E+07
CS-137	1.01E+10	1.35E+10	4.69E+09	0.00E+00	4.59E+09	1.78E+09	1.92E+08
BA-140	1.39E+08	1.71E+05	8.97E+06	0.00E+00	5.78E+04	1.15E+05	2.15E+08
CE-141	2.83E+05	1.89E+05	2.17E+04	0.00E+00	8.90E+04	0.00E+00	5.41E+08
CE-144	5.28E+07	2.18E+07	2.83E+06	0.00E+00	1.30E+07	0.00E+00	1.33E+10
PR-143	6.99E+04	2.79E+04	3.48E+03	0.00E+00	1.62E+04	0.00E+00	2.30E+08
ND-147	3.62E+04	3.94E+04	2.36E+03	0.00E+00	2.31E+04	0.00E+00	1.42E+08

TABLE 5.7.4

PATHWAY DOSE FACTORS, Ri

AGE GROUP: ADULT PATHWAY: VEGETATION

NUCLIDE	ORGAN DOSE FACTORS; m^2 - mrem/year per µCi/sec						
	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03
C-14	2.28E+08	4.55E+07	4.55E+07	4.55E+07	4.55E+07	4.55E+07	4.55E+07
CR-51	0.00E+00	0.00E+00	4.64E+04	2.77E+04	1.02E+04	6.05E+04	1.17E+07
MN-54	0.00E+00	3.13E+08	5.97E+07	0.00E+00	9.31E+07	0.00E+00	9.58E+08
FE-55	2.10E+08	1.45E+08	3.38E+07	0.00E+00	0.00E+00	8.08E+07	8.31E+07
FE-59	1.26E+08	2.97E+08	1.14E+08	0.00E+00	0.00E+00	8.29E+07	9.89E+08
[illegible]-58	0.00E+00	3.07E+07	6.89E+07	0.00E+00	0.00E+00	0.00E+00	6.23E+08
[illegible]-60	0.00E+00	1.67E+08	3.69E+08	0.00E+00	0.00E+00	0.00E+00	3.14E+09
NI-63	1.04E+10	7.21E+08	3.49E+08	0.00E+00	0.00E+00	0.00E+00	1.50E+08
ZN-65	3.17E+08	1.01E+09	4.56E+08	0.00E+00	6.75E+08	0.00E+00	6.36E+08
RB-86	0.00E+00	2.19E+08	1.02E+08	0.00E+00	0.00E+00	0.00E+00	4.32E+07
SR-89	9.98E+09	0.00E+00	2.86E+08	0.00E+00	0.00E+00	0.00E+00	1.60E+09
SR-90	6.05E+1[illegible]	0.00E+00	1.48E+11	0.00E+00	0.00E+00	0.00E+00	1.75E+10
Y-91	5.12E+0	0.00E+00	1.37E+05	0.00E+00	0.00E+00	0.00E+00	2.82E+09
ZR-95	1.17E+06	3.77E+05	2.55E+05	0.00E+00	5.91E+05	0.00E+00	1.19E+09
NB-95	1.42E+05	7.92E+04	4.26E+04	0.00E+00	7.83E+04	0.00E+00	4.81E+08
RU-103	4.77E+06	0.00E+00	2.06E+06	0.00E+00	1.82E+07	0.00E+00	5.57E+08
RU-106	1.93E+08	0.00E+00	2.44E+07	0.00E+00	3.72E+08	0.00E+00	1.25E+10
AG-110M	1.05E+07	9.75E+06	5.79E+06	0.00E+00	1.92E+07	0.00E+00	3.98E+09
TE-125M	9.66E+07	3.50E+07	1.29E+07	2.90E+07	3.93E+08	0.00E+00	3.86E+08
TE-127M	3.49E+08	1.25E+08	4.26E+07	8.93E+07	1.42E+09	0.00E+00	1.17E+09
TE-129M	2.51E+08	9.37E+07	3.97E+07	8.63E+07	1.05E+09	0.00E+00	1.26E+09
I-131	8.08E+07	1.16E+08	6.62E+07	3.79E+10	1.98E+08	0.00E+00	3.05E+07
I-133	2.09E+06	3.63E+06	1.11E+06	5.34E+08	6.33E+06	0.00E+00	3.26E+06
CS-134	4.67E+09	1.11E+10	9.08E+09	0.00E+00	3.59E+09	1.19E+09	1.94E+08
CS-136	4.28E+07	1.69E+08	1.22E+08	0.00E+00	9.41E+07	1.29E+07	1.92E+07
CS-137	6.36E+09	8.70E+09	5.70E+09	0.00E+00	2.95E+09	9.81E+08	1.68E+08
BA-140	1.29E+08	1.62E+05	8.47E+06	0.00E+00	5.52E+04	9.29E+04	2.66E+08
CE-141	1.97E+05	1.33E+05	1.51E+04	0.00E+00	6.20E+04	0.00E+00	5.10E+08
CE-144	3.29E+07	1.38E+07	1.77E+06	0.00E+00	8.16E+06	0.00E+00	1.11E+10
PR-143	5.25E+04	2.51E+04	3.10E+03	0.00E+00	1.45E+04	0.00E+00	2.74E+08
ND-147	3.34E+04	3.85E+04	2.31E+03	0.00E+00	2.25E+04	0.00E+00	1.85E+08

6.0 TMI-1 GASEOUS WASTE TREATMENT SYSTEM

6.1 Description of the TMI-1 Gaseous Radwaste Treatment System (see Figure 6.1)

6.1.1 Waste Gas System

a. Reactor Building:

- Reactor Coolant Drain Tank (RCDT) header

b. Auxiliary Building:

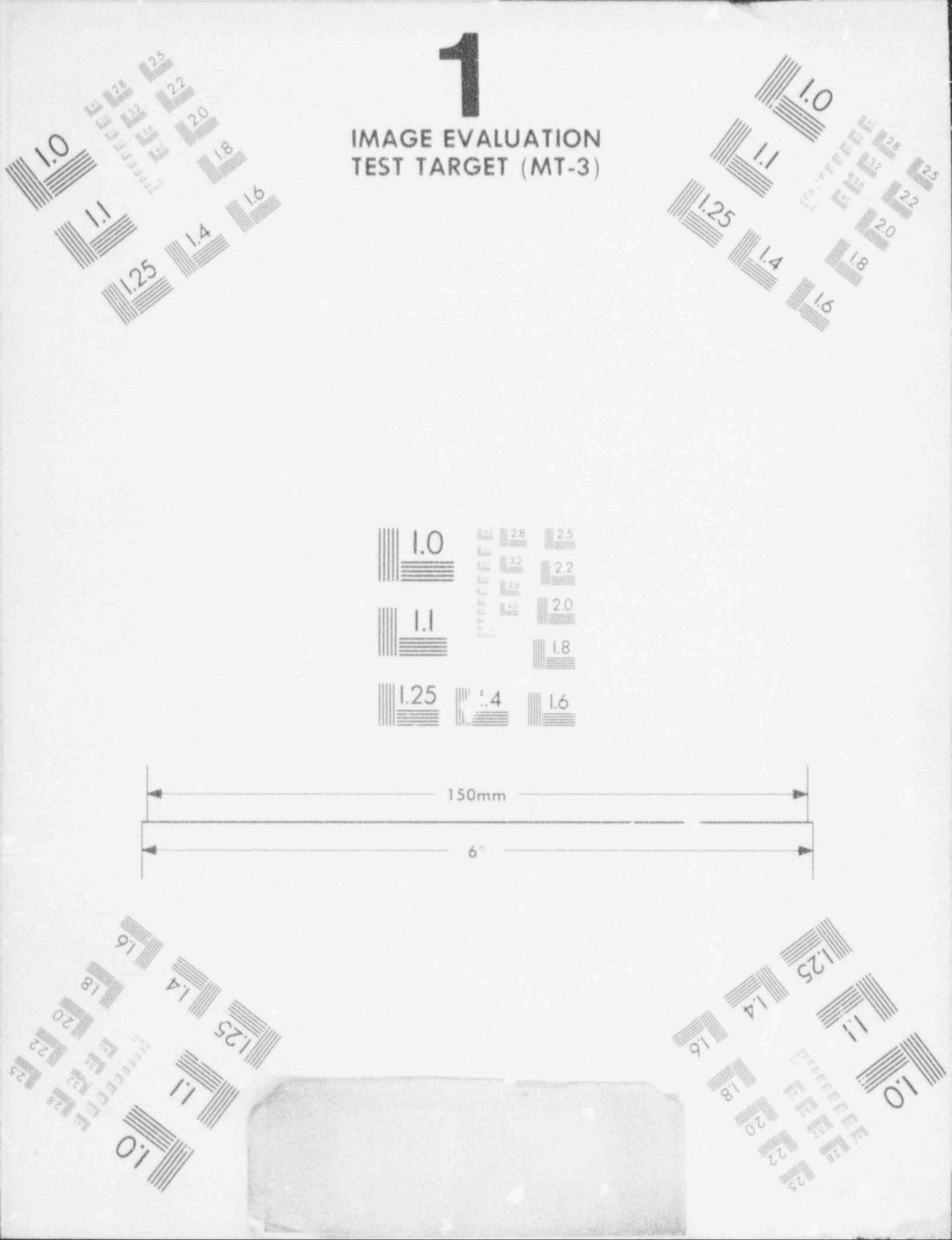
- Vent Header from
  1. Miscellaneous Waste Storage Tank (MWST)
  2. Three (3) Reactor Coolant Bleed Tanks (RCBT)
- Waste Gas Delay Tank
- Two (2) Waste Gas Compressors
- Three (3) Waste Gas Decay Tanks (WGDT)

c. Filtration and dilution provided by the Station Ventilation System.

6.2 Operability

Operability of the Gaseous Waste Treatment System is defined as the ability to remove gas from the vent header/tank gas spaces and store it under a higher pressure in the Waste Gas Decay Tanks for subsequent release.

Except for initiating the make up tank sample and waste gas venting and the recycle or disposal of compressed waste gases stored in the waste gas decay tanks, the operation of the waste gas system is entirely automatic. One waste gas compressor comes on automatically, removing gases from the vent header system as required, to maintain the pressure in the system at a maximum of about 16.4 psia.


1
IMAGE EVALUATION
TEST TARGET (MT-3)
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
150mm
6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

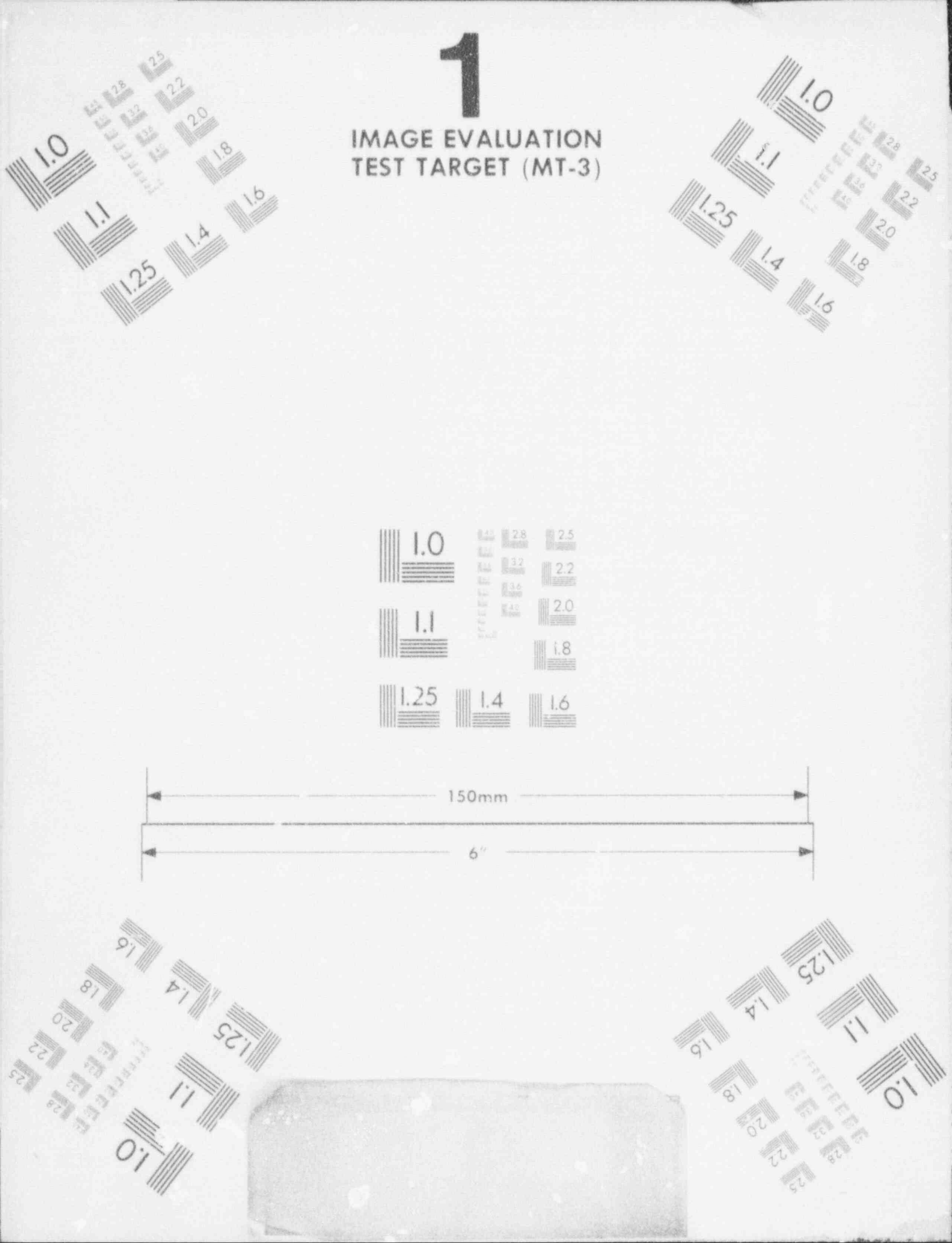
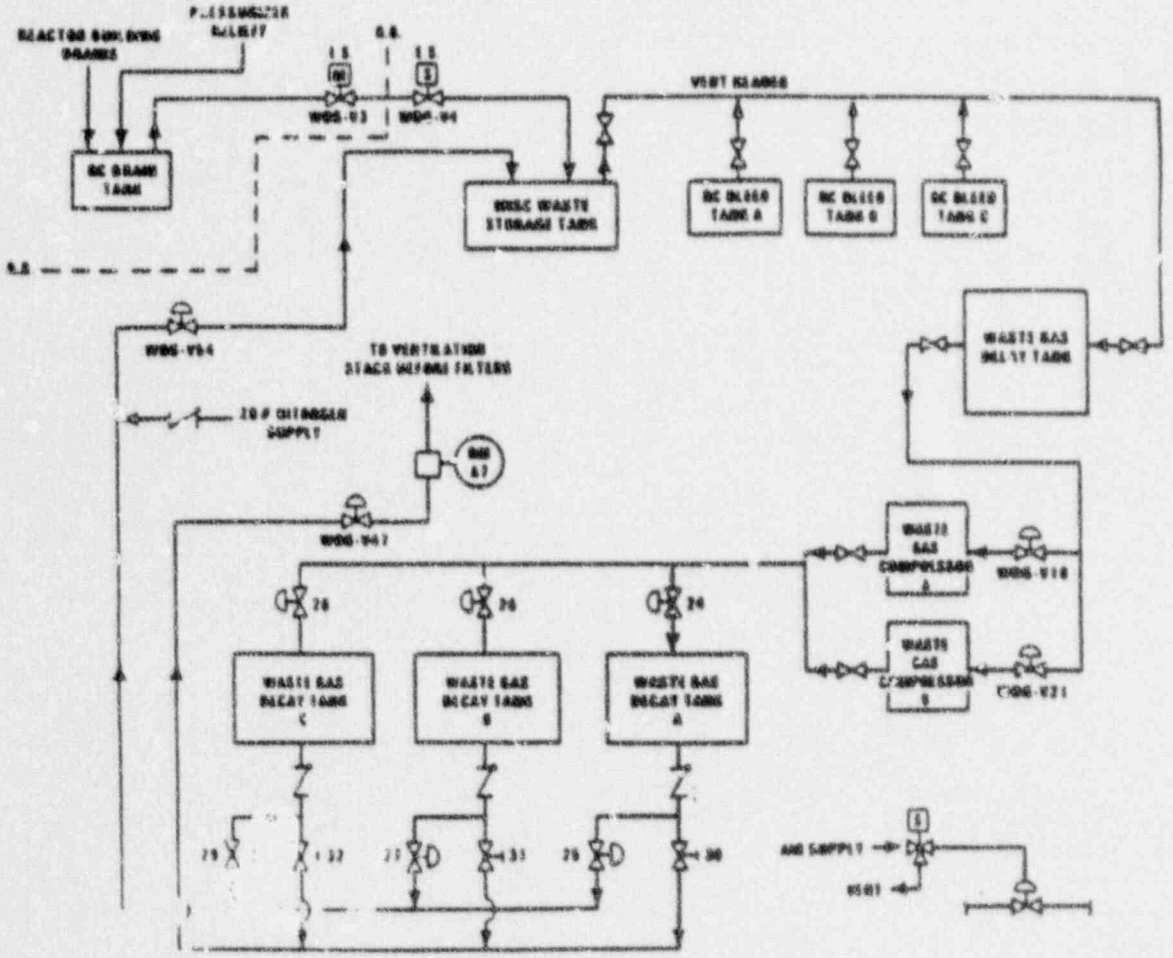


FIGURE 6.1

WASTE GAS SYSTEM



7.0 TMINS RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

7.1 Monitoring Program Requirements

7.1.1 Controls

In accordance with the TMI-1 Tech. Specs. and TMI-2 Tech. Specs., the radiological environmental monitoring program shall be conducted as specified in Table 7.1.

7.1.2 Applicability

At all times.

7.1.3 Action

a. With the radiological environmental monitoring program not being conducted as specified in Table 7.1, prepare and submit to the Commission in the Annual Radiological Environmental Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity as the result of plant effluents in an environmental sampling medium exceeding the reporting levels of Table 7.2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from the end of the affected calendar quarter, a special report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose* to a member of the public is less than the calendar year limits of TMI-1 Tech. Spec. Sections 3.22.1.2, 3.22.2.2, 3.22.2.3 and ODCM Part II, Sections 2.1.1.3F, 2.1.2.3I, and 2.1.2.3J. When more than one of the radionuclides in Table 7.2 are detected as the result of plant effluents in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \ldots \geq 1.0$$

When radionuclides other than those in Table 7.2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to a member of the public is equal to or greater than the calendar year limits of TMI-1 Tech. Spec. Sections 3.22.1.2, 3.22.2.2, 3.22.2.3 and ODCM Part II, Sections 2.1.1.3F, 2.1.2.3I, and 2.1.2.3J. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

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* The methodology and parameters used to estimate the potential annual dose to a member of the public shall be indicated in this report.

c. With milk or fresh leafy vegetables samples unavailable from one or more of the sample locations required by Table 7.1, prepare and submit to the Commission, within 30 days, a special report which identifies the cause of the unavailability of samples and identifies the locations for obtaining replacement samples. Add the new locations to the radiological environmental monitoring program within 30 days.

The locations from which samples were unavailable may then be deleted from the monitoring program. Identify the cause of the unavailability of samples and identify the new location(s) for obtaining replacement samples in the next Semi-annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table(s) from the ODCM reflecting the new locations.

7.1.4 Bases

The radiological monitoring program required by this control provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of members of the general public resulting from the station operation. This monitoring program implements Section IV B.2 of Appendix I to 10CFR50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. Guidance for this monitoring is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring (Revision 1, November 1979). Program changes may be initiated based on operational experience.

7.1.5 Surveillance Requirements

The radiological environmental monitoring samples shall be collected pursuant to Table 7.1, from the specific locations given in Tables 7.4 through 7.10 and Maps 7.1 through 7.3, and shall be analyzed pursuant to the requirements of Table 7.1 and the detection capabilities required by Table 7.3.

7.2 Land Use Census

7.2.1 Controls

In accordance with the TMI-1 Tech. Specs. and TMI-2 Tech. Specs., a land use census shall be conducted during the grazing season and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors the nearest milk animal, the nearest garden* of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation, and the nearest residence.

7.2.2 Applicability

At all times.

7.2.3 Action

a. With a land use census identifying a location(s) which yields a calculated dose or dose commitment greater than the values currently being calculated in TMI-1 Technical Specification 4.22.2.3 and ODCM Part II, Sections 2.1.1 and 2.1.2, prepare and submit a special report to the Commission within 30 days which identifies the new location(s). Identify the new location(s) in the next Semi-Annual Radioactive Effluent Release Report.

b. With a land use census identifying a location which yields a calculated dose or dose commitment (via the same exposure pathway) greater than at a location from which samples are currently being obtained in accordance with Table 7.1, add the new location(s) to the radiological environmental monitoring program within 30 days. Submit a special report to the Commission within 30 days which identifies the new locations(s). The sampling location, excluding the control station location, having the lowest calculated dose or dose commitment (via the same exposure pathway) may be deleted from the monitoring program after October 31 of the year in which the land use census was conducted. Identify the new location(s) in the next Semi-Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table(s) from the ODCM reflecting the new location(s).

7.2.4 Bases

This Control is provided to ensure that changes in the use of unrestricted areas are identified and modifications to the monitoring program are made if required by the results of this census. The best information from the door-to-door survey, aerial surveys, or consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR 50. Restricting the census to gardens

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* Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the site boundary in each of two different sectors with the highest predicted D/Qs in lieu of the garden census. Requirements for broad leaf sampling in Table 7.1 shall be followed, including analysis of control samples.

of greater than 500 square feet (50 m^2) provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/yr) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were used: 1) that 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and 2) a vegetation yield of 2 kg/square meter.

7.2.5 Surveillance Requirements

The land use census shall be conducted at least once per 12 months, between the dates of June 1 and October 1, using the information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agricultural authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report.

7.3 Interlaboratory Comparison Program

7.3.1 Controls

In accordance with the TMI-1 Tech. Specs. and TMI-2 Tech. Specs., analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the Commission (NRC). Only those samples and analyses which are required by Table 7.1 shall be performed.

7.3.2 Applicability

At all times.

7.3.3 Action

With analysis not being performed as required above, report the corrective action taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report.

7.3.4 Bases

The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of a quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid for the purpose of Section IV, B.2 of Appendix I to 10 CFR 50.

7.3.5 Surveillance Requirements

A summary of the Interlaboratory Comparison Program results shall be included in the Annual Radiological Environmental Operating Report.

TABLE 7.1

SAMPLE COLLECTION AND ANALYSIS REQUIREMENTS

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency[b]	Type and Frequency of Analysis[b]
1. Airborne Radioiodine and Particulates	Samples from 5 locations from Table 7.4.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine Canister: Analyze weekly for I-131. Particulate Filter: Analyze for gross beta radioactivity following filter change[d]. Perform gamma isotopic analysis[e] on composite (by location) sample quarterly.
2. Direct Radiation[c]	Samples from 40 locations from Table 7.5 (using either 2 dosimeters or at least 1 instrument for continuously measuring and recording dose rate at each location).	Sample Quarterly	Analyze for gamma dose quarterly.

TABLE 7.1 (Cont'd)

SAMPLE COLLECTION AND ANALYSIS REQUIREMENTS

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency[b]	Type and Frequency of Analysis[b]
3. Waterborne			
a. Surface[f]	Samples from 2 locations from Table 7.6. • 1 sample from downstream (indicator) location • 1 sample from upstream (control) location (or location not influenced by the station discharge)	Composite[g] sample over 1 monthly period.	Perform gamma isotopic analysis[e] monthly. Composite for tritium analysis quarterly.
b. Drinking	Samples from 2 locations from Table 7.6. • 1 sample at the location of the nearest water supply that could be affected by the station discharge. • 1 sample from a control location.	Composite[g] sample over 1 monthly period.	Perform gross beta and gamma isotopic analysis[e] monthly. Perform Sr-90 analysis if gross beta of monthly composite >10 times control. Composite for tritium analysis quarterly.
c. Sediment from Shoreline	Samples from 2 locations (1 Control and 1 Indicator) from Table 7.7.	Sample twice per year (Spring and Fall), the interval not to exceed 184 days.	Perform gamma isotopic analysis[e] on each sample.

TABLE 7.1 (Cont'd)

SAMPLE COLLECTION AND ANALYSIS REQUIREMENTS

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency[b]	Type and Frequency of Analysis[b]
4. Ingestion			
a. Milk	Samples from 4 locations from Table 7.8.	Sample semimonthly when animals are on pasture; monthly at other times.	Perform gamma isotopic analysis[e] and I-131 analysis on each sample. Composite for Sr-90 analysis quarterly.
b. Fish	Samples from 2 locations from Table 7.9. • 1 sample of recreationally important bottom feeders and 1 sample of recreationally important predators in the vicinity of the station discharge. • 1 sample of recreationally important bottom feeders and 1 sample of recreationally important predators from an area not influenced by the station discharge.	Sample twice per year (Spring and Fall), the interval not to exceed 184 days.	Perform gamma isotopic[e] and Sr-90 analysis on edible portions.

TABLE 7.1 (Cont'd)

SAMPLE COLLECTION AND ANALYSIS REQUIREMENTS

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency[b]	Type and Frequency of Analysis[b]
c. Food Products	Samples from 2 locations from Table 7.10 (when available) • 1 sample of green leafy vegetables or leafy vegetation at a location in the immediate vicinity of the station. (indicator) • 1 sample of same species or group from a location not influenced by the station discharge.	Sample at time of harvest.	Perform gamma isotopic[e], I-131, and Sr-90 analysis on edible portions.
	Samples from 4 locations (3 indicator and 1 control) from Table 7.10 (when available).	Sample fruits and vegetables at time of harvest.	Perform gamma isotopic analysis[e] on edible portions.

TABLE 7.1 (Cont'd)

SAMPLE COLLECTION AND ANALYSIS REQUIREMENTS

TABLE NOTATION

a. Sampling locations are provided in Tables 7.4 through 7.10. They are depicted in Maps 7.1 through 7.3. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. All deviations from the sampling schedule shall be explained in the Annual Radiological Environmental Operating Report.

b. Frequency notation: weekly (7 days), semimonthly (15 days), monthly (31 days), and quarterly (92 days). All surveillance requirements shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the surveillance interval. A total maximum combined interval time for any 4 consecutive tests shall not exceed 3.25 times the specified collection or analysis interval.

c. One or more instruments, such as a pressurized ion chamber for measuring and recording dose rate continuously, may be used in place of, or in addition to, integrating dosimeters. For the purpose of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation.

d. Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in an air particulate sample(s) is greater than ten times the calendar year mean of control samples, Sr-90 and gamma isotopic analysis shall be performed on the individual sample(s).

e. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

f. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream sample" shall be taken in an area beyond but near the mixing zone.

g. Composite sample aliquots shall be collected at time intervals that are short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

TABLE 7.2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Analysis	Water (pCi/L)	Airborne Particulate or gas (pCi/m^3)	Fish (pCi/kg,wet)	Milk (pCi/L)	Food Products (PCi/kg, wet)
H-3	20,000[a]				
Mn-54	1000		30,000		
Fe-59	400		10,000		
Co-58	1000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Sr-90	8	0.1	100	8	100
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1000	60	1000
Cs-137	50	20	2000	70	2000
Ba-La-140	200			300	

[a]For drinking water samples. This is 40 CFR Part 141 value.

TABLE 7.3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[a]

LOWER LIMIT OF DETECTION (LLD)[b,c]

Analysis	Water (pCi/L)	Airborne Particulate or Gas (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/L)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-95	30					
Sr-90	2	0.01	10	2	10	
Nb-95	15					
I-131	1[d]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	14	80	180
Ba-140	60			60		
La-140	15			15		

TABLE 7.3 (Cont'd)

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[a]

TABLE NOTATION

a. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, which may be related to plant operations, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.

b. Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13 (Rev. 1).

c. The LLD is defined, for purposes of these controls, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above, as picocuries per unit mass or volume.

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,

E is the counting efficiency, as counts per disintegration,

V is the sample size in units of mass or volume,

2.22 is the number of disintegrations per minute per picocurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide and

Δt for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting.

Typical values of E, V, Y and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an "a priori" (before the fact) limit representing the capability of a measurement system and not as an "a posteriori" (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small samples sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

d. LLD for drinking water.

TABLE 7.4

TMINS REMP STATION LOCATIONS-AIR PARTICULATE AND AIR IODINE

Station Code	Distance (miles)	Azimuth (°)	Map No.
B1-4	0.8	28	60
E1-2	0.4	95	2
F1-3	0.6	105	70
G2-1	1.4	125	75
M2-1	1.3	253	3
A3-1	2.6	358	4
H3-1	2.3	159	5
J3-2	2.9	181	71
Q4-1	3.5	325	92
G10-1	9.8	127	6
J15-1	12.6	180	7
Q15-1	13.5	305	8

TABLE 7.5

TMINS REMP STATION LOCATIONS-DIRECT RADIATION (TLD)

Station Code	Distance (miles)	Azimuth (°)	Map No.
A1-1	0.4	0	1
A1-4	0.3	5	9
B1-1	0.6	25	10
B1-2	0.4	26	11
B1-3	0.5	15	12
C1-2	0.3	54	13
D1-1	0.2	74	14
E1-1	0.2	95	15
E1-2	0.4	95	2
E1-4	0.2	98	16
F1-2	0.2	109	17
G1-3	0.3	129	18
H1-1	0.5	167	19
H1-9	0.3	167	20
J1-1	0.8	184	21
J1-3	0.3	189	22
J1-4	0.4	188	23
K1-4	0.2	208	24
K1-5	0.2	202	25
L1-1	0.1	235	26
M1-1	0.1	249	27
N1-3	0.1	270	28
P1-1	0.4	293	29
P1-2	0.2	290	30

TABLE 7.5 (Cont'd)

TMINS REMP STATION LOCATIONS-DIRECT RADIATION (TLD)

Station Code	Distance (miles)	Azimuth (°)	Map No.
Q1-2	0.2	318	31
R1-1	0.2	335	32
C2-1	1.6	48	33
K2-1	1.1	200	34
M2-1	1.3	253	3
A3-1	2.6	358	4
H3-1	2.3	159	5
R3-1	2.6	338	35
B5-1	4.8	18	36
C5-1	4.5	42	37
E5-1	4.6	81	38
F5-1	4.7	107	39
G5-1	4.8	131	40
H5-1	4.1	157	41
J5-1	4.9	182	42
K5-1	5.0	200	43
L5-1	4.1	228	44
M5-1	4.3	249	45
N5-1	4.9	268	46
P5-1	4.9	285	47
Q5-1	5.0	318	48
R5-1	4.9	339	49
D6-1	5.2	65	50
E7-1	6.8	86	51
Q9-1	8.5	308	52
B10-1	9.4	21	53
G10-1	9.8	127	6
G15-1	14.4	124	54
J15-1	12.6	180	7
Q15-1	13.5	305	8
R15-?	12.4	329	55

TABLE 7.6

TMINS REMP STATION LOCATIONS-SURFACE WATER

Station Code	Distance (miles)	Azimuth (°)	Map No.
P1-3 (R)	0.1	284	56
J1-2 (R)	0.5	188	57
J2-1 (R)	1.5	182	58
A3-2 (R)	2.5	355	59
H5-2 (F)	4.2	157	61
Q9-1 (F)	8.5	308	52
G15-1 (F)	14.4	124	54
G15-2 (F)	13.6	128	62
G15-3 (F)	14.8	124	63
J15-2 (F)	14.7	178	64
F15-1 (R)	12.6	122	65

(R) = Raw Water
(F) = Finished Water

TABLE 7.7

TMINS REMP STATION LOCATIONS-AQUATIC SEDIMENT

Station Code	Distance (miles)	Azimuth (°)	Map No.
A1-2	0.8	6	66
A1-3	0.5	0	67
G1-1	0.3	137	68
K1-3	0.3	202	69
J2-1	1.5	182	58

TABLE 7.8

TMINS REMP STATION LOCATIONS-MILK

Station Code	Distance (miles)	Azimuth (°)	Map No.
A2-1 (MG)	1.2	5	72
A15-2 (MG)	14.2	9	73
D2-1 (M)	1.1	65	74
G2-1 (M)	1.4	125	75
P7-1 (M)	6.7	293	76
K15-2 (M)	12.8	208	77
F3-1 (M)	2.3	104	78
E7-2 (M)	1.1	93	79
A4-1 (M)	3.3	10	93

(MG) = Goat Milk
(M) = Cow Milk

TABLE 7.9

TMINS REMP STATION LOCATIONS-FISH

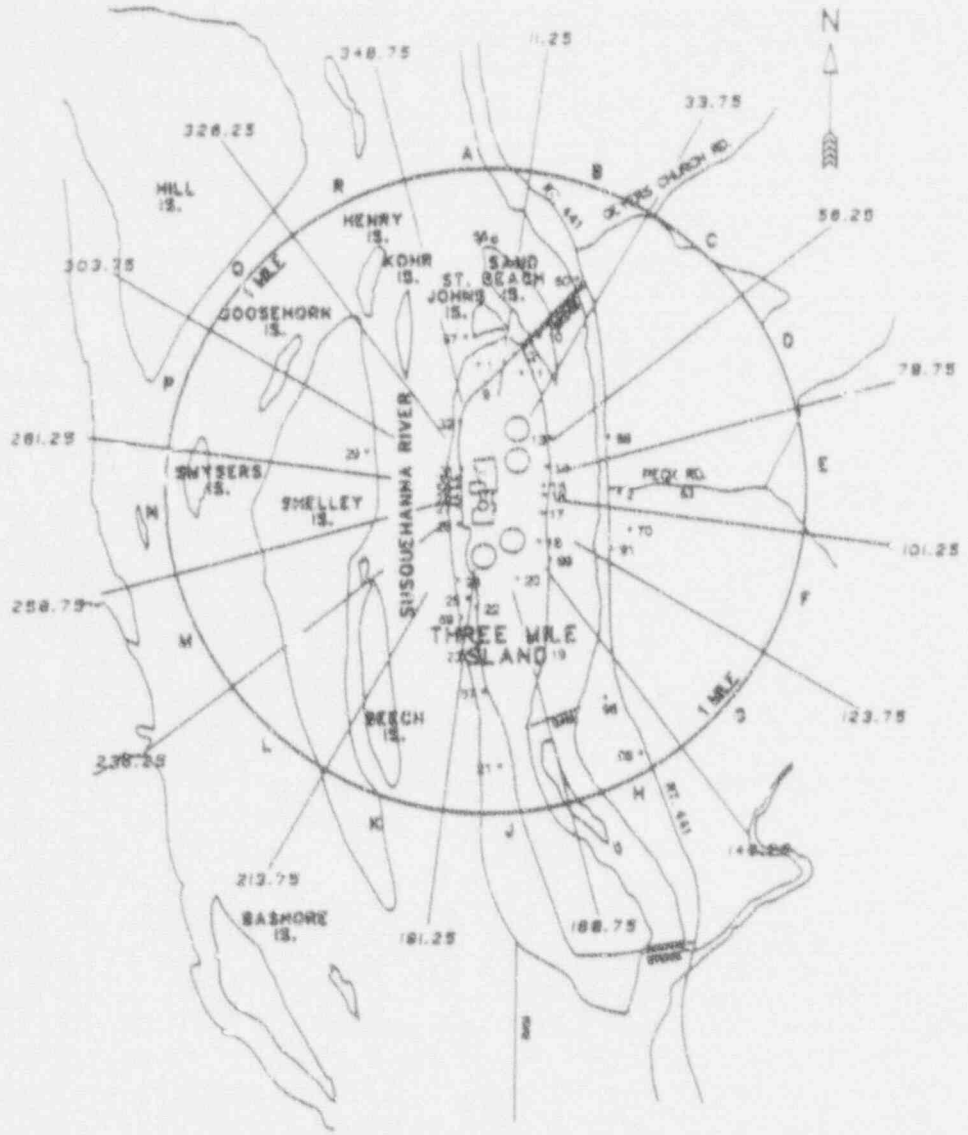
Station Code	Station Location
TM-AQF-IND	Downstream of Station Discharge
TM-AQF-BKG	Upstream of Station Discharge

AQF = Fish

TABLE 7.10

TMINS REMP STATION LOCATIONS-FOOD PRODUCTS

Station Code	Distance (miles)	Azimuth (°)	Map No.
D2-1	1.1	65	74
G2-1	1.4	125	75
A9-2	9.3	357	80
P3-1	2.6	293	81
A15-1	10.5	10	82
E1-3	0.7	90	83
E2-1	1.1	80	84
H1-2	0.9	150	85
E6-1	5.9	100	86
M15-2	13.6	253	87
D1-3	0.5	65	88
A2-1	1.2	5	72
P7-1	6.7	293	76
K15-2	12.8	208	77
A15-2	14.2	9	73
F3-1	2.3	104	78
E2-2	1.1	93	79
B15-1	10.3	12	89
E5-2	0.4	95	2
R15-2	12.4	329	55
F1-1	0.5	117	91
J2-2	1.5	178	90
A4-1	3.3	10	93
M2-2	1.3	252	94
N2-2	1.3	265	95
H1-3	0.7	150	96

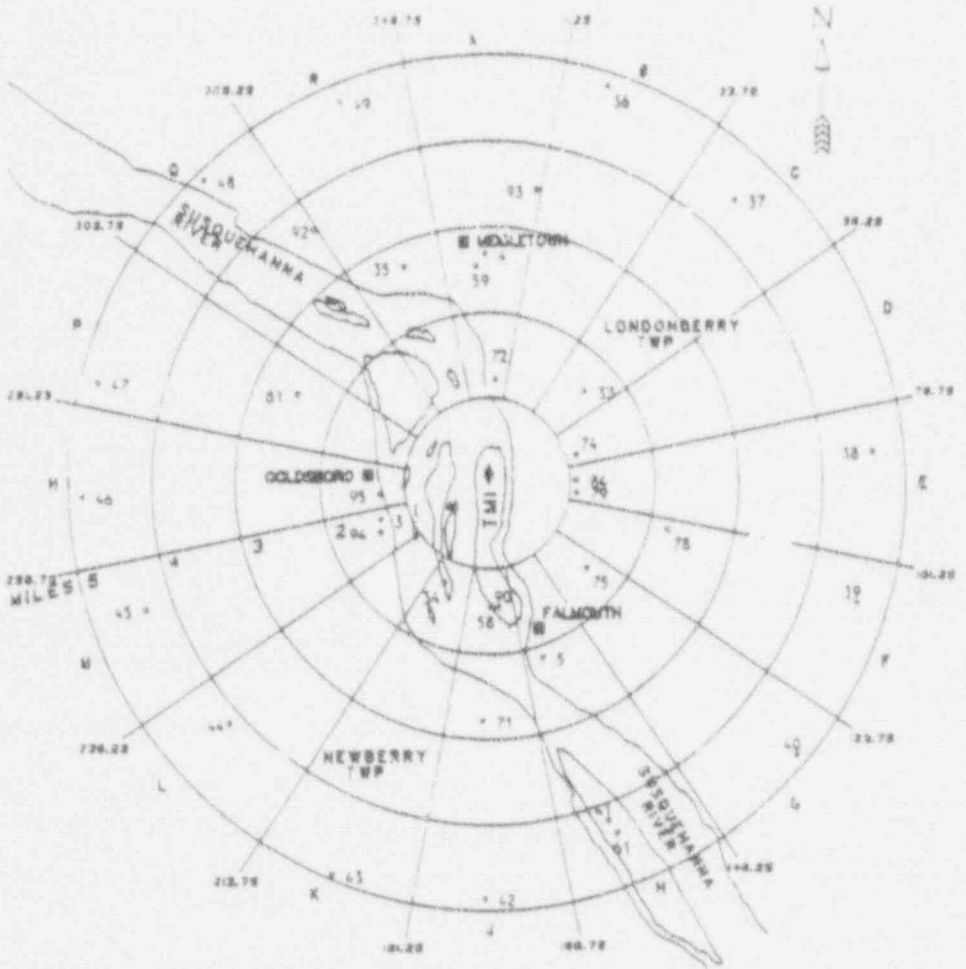


MAP 1

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
STATIONS WITHIN 1 MILE OF THE SITE

MAP 7.1

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
STATIONS WITHIN 1 MILE OF THE SITE

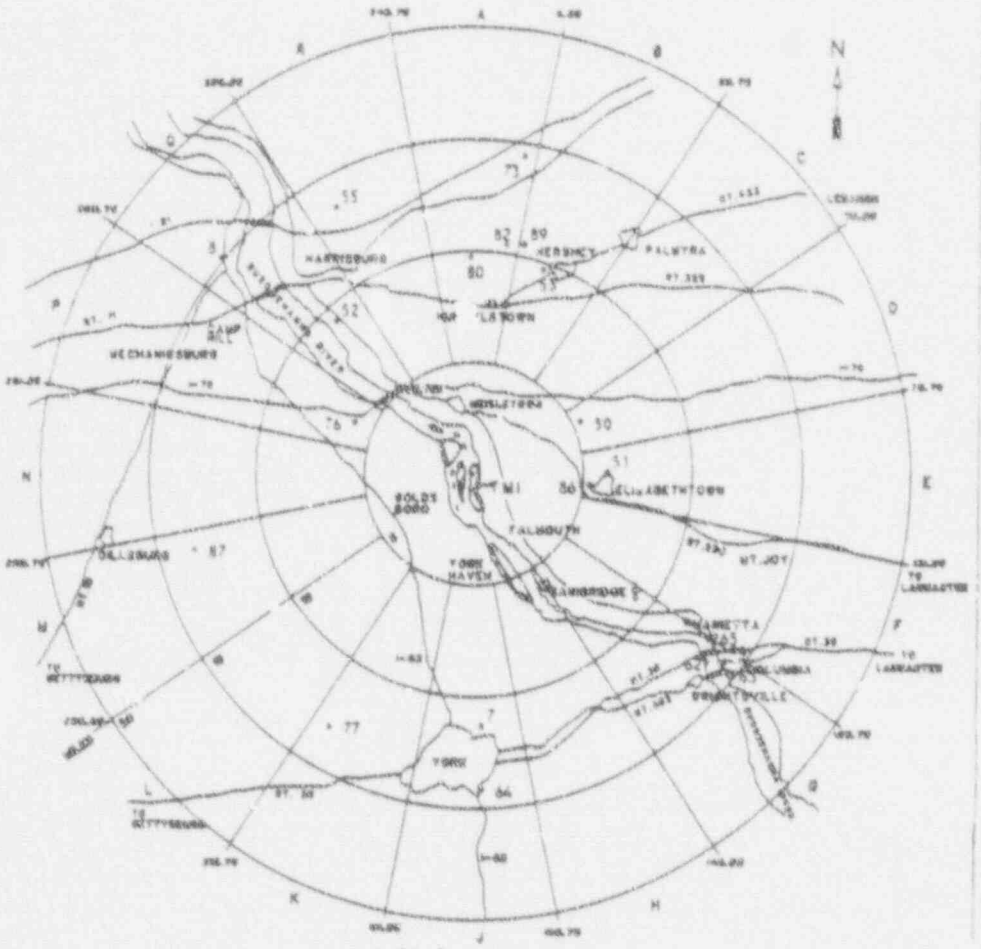


MAP 2

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
STATIONS WITHIN 5 MILES OF THE SITE

MAP 7.2

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
STATIONS WITHIN 5 MILES OF THE SITE



MAP 3

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
STATIONS GREATER THAN 5 MILES FROM THE SITE

MAP 7.3

THREE MILE ISLAND NUCLEAR STATION
LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
STATIONS GREATER THAN 5 MILES FROM THE SITE

8.0 PART I REFERENCES

1. EPRI NP-3840, RP 1560-3 Final Report, "Environmental Radiation Doses From Difficult-To-Measure Nuclides," January 1985

2. "Evaluation of the Three Mile Island Nuclear Station Unit 1 to Demonstrate Conformance to the Design Objectives of 10 CFR 50, Appendix I," Nuclear Safety Associates, May 1976

3. TMI-1 Final Safety Analysis Report (FSAR)

4. TMI-2 Final Safety Analysis Report (FSAR)

5. Meteorological Information and Dose Assessment System (MIDAS)

6. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from PWR," Revision 1, 1985

7. NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978

8. NUREG-0172, "Age-Specific Radiation Dose Commitment Factors For A One-Year Chronic Intake," November 1977

9. Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants," Revision 1, June 1974

10. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Revision 1, October 1977

11. Simplified Environmental Effluent Dosimetry System (SEEDS)

12. TMI Recirculation Factor Memos, April 12, 1988 and March 17, 1988

13. TMI-1 Operations Procedure, 1101-2.1, "Radiation Monitor Set Points"

14. Title 10, Code of Federal Regulations, "Energy"

15. TMI-1 Technical Specifications, attached to Facility Operating License No. DPR-50

16. TMI-2 Operating Procedure 4210-OPS-3651.02, "Radiation Monitor System Setpoints"

17. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977

18. TMI-2 Recovery Technical Specifications, attached to Facility Operating License No. DPR-73

19. Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979

20. Title 40, Code of Federal Regulations, "Protection of Environment"

21. Regulatory Guide 4.13, "Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications," Revision 1, July 1977

PART II

TMI-2 RADIOLOGICAL EFFLUENT CONTROLS

PART II

DEFINITIONS

1.0 DEFINITIONS

DEFINED TERMS

1.1 The DEFINED TERMS of this section appear in capitalized type and are applicable throughout Part II of the ODCM.

FACILITY MODE 3

1.2 FACILITY MODE 3 is the current condition of TMI-2 and corresponds to the following plant conditions:

a. The Reactor Vessel and Reactor Coolant System have been defueled to the extent reasonably achievable.

b. The possibility of criticality in the Reactor Building is precluded.

c. There are no canisters containing core material stored on the TMI-2 site.

ACTION

1.3 ACTION shall be those additional requirements specified as corollary statements to each control and shall be part of the controls.

OPERABLE - OPERABILITY

1.4 A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s). Implicit in this definition shall be the assumption that all necessary attendant instrumentation, controls, normal and emergency electrical power sources, cooling or seal water, lubrication or other auxiliary equipment, that are required for the system, subsystem, train, component or device to perform its function(s), are also capable of performing their related support function(s).

CHANNEL CALIBRATION

1.5 A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including the sensor and alarm and/or trip functions, and shall include the CHANNEL FUNCTIONAL TEST. CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

CHANNEL CHECK

1.6 A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

NOTE: For radioactive effluent monitors, except for those in Table 2.3-1, this shall include a verification which provides a qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

CHANNEL FUNCTIONAL TEST

1.7 A CHANNEL FUNCTIONAL TEST shall be:

a. Analog channels - the injection of a simulated signal into the channel as close to the primary sensor as practicable to verify OPERABILITY including alarm and/or trip functions.

b. Bistable channels - the injection of a simulated signal into the channel sensor to verify OPERABILITY including alarm and/or trip functions.

FREQUENCY NOTATION

1.8 The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 1.1.

COMPOSITE SAMPLE

1.9 A COMPOSITE SAMPLE is a combination of individual samples obtained at regular intervals over a time period. Either the volume of each individual sample is proportional to the flow rate discharge at the time of sampling or the number of equal volume samples is proportional to the time period used to produce the composite.

GRAB SAMPLE

1.10 A GRAB SAMPLE is an individual sample collected in less than fifteen minutes.

BATCH RELEASE

1.11 A BATCH RELEASE is the discharge of fluid waste of a discrete volume.

CONTINUOUS RELEASE

1.12 A CONTINUOUS RELEASE is the discharge of fluid waste of a non-discrete volume e.g., from a volume or system that has an input flow during the CONTINUOUS RELEASE.

TABLE 1.1

FREQUENCY NOTATION

NOTATION	FREQUENCY
S (Shiftly)	At least once per 12 hours.
D (Daily)	At least once per 24 hours.
W (Weekly)	At least once per 7 days.
M (Monthly)	At least once per 31 days.
Q (Quarterly)	At least once per 92 days.
SA (Semi-Annually)	At least once per 184 days.
A (Annually)	At least once per 12 months.
R	At least once per 18 months.
N.A.	Not applicable.

SECTIONS 2.0, 3.0 AND 4.0

CONTROLS AND SURVEILLANCE REQUIREMENTS

2/3.0 APPLICABILITY

CONTROLS

2/3.0.1 Controls and ACTION requirements shall be applicable during the conditions specified for each control.

2/3.0.2 Adherence to the requirements of the Control and/or associated ACTION within the specified time interval shall constitute compliance with the control. In the event the Control is restored prior to expiration to the specified time interval, completion of the ACTION statement is not required.

2/3.0.3 In the event the Control and/or associated ACTION requirements cannot be satisfied because of circumstances in excess of those addressed in the Control, initiate appropriate actions to rectify the problem to the extent possible under the circumstances, and submit a special report to the Commission pursuant to TMI-2 Recovery Technical Specification (Tech. Spec.) Section 6.9.2 within 30 days unless otherwise specified.

SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be applicable during the conditions specified for individual Controls unless otherwise stated in an individual Surveillance Requirement. The Surveillance Requirements shall be performed to demonstrate compliance with the OPERABILITY requirements of the Control.

4.0.2 Each Surveillance Requirement shall be performed within the specified time interval with:

a. A maximum allowable extension not to exceed 25% of the surveillance interval, and

b. A total maximum combined interval time for any 4 consecutive tests not to exceed 3.25 times the specified surveillance interval.

4.0.3 Performance of a Surveillance Requirement within the specified time interval shall constitute compliance with OPERABILITY requirements for a Control and associated ACTION statements unless otherwise required by the Control.

BASES

The Controls of this section provide the general requirements applicable to each of the Control and Surveillance Requirements.

2/3.0.1 This Control defines the applicability of each Control in terms of the specified conditions and is provided to delineate specifically when each Control is applicable.

2/3.0.2 This Control defines those conditions necessary to constitute compliance with the terms of an individual Control and associated ACTION requirement.

2/3.0.3 This Control delineates the ACTION to be taken for circumstances not directly provided for in the ACTION statements or when the provisions of the stated ACTION statement are not or cannot be complied with. The intent of this Control is to require that inoperable equipment be restored to an OPERABLE status in a prompt manner, that the unit be maintained in stable conditions, and that the Commission be promptly notified of such conditions.

4.0.1 This Control provides that surveillance activities necessary to ensure the Controls are met and will be performed during the FACILITY MODE or other conditions for which the Controls are applicable.

4.0.2 The provisions of this Control provide allowable tolerances for performing surveillance activities beyond those specified in the normal surveillance interval. These tolerances are necessary to provide operational flexibility because of scheduling and performance considerations. The phrase "at least" associated with a surveillance frequency does not negate this allowable tolerance value and permits the performance of more frequent surveillance activities.

The tolerance values, taken either individually or consecutively over 3 test intervals, are sufficiently restrictive to ensure that the reliability associated with the surveillance activity is not degraded beyond that obtained from the nominal specified interval.

4.0.3 The provisions of this Control set forth the criteria for determination of compliance with the OPERABILITY requirements of the Control. Under this criteria, equipment, systems or components are assumed to be OPERABLE if the associated surveillance activities have been satisfactorily performed within the specified time interval. Nothing in this provision is to be construed as defining equipment, systems or components OPERABLE, when such items are found or known to be inoperable although still meeting the Surveillance Requirements.

2.0 RADIOLOGICAL EFFLUENT REQUIREMENTS

2.1 Radioactive Discharges

2.1.1 Liquid Effluents

2.1.1.1 OBJECTIVES

To define the limits and conditions for the controlled release of liquid radioactive effluents to the environs to ensure that these releases are as low as practicable. These releases should not result in radiation exposures to offsite areas greater than a few percent of background exposures. The instantaneous release rate for all effluent discharges should be within the limits specified in 10 CFR Part 20.

To assure that the releases of radioactive liquids to offsite areas meet the "as low as practicable" concept, the following objectives apply:

A. The annual total quantity of radioactive materials in liquid waste, excluding tritium and dissolved gases, should not exceed 5 curies per radioactive waste-producing reactor, and the annual dose to the whole body or any organ of an individual should not exceed 3 mrem to the total body and shall be less than or equal to 10 mrem to any organ.

B. The annual average concentration of radioactive materials in the effluent from the Mechanical Draft Cooling Towers prior to dilution in the Susquehanna River, excluding tritium and dissolved gases, should not exceed 2E-8 μCi/ml.

C. The annual average concentration of tritium in liquid waste prior to dilution in the environment should not exceed 5E-6 μCi/ml.

2.1.1.2 APPLICABILITY

Applies to the controlled release of radioactive liquids from TMI-2.

2.1.1.3 CONTROLS

A. The radioactivity release concentration in liquid effluents from TMI-2 to the environment shall not exceed the values specified in 10 CFR 20, Appendix B, for unrestricted areas.

B. The total release of radioactive liquid effluent from TMI-2, excluding tritium and noble gases, shall not exceed 10 curies during any calendar quarter.

C. The equipment installed in the liquid radioactive waste system shall be maintained and shall be operated to process all radioactive liquid wastes prior to this discharge when the activity release rate will exceed 1.25 curies, excluding tritium and dissolved gases, during any calendar quarter.

D. The maximum radioactivity to be contained in one liquid radwaste tank, excluding tritium and dissolved gases, that can be discharged directly, to the environs, shall not exceed 10 curies.

E. When the average release rate of radioactive effluents, excluding tritium and dissolved gases, exceeds 2.5 curies per radioactive waste-producing reactor during any calendar quarter, the licensee shall notify the NRC within 30 days, identifying the causes and describing the proposed program of action to reduce such release rates.

For the purposes of this Control, the MPC_w (168 hour) for Xe-133 is 5E-3 µCi/ml. The MPC_w (168 hour) for Xe-135 is 1E-3 µCi/ml.

F. The dose or dose commitment from liquid effluents shall be less than or equal to 3 mrem total body and less than or equal to 10 mrem to any organ for the calendar year.

2.1.1.4 BASES

Liquid radioactive waste release levels to unrestricted areas should be kept "as low as practicable" and are not to exceed the concentration limits specified in 10 CFR 20. The Controls provide reasonable assurance that the resulting annual exposure to an individual in off-site areas will not exceed the design objectives of Appendix I to 10 CFR Part 50, which were established as requirements for the cleanup of TMI-2 in the NRC's Statement of Policy of April 27, 1981. This assurance is based on the fact that the Susquehanna River will dilute the liquid effluents upon their release from the site. The effluents will be diluted by a factor of about 250 in the region where finfish can exist (within a one-quarter mile radius of the discharge point). At the same time these Controls permit the flexibility of operation, compatible with considerations of health and safety, to assure that the public is provided a dependable source of power under unusual operating conditions, which may temporarily result in higher than normal releases, but still within the concentration limits specified in 10 CFR 20. It is expected that by using this operational flexibility under unusual operating conditions, and exerting every effort to keep levels of radioactive material in liquid wastes as low as practicable, the annual releases will not exceed a small fraction of the annual average concentration limits specified in 10 CFR 20.

Control 2.1.1.3 A. above requires the licensee to limit the concentration of radioactive materials in liquid effluents from TMI-2 to levels specified in 10 CFR 20, Appendix B, for unrestricted areas. This Control provides assurance that no member of the general public can be exposed to liquids containing radioactive materials in excess of limits considered permissible under the Commission's rules and regulations.

Control 2.1.1.3 B. above establishes an upper limit for the release of radioactive liquid effluents, excluding tritium and dissolved gases, of 10 curies during any calendar quarter. The intent of this Control is to

permit the licensee the flexibility of operation to assure that the public is provided a dependable source of power under unusual operating conditions, which may temporarily result in releases higher than the levels normally achievable when the unit and the liquid radwaste equipment are functioning as designed. Releases of up to 10 curies during any calendar quarter will result in concentrations of radioactive materials in liquid effluents at small percentages of the limits specified in 10 CFR 20.

Control 2.1.1.3 C. requires the licensee to maintain and operate the equipment installed in the liquid radioactive waste system to reduce the release of radioactive materials in liquid effluents to as low as practicable, consistent with the requirements of 10 CFR 50.36a. Normal use and maintenance of installed equipment in the liquid radioactive system is expected to result in releases of not more than about five curies per year, excluding tritium and dissolved gases during normal operations. In order to keep releases of radioactive materials as low as practicable, the Control requires, as a minimum, operation of equipment whenever the rate of release exceeds 1.25 curies per quarter, excluding tritium and dissolved gases.

In addition to Control 2.1.1.3 B., the reporting requirements of Control 2.1.1.3 E. and Appendix A, Section 6.6 C. the TMI-2 Tech. Specs., delineate that the licensee shall identify the cause whenever the rate of radioactive effluents, excluding tritium and noble gases, exceeds 2.5 curies during any calendar quarter and describe the proposed program of action to reduce such release rates. This report must be filed within 30 days following the calendar quarter in which the 2.5 curie release occurred.

Control 2.1.1.3 F. requires that the dose to offsite personnel be limited to the design objectives of Appendix I of 10 CFR Part 50. This will assure the dose received by the public during the cleanup is equivalent to or less than that from a normal operating reactor. The limits also assure that the environmental impacts are consistent with those assessed in NUREG-0683, the TMI-2 Programmatic Environmental Impact Statement (PEIS).

2.1.2 Gaseous Effluents

2.1.2.1 OBJECTIVES

To define the limits and conditions for the controlled release of radioactive gaseous effluents to the environs to ensure that these releases are as low as practicable. These releases should not result in radiation exposures in offsite areas greater than a few percent of background exposures. The instantaneous release rate for all effluent discharge should be within the limits specified in 10 CFR 20.

To assure that the release of radioactive gases to offsite areas meet the as low as practicable concept, the release rate of gaseous effluents shall not result in doses to the public exceeding the design objectives of Appendix I to 10 CFR Part 50.

2.1.2.2 APPLICABILITY

Applies to the controlled release of radioactive gases from TMI-2.

2.1.2.3 CONTROLS

A. The instantaneous release rate of gross gaseous activity except for halogens and particulates with half-lives longer than eight days shall not exceed:

$$\sum \left(\frac{Q_i}{(MPC)_i} \right) \leq 1.5 \times 10^3 \ m^3/sec$$

where Q_i is the release rate in $\mu Ci/sec$ for isotope i, and MPC_i ($\mu Ci/m^3$) is the maximum permissible concentration of isotope i as defined in Appendix B, Table II, Column 1 of 10 CFR 20.

B. The instantaneous release rate of particulates with half-lives greater than eight days, released to the environs as part of the airborne effluents, shall not exceed 0.3 $\mu Ci/sec$.

C. The release rate of gross gaseous activity shall not exceed:

$$\sum \left(\frac{Q_i}{(MPC)_i} \right) \leq 2.4 \times 10^4 \ m^3/sec$$

when averaged over any calendar quarter.

D. The release rate of particulates with half-lives greater than eight days, shall not exceed 0.024 $\mu Ci/sec$. when averaged over any calendar quarter.

E. Radioactive gaseous wastes collected in the gas decay tanks shall be held up to a minimum of 45 days, except when the release rate does not exceed:

1. $$\sum \left(\frac{Q_i}{(MPC)_i} \right) \leq 3 \times 10^3 \ m^3/sec$$ (noble gases)

or

2. 0.003 $\mu Ci/sec$ (particulates with half-lives greater than 8 days)

F. Radioactive gases and particulates purged from the Reactor Building shall be filtered through the high efficiency particulate air filters.

G. The maximum activity to be contained in one gas decay tank shall not exceed 8800 curies (equivalent to Xe-133).

H. When the release rate of radioactive materials in gaseous wastes, averaged over a calendar quarter exceeds:

1. $\sum \left(\frac{Q_i}{(MPC)_i} \right) \leq 6 \times 10^3 \ m^3/sec$

(noble gases)

or

2. 0.006 μCi/sec (particulates with half-lives greater than 8 days)

the licensee shall notify the NRC within 30 days, identifying the causes and describing the proposed program of action to reduce such release rates.

I. The air dose due to noble gases in gaseous effluents shall be less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation for the calendar year.

J. The dose for radioactive (other than noble gaseous effluents) shall be less than or equal to 15 mrem to any organ for the calendar year.

2.1.2.4 BASES

The specified levels provide reasonable assurance that the resulting annual exposure rate from noble gases at any location at the site boundary will not exceed 10 millirems per year. At the same time, these Controls permit the flexibility of operation, compatible with consideration of health and safety, to assure that the public is provided a dependable source of power under unusual operating conditions, which may temporarily result in higher than the design objective levels, but still within the concentration limits specified in 10 CFR 20 and within the design objectives of Appendix I to 10 CFR 50. It is expected that using this operational flexibility under unusual operating conditions, and by exerting every effort to keep levels of radioactive material in gaseous wastes as low as practicable, the annual releases will not exceed a small fraction of the annual concentration limits specified in 10 CFR 20 and will not result in doses which exceed the design objectives of Appendix I to 10 CFR 50, which were endorsed as limits for the cleanup of TMI-2 by the NRC's Statement of Policy of April 27, 1981.

These efforts should include consideration of meteorological conditions during releases.

The annual objectives have been developed taking into account a combination of system variables including fuel failures, primary system leakage, primary to secondary system leakage, and the performance of radionuclide removal mechanisms. I-131 is not specifically monitored because it has decayed to less than detectable activity since the March 28, 1979 accident.

Control 2.1.2.3 A., requires the licensee to limit the concentration of noble gases from TMI-2 to levels specified in 10 CFR 20, Appendix B, for unrestricted areas. Based on a X/Q of 6.7×10^{-6} sec/m^3, this Control provides assurance that no member of the general public would be exposed to radioactive materials in excess of limits specified in the Commission's rules and regulations.

Control 2.1.2.3 B., requires the licensee to limit the concentration of particulates with half-lives greater than eight days, released from TMI-2 to unrestricted areas to levels such that no individual will receive more than 500 mrem/yr to the total body or 3000 mrem/yr to the skin. The absence of iodine ensures that the corresponding thyroid dose rate above background to an infant via the cow-milk-infant pathway is less than or equal to 1500 mrem/yr. A grazing period of 6 months has been applied to all radionuclides in particulate form with half-lives greater than 8 days, to allow for the milk exposure pathway.

The release rate is determined by using the methodology of Regulatory Guide 1.109 (Rev. 1) and a relative deposition factor (D/Q) of 2.1×10^{-8} m^{-2}. The D/Q of 2.1×10^{-8} m^{-2} was calculated for the nearest cow located 1.2 miles SE of the station, using onsite meteorological data.

Controls 2.1.2.3 C. and D., establish an upper limit for the release of gaseous activity at 16% of instantaneous release limit of noble gases and at eight percent of the release rate of particulates with half-lives greater than 8 days, averaged over any calendar quarter, respectively. The intent of those Controls is to permit the licensee the flexibility of operation to assure that the public is provided a dependable source of power under unusual operating conditions which may temporarily result in higher releases than the objectives.

Control 2.1.2.3 E., requires a 45 day holdup time for radioactive gaseous wastes collected in the gas decay tanks to assure decay of most radionuclides. The whole body dose from noble gases at the site boundary is expected to be less than 10 mrem/yr (primarily from Kr-85). The whole body dose from particulates at the nearest farm is expected to be less than 5 mrem/yr.

Control 2.1.2.3 F., limits the radioactivity that may be released to the environment to "as low as practicable."

Control 2.1.2.3 G., limits the maximum offsite dose to well below the limits of 10 CFR 100, postulating that the rupture of a Waste Gas Decay Tank holding the maximum activity releases all of the contents to the atmosphere.

In addition to the requirements of Controls 2.1.2.3 A., B. and C., the reporting requirements of Control 2.1.2.3 H. delineate that the licensee shall identify the cause whenever the radioactive gaseous release rate exceeds 4 percent of Control 2.1.2.3 A. or 2 percent of Control

2.1.2.3 B., averaged over a calendar quarter, and describe the proposed program of action to reduce such release rates. The report must be filed within 30 days following the calendar quarter in which more than twice t'· esign release rate occurred.

2.2 Radioactive Gaseous Effluent Monitoring Instrumentation

2.2.1 OBJECTIVE

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 2.2-1 shall be OPERABLE.

2.2.2 APPLICABILITY

As shown in Table 2.2-1.

2.2.3 CONTROL

With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 2.2-1.

2.2.4 BASES

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criterion 64 of Appendix A to 10 CFR Part 50.

2.3 Radiation Monitoring Instrumentation

2.3.1 OBJECTIVE

The radiation monitors listed in Table 2.3-1 shall be OPERABLE.

2.3.2 APPLICABILITY

As required in Table 2.3-1.

2.3.3 CONTROL

As required in Table 2.3-1.

2.3.4 BASES

The OPERABILITY of the radiation monitoring channels ensures that the radiation levels are measured in the areas served by the respective monitors.

TABLE 2.2-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
EPICOR II VENTILATION SYSTEM			
a. Noble Gas Activity Monitor	1	*	1
b. Particulate Sampler	1	*	2
c. Flow Rate Monitor	1	*	3
d. Sampler Flow Rate Monitor	1	*	3

TABLE NOTATION

*At all times.

ACTION 1 - With the number of channels OPERABLE less than required by the Minimum Channels Operable requirement, effluent releases via the pathway may continue for up to 30 days provided GRAB SAMPLES are taken at least once per 8 hours and these samples are analyzed for gross activity within 24 hours.

ACTION 2 - With the number of channels OPERABLE less than required by the Minimum Channels Operable requirement, effluent releases via the affected pathway may continue for up to 30 days provided samples are continuously collected with auxiliary sampling equipment as required in Table 3.1-3.

ACTION 3 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours.

TABLE 2.3-1

RADIATION MONITORING INSTRUMENTATION

FUNCTIONAL UNIT	CHANNEL CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. CONTAINMENT						
a. Reactor Building Equipment Doors (AMS-3)	D	SA	W	1	Note 1	Note 2
2. WASTE HANDLING AND PACKAGING FACILITY						
a. Exhaust Monitor	D	R	M	1	Note 3	Note 4

NOTES:

1. With both Reactor Building equipment hatch airlock doors open simultaneously.

2. With the AMS-3 inoperable, close at least one of the Reactor Building Equipment Doors and restore the inoperable equipment to OPERABLE status prior to the reopening of both Equipment Doors.

3. During operation of the monitored system.

4. With less than one channel operable, effluent releases via the affected pathway may continue for up to thirty (30) days provided that samples are continuously collected with auxiliary sampling equipment within the WHPF. These auxiliary filter samples will be changed daily and a gamma scan performed within 24-hours. After completion of the gamma scan, an analysis for gross alpha, gross beta, and Sr/Y-90 activities will be completed within 96 hours.

3.0 MONITORING REQUIREMENTS

3.1 Radioactive Discharges

3.1.1 Liquid Effluents

3.1.1.1 OBJECTIVE

To ensure that radioactive liquid releases from the facility are within the limits of Controls 2.1.1.3 A. through F.

3.1.1.2 CONTROLS

During release of liquid radioactive wastes from the Waste Evaporator Condensate Storage Tank and the Waste Evaporator Condensate Test Tank, the following conditions shall be met:

A. The liquid gross activity monitor (WDL-R-1311 or similar device) and recorder on the radwaste effluent line shall be OPERABLE.

B. The liquid gross activity monitor (WDL-R-1311 or similar device) shall be set to alarm and automatically close waste discharge valve (WDL-V-99) prior to exceeding the limits specified in 10 CFR 20, Appendix B for unrestricted areas.

C. Liquid waste radioactivity and flow rate from the Waste Evaporator Condensate Test Tank shall be continuously monitored and recorded during release. If this requirement cannot be met, continued release of liquid effluents shall be permitted only during the succeeding 48 hours provided that during this 48-hour period two independent samples of each tank shall be analyzed and two station personnel shall independently check valve line-up prior to the discharge.

D. Facility records shall be maintained of the radioactive concentrations and volume before dilution of each batch of liquid effluent released, and the average dilution flow and length of time over which each discharge occurred. Estimates of the error associated with each reported value should be included in facility records.

E. Radioactive liquid waste sampling and activity analysis shall be performed in accordance with Table 3.1-1. Prior to the release of each batch of liquid effluent, a sample shall be taken from that batch and analyzed for the concentration of each significant gamma emitter to demonstrate compliance with Control 2.1.1.3 A. using the flow into which the effluent is discharged.

F. The liquid effluent radiation monitor (WDL-R-1311) shall be calibrated at least quarterly by means of a known radioactive source. WDL-R-1311 shall also have a CHANNEL FUNCTIONAL TEST

monthly and a CHANNEL CHECK prior to each discharge to verify that the read-out device is indicating as expected.

G. The ability of WDL-V-99 to close automatically on receipt of a high radiation alarm signal from WDL-R-1311 shall be checked annually.

3.1.1.3 BASES

Controls 3.1.1.2 A., B., and C. require that suitable equipment to monitor the release of radioactive materials in liquid effluent are operating during any period these releases are taking place.

The monitoring requirements given in the remaining Controls provide assurance that liquid wastes are properly controlled and monitored during any planned release of radioactive materials in liquid effluents.

These monitoring requirements provide the data for the licensee and the Commission to evaluate the station's performance relative to radioactive liquid wastes released to the environment. Reports on the quantities of radioactive materials released in liquid effluents shall be furnished to the Commission on the basis of ODCM Part III Requirements. On the basis of such reports and any additional information obtained from the licensee or others, the Commission may require the licensee to take appropriate action.

3.1.2 Gaseous Effluents

3.1.2.1 OBJECTIVE

To ensure that radioactive gaseous releases from the facility are within the limits of Controls 2.1.2.3 A. through J.

3.1.2.2 CONTROLS

During release of radioactive gaseous wastes, the following conditions shall be met:

A. During release of gaseous waste from the waste gas decay tanks, the following conditions shall be met:

1. The waste gas discharge monitor (WDG-R-1480 or similar device) shall be OPERABLE.

2. The Auxiliary and Fuel Handling Buildings and Unit Exhaust Vent exhaust gas, iodine and particulate monitor (HP-R- 9 or similar device) shall be OPERABLE.

3. The waste gas decay tank discharge valves (WDG-V-30A and 30B) shall be OPERABLE.

4. The waste gas decay tank discharge valves (WDG-V-30A and 30B) shall be closed in receipt of any one of the following conditions:

   a. A high radiation signal from the waste gas discharge monitor (WDG-R-1480).

   b. A high radiation signal from the Auxiliary and Fuel Building exhaust monitor (HP-R-219).

   c. A high flow signal from the Waste Gas Decay Tank discharge flow transmitter (WDG-FT-3923).

   d. Observation of loss of flow through the Unit Vent.

B. During purge of the Reactor Building, the following conditions shall be met:

   1. The Reactor Building Purge Exhaust Monitors (HP-R-225 or HP-R-226, and HP-R-219 or similar device) shall be OPERABLE.

   2. The Purge Exhaust Valves (D5129 A/D and D5129 B/C) shall be OPERABLE.

   3. The Purge Exhaust Valves (D5129 A/D and D5129 B/C) shall be interlocked to recirculate on receipt of a high radiation signal from their respective Reactor Building Exhaust Monitors (HP-R-225 and HP-R-226).

C. The flow rate for radioactive effluent streams and the Auxiliary and Fuel Handling Buildings and the Reactor Building, shall be monitored and recorded. Gaseous effluents from the Waste Gas Decay Tanks and the Reactor Building Purge Exhaust shall be continuously monitored and recorded.

D. Radioactive gaseous waste sampling and activity analysis shall be performed in accordance with Table 3.1-2.

E. The waste gas decay tank effluent monitor (WDG-R-1480) shall be tested using the installed check source or equivalent prior to any release of radioactive gas from a holdup tank and shall be calibrated quarterly using a referenced calibration source in a controlled reproducible geometry.

F. During power operation, the condenser vacuum pump discharge shall be continuously monitored for gross gaseous activity. The monitor shall not be inoperable for more than a week. Whenever this monitor is inoperable, a GRAB SAMPLE shall be taken daily and analyzed for gross radioactivity (β, γ).

G. Facility records shall be maintained of radioactive concentration, release ratio and volume of each batch of gaseous effluents

released and the length of time over which release occurred. Estimates of the error associated with each reported value should be included in facility records.

H. At least annually, automatic initiation and closure of the Waste Gas Decay Tank Discharge valve on alarm of WDG-R-1480 shall be verified.

I. The Unit Vent monitors (HP-R-219, HP-R-219A, HP-R-225, and HP-R-226) shall be CALIBRATED at least every eighteen months by means of a known radioactive source. These detectors shall have a CHANNEL FUNCTIONAL TEST at least monthly, and a CHANNEL CHECK at least daily, to verify that the read-out device is indicated as expected.

J. The release rate of radioactive materials, other than noble gases, in gaseous effluents shall be determined to be within the limits calculated in accordance with this Control by obtaining representative samples and performing analyses in accordance with the sampling and analysis program, specified in Table 3.1-3.

3.1.2.3 BASES

Controls 3.1.2.2 A. through I. require that suitable equipment to monitor the radioactive gaseous releases are operating during any period these releases are taking place.

Control 3.1.2.2 J. is provided to ensure that the dose at any time at the site boundary from gaseous effluents from TMI-2 will be within the annual dose limits of 10 CFR Part 20 for unrestricted areas. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual in an unrestricted area, either within or outside the site boundary, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR Part 20.106(b)). For individuals who may at times be within the site boundary, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the site boundary. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the site boundary to less than or equal to 500 mrem/yr to the total body or to less than or equal to 3000 mrem/yr to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to an infant via the cow-milk-infant pathway to less than or equal to 1500 mrem/yr for the nearest cow to the plant.

These monitoring requirements provide assurance that radioactive gaseous effluents from the station are properly controlled and monitored over the life of the station. These monitoring requirements provide the data for the licensee and the Commission to evaluate the station's

performance relative to radioactive gaseous wastes released to the environment.

Reports on the quantities of radioactive materials released in gaseous effluents shall be furnished to the Commission on the basis of ODCM Part III requirements. On the basis of such report and any additional information the Commission may obtain from the licensee or others, the Commission may from time to time require the licensee to take such action as the Commission deems appropriate.

3.2 Radioactive Gaseous Effluent Monitoring Instrumentation

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 3.2-1 (per occupational exposure considerations and detector sensitivity in ambient radiation areas).

3.9 Radiation Monitoring Instrumentation

Each radiation monitoring instrumentation channel shall be demonstrated OPERABLE by the performance of the CHANNEL CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3-1.

TABLE 3.1-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS (4, 5)

A. Monitor Tank Releases

Sampling Frequency	Type of Activity Analysis	Detectable Concentration (3)
Each Batch	Individual Gamma	5E-7 μCi/ml (2)
	H-3	1E-5 μCi/ml
Monthly Composite (1)	Gross Alpha	1E-7 μCi/ml
	Sr-89	5E-8 μCi/ml
	Sr-90	5E-8 μCi/ml

NOTES

(1) A COMPOSITE SAMPLE is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged from the plant.

(2) For certain mixtures of gamma emitters, it may not be possible to measure radionuclides in concentrations near this sensitivity limit when other nuclides are present in the sample in much greater concentrations. Under these circumstances, it will be more appropriate to calculate the concentrations of such radionuclides using measured ratios with those radionuclides which are routinely identified and measured.

(3) The detectability limits for radioactivity analysis are based on the technical feasibility and on the potential significance in the environment of the quantities released. For some nuclides, lower detection limits may be readily achievable and when nuclides are measured below the stated limits, they should also be reported.

(4) The results of these analyses should be used as the basis for recording and reporting the quantities of radioactive material released in liquid effluents during the sampling period. In estimating releases for a period when analyses were not performed, the average of the two adjacent data points spanning this period should be used. Such estimates should be included in the effluent records and reports; however, they should be clearly identified as estimates, and the method used to obtain these data should be described.

(5) Deviations from the sampling/analysis regime will be noted in the report specified in ODCM Part III.

TABLE 3.1-2

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS (5)

SAMPLE POINT	SAMPLE TYPE	SAMPLING FREQUENCY	TYPE OF ACTIVITY ANALYSIS	DETECTABLE CONCENTRATION(1)
Waste Gas Decay Tank Release	Gas	Each Tank Release	H-3	1E-6 µCi/cc
			Individual Gamma Emitters	1E-4 µCi/cc (2)
Reactor Building Purge Releases	Gas	Each Purge	H-3	1E-6 µCi/cc
			Individual Gamma Emitters	1E-4 µCi/cc (2)
Condenser Vacuum Pump Releases	Gas	Monthly	H-3	1E-6 µCi/cc
		Monthly (3)	Individual Gamma Emitters	1E-4 µCi/cc (2)
Unit Exhaust Vent Release Points	Gas	Monthly (4)	H-3	1E-6 µCi/cc
			Individual Gamma Emitters	1E-4 µCi/cc (2)
	Charcoal	Weekly (6)	I-131, I-133, I-135	1E-12 µCi/cc
	Particulates	Weekly	Individual Gamma Emitters	1E-10 µCi/cc (2)
		Monthly Composite	Sr-89, Sr-90	1E-11 µCi/cc
		Monthly Composite	Gross Alpha Emitters	1E-11 µCi/cc

(1) The above detectability limits are based on technical feasibility and on the potential significance in the environment of the quantities released. For some nuclides, lower detection limits may be readily achievable and when nuclides are measured below the stated limits, they should also be reported.

TABLE 3.1-2 (Cont'd)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS (5)

(2) For certain mixtures of gamma emitters, it may be possible to measure radionuclides at levels near their sensitivity limits when other nuclides are present in the sample at much higher levels. Under these circumstances, it will be more appropriate to calculate the levels of such radionuclides using observed ratios in the gaseous component in the reactor coolant for those radionuclides which are measurable.

(3) Analysis shall also be performed following each refueling period, start-up or similar operational occurrence which could alter the mixture of radionuclides.

(4) Sampled during periods when no waste gas decay tank release or reactor building purge is in progress.

(5) Deviations from the sampling and analysis regime will be noted in the report specified in ODCM Part III.

(6) Sample not required for Unit Exhaust Vent. However, the charcoal in the charcoal sampler should be replaced on a weekly basis although a weekly analysis is not required.

TABLE 3.1-3

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
EPICOR-II Ventilation	M[b] Grab Sample	M	Principal Gamma Emitters[c]	1E-4
			H-3	1E-6

TABLE 3.1-3 (Cont'd)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION

a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ S_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where

LLD is the lower limit of detection as defined above (as picocurie per unit mass or volume).

S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute).

E is the counting efficiency (as counts per transformation),

V is the sample size (in units of mass or volume),

2.22 is the number of transformations per minute per picocurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide, and

Δt is the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples),

The value of S_b used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples. Typical values of E, V, Y, and Δt shall be used in the calculation. The background count rate is calculated from the background counts that are determined to be with $\pm$ one FWHM (Full-Width-at-Half-Maximum) energy band about the energy of the gamma-ray peak used for the quantitative analysis for that radionuclide.

b. Tritium GRAB SAMPLES shall be taken at least once per 7 days from the ventilation exhaust from the Chemical Cleaning Building.

TABLE 3.1-3 (Cont'd)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

TABLE NOTATION

c. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses shall be reported as "less than" the nuclide's LLD and shall not be reported as being present at the LLD level for that nuclide. The "less than" values shall not be used in the required dose calculations.

TABLE 3.2-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING
INSTRUMENTATION MONITORING REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
EPICOR II VENTILATION SYSTEM			
a. Noble Gas Activity Monitor	L	R(1)	Q(2)
e. Particulate Sampler	W	N/A	N/A
c. Flow Rate Monitor	D	SA	SA
d. Sampler Flow Rate Monitor	D	SA	SA

TABLE NOTATION

(1) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

(2) CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm setpoint.
2. Circuit failure (alarm function only).
3. Instrument indicates a downside failure (alarm function only).
4. Instrument controls not set in operate mode or the switch position administratively monitored and controlled.

SECTION 4.0

DESIGN FEATURES

4.0 DESIGN FEATURES

4.1 SITE

EXCLUSION AREA

4.1.1 The exclusion area is shown in Figure 5-1, TMI-1 Tech. Specs.

LOW POPULATION ZONE

4.1.2 The low population zone is shown in Figure 5-2, TMI-1 Tech. Specs.

SITE BOUNDARY FOR GASEOUS EFFLUENTS

4.1.3 The site boundary for gaseous effluents shall be as shown in Figure 5-3, TMI-1 Tech. Specs.

SITE BOUNDARY FOR LIQUID EFFLUENTS

4.1.4 The site boundary for liquid effluents shall be as shown in Figure 5-3, TMI-1 Tech. Specs.

5.0 PART II REFERENCES

5.1 NUREG-0683, "Final Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979, accident Three Mile Island Nuclear Station, Unit 2," March 1981

5.2 TMI-2 Recovery Technical Specifications, attached to Facility Operating License No. DPR-73

5.3 Title 10, Code of Federal Regulations, "Energy"

5.4 "Statement of Policy Relative to the NRC Programmatic Environmental Impact Statement on the Cleanup of Three Mile Island Unit 2," dated April 27, 1981

5.5 Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977

5.6 DCE/TIC-27601, Atmospheric Science and Power Reduction

5.7 TMI-1 Technical Specifications, attached to Facility Operating License No. DPR-50

PART III

REPORTING REQUIREMENTS

PART III

REPORTING REQUIREMENTS

1.0 TMI ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT*

1.1 Routine Radiological Environmental Operating Reports covering the operation of the unit during the previous calendar year shall be submitted to the Commission prior to May 1 of each year.

1.2 The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental monitoring activities for the report period, including a comparison with pre-operational studies, with operational controls as appropriate, and with previous environmental monitoring reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by Part I, Section 7.2.

1.3 The Annual Radiological Environmental Operating Reports shall include the summarized tabulated results of analysis of all radiological environmental samples and environmental radiation measurements required by Part I Table 7.1 taken during the period pursuant to the locations specified in the tables and figures in this ODCM, as well as summarized and tabulated results of these analyses and measurements in a format similar to the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

1.4 The reports shall also include the following: a summary description of the radiological environments monitoring program; a map(s) of all sampling locations keyed to a table giving distances and directions from a point that is midway between the Reactor Buildings of TMI-1 and TMI-2; the results of licensee participation in the Interlaboratory Comparison Program, required by Part I, Section 7.3; discussion of all deviations from the sampling schedule of Part I, Table 7.1; discussion of all the required analyses in which the LLD required by Part I, Table 7.3 was not achievable.

*A single submittal may be made for the station.

2.0 TMI SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

NOTE: A single submittal may be made for the station. The submittal should combine those sections that are common to both units at the station however, for units with separate radwaste systems, the submittal shall specify the release of radioactive material from each unit.

2.1 Routine Radioactive Effluent Release Reports covering the operations of the unit during the previous 6 months of operation shall be submitted within 60 days after January 1 and July 1 of each year.

2.2 The following information shall be included in both Radioactive Effluent Release Reports to be submitted each year:

The Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Reg. Guide 1.21, Rev. 1, with data summarized on a quarterly basis following the format of Appendix B thereof.

2.3 The Radioactive Effluent Release Reports shall include the following information for each type of solid waste shipped offsite during the report period:

a. container volume,

b. total curie quantity (specify whether determined by measurement or estimate),

c. principal radionuclides (specify whether determined by measurement or estimate),

d. type of waste (e.g., spent resin, compacted dry waste, evaporator bottoms),

e. type of shipment (e.g., LSA, Type A, Type B) and

f. solidification agent (e.g., cement).

2.4 The Radioactive Effluent Release Reports shall include a summary of unplanned releases from the site to unrestricted areas of radioactive materials in gaseous and liquid effluents made during the reporting period.

2.5 The Radioactive Effluent Release Reports shall include any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP) documents and to the OFFSITE DOSE CALCULATION MANUAL (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to Part I Section 7.2.

2.6 The Radioactive Effluent Release Reports shall include the instrumentation not returned to OPERABLE status within 30 days per TMI-1 Tech. Spec. Sections 3.21.1.b and 3.21.2.b.

2.7 The following information shall be included in the Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year:

2.7.1 The Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing of wind speed, wind direction, atmosphere stability, and precipitation (if measured) on magnetic tape, or in the form of joint frequency distribution of wind speed, wind direction, and atmospheric stability.

2.7.2 The Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year.

2.7.3 The Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year shall include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the site boundary (Figure 5-3, TMI-1 Tech. Specs.) during the report period. All assumptions used in making these assessments (i.e., specific activity, exposure time and location) shall be included in these reports. The meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents (as determined by sampling frequency and measurement) shall be used for determining the gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with this ODCM.

2.7.4 The Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year shall also include an assessment of radiation doses to the likely most exposed real individual from reactor releases and other nearby uranium fuel cycle sources including doses from primary effluent pathways and direct radiation for the previous 12 consecutive months to show conformance with 40 CFR 190 "Environmental Radiation Protection Standards for Nuclear Power Operation." Acceptable methods for calculating the dose contributions from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1.

3.0 TMI-2 QUARTERLY RADIOLOGICAL RELEASES AND ESTIMATED DOSE REPORT

The following information shall be submitted in accordance with 10 CFR 50.4. This information shall be submitted on a calendar quarter basis (January-March, April-June, July-September, and October-December) and shall be submitted no later than 60 days following the end of each calendar quarter.

1. Estimates of the amounts and types of radioactivity that were released to the environment during the quarter and during the calendar year. This shall include estimates of the total activity of each nuclide and time rate of release of each nuclide.

2. Estimates of populations and maximum individual doses which occurred during the calendar quarter and during the calendar year shall be provided. The estimates shall be based on actual hydrological and meteorological conditions which occurred during the releases. Calculational methods shall be those of U.S. NRC Regulatory Guides 1.109 (Revision 1), 1.111 (Revision 1), 1.112 (Revision O-R) and 1.113 (Revision 1). These calculations shall be based on estimates of actual population distributions during the releases and shall take into consideration factors such as boating or fishing recreation.

4.0 PART III REFERENCES

4.1 Radiological Assessment Branch Technical Position, Revision 1, November 1979

4.2 Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974

4.3 TMI-1 Technical Specifications, attached to Facility Operating License No. DPR-50

4.4 Title 40, Code of Federal Regulations, "Protection of Environment"

4.5 Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977

4.6 Title 10, Code of Federal Regulations, "Energy"

4.7 Regulatory Guide 1.111, "Methods of Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977

4.8 Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," Revision O-R, April 1976

4.9 Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," Revision 1, April 1977

APPENDIX A

P_i - PATHWAY DOSE RATE PARAMETER

$$P_i \text{ (inhalation)} = k' \text{ (BR) } DFA_i \qquad \text{(Eq A-1)}$$

Where:

P_i = the pathway dose rate parameter for radionuclide, i, (other than noble gases) for the inhalation pathway, in mrem/yr per microcurie/m^3. The dose factors are based on the critical individual organ for the infant age group.

k' = conversion factor, 1E6 pCi/microcurie

BR = 1400 m^3/yr, breathing rate for infant (Reg. Guide 1.109, Rev. 1, Table E-5)

DFA_i = the maximum organ inhalation dose factor for the infant age group for the ith radionuclide (mrem/pCi). Values are taken from Table E-10, Reg. Guide 1.109 (Rev. 1).

Resolution of the units yields: (ODCM Part I Table 4.6)

$$P_i \text{ (inhalation)} = 1.4E9\ DFA_i \text{ (mrem/yr per } \mu Ci/m^3) \qquad \text{(Eq A-2)}$$

NOTE: The latest NRC Guidance has deleted the requirement to determine P_i (ground plane) and P_i (food). In addition, the critical age group has been changed from infant to child. However, TMI-1 Tech. Spec. Section 3.22.2.1 currently states infant as the critical age group.

APPENDIX B

Ri - INHALATION PATHWAY DOSE FACTOR

$R_i = k' (BR) (DFA_{i,a,o})$ (mrem/yr per microcurie/m^3) (Eq B-1)

Where:

k' = conversion factor, 1E6 pCi/microcurie

BR = breathing rate, 1400, 3700, 8000, 8000 m^3/yr for infant, child, teenager, and adult age groups, respectively. (Reg. Guide 1.109, Rev. 1, Table E-5)

$DFA_{i,a,o}$ = the inhalation dose factor for organ, o, of the receptor of a given age group, a, and for the ith radionuclide, in mrem/pCi. The total body is considered as an organ in the selection of $DFA_{i,a,o}$. Values are taken from Tables E-7 through E-10, Reg. Guide 1.109 (Rev. 1).

Resolutions of the units yields:

Ri = (1.4E9) ($DFA_{i,a,o}$) infant (ODCM Part I Table 5.2.1)

Ri = (3.7E9) ($DFA_{i,a,o}$) child (ODCM Part I Table 5.2.2)

Ri = (8.0E9) ($DFA_{i,a,o}$) teen and adult (ODCM Part I Tables 5.2.3 and 5.2.4)

APPENDIX C

Ri - GROUND PLANE PATHWAY DOSE FACTOR

$$R_i = k' \, k'' \, (SF) \, (DFG_i) \, [(1-e^{-\lambda_i t})/\lambda_i] \qquad \text{(Eq C-1)}$$

Where:

k' = conversion factor, 1E6 pCi/microcurie

k'' = conversion factor, 8760 hr/yr

λ_i = decay constant for the i^{th} radionuclide, sec^{-1}

t = the exposure time (this calculation assumes that decay is the only operating removal mechanism) 4.73×10^8 sec. (15 yrs), Reg. Guide 1.109 (Rev. 1), Appendix C

DFG_i = the ground plane dose conversion factor for the i^{th} radionuclide (mrem/hr per pCi/m^2). Values are taken from Table E-6, Reg. Guide 1.109 (Rev. 1). These values apply to all age groups.

SF = 0.7, shielding factor, from Table E-15 Reg. Guide 1.109 (Rev. 1)

Refarence ODCM Part I Table 5.3.1

APPENDIX D

Ri - GRASS COW-MILK PATHWAY DOSE FACTOR

$$R_i = k' \left[(Q_F \times U_{AP}) / (\lambda_i + \lambda_w)\right] \times (F_m) \times (r) \times (DFL_{i,a,o}) \times \left[((f_p \times f_s)/Y_p) + ((1-f_p \times f_s)\, e^{-\lambda_i t_h})/Y_s\right] e^{-\lambda_i t_f} \quad \text{(Eq D-1)}$$

Where:

k' = conversion factor, 1E6 picocurie/microcurie (pCi/µci)

Q_F = cow consumption rate, 50 kg/day, (Reg. Guide 1.109, Rev. 1)
goat consumption rate, 6 kg/day, (Reg. Guide 1.109, Rev. 1, Table E-2)

U_{AP} = Receptor's milk consumption rate; 330, 330, 400, 310 liters/yr for infant, child, teenager, and adult age groups, respectively (Reg. Guide 1.109, Rev. 1)

Y_p = agricultural productivity by unit area of pasture feed grass, 0.7 kg/m^2 (NUREG-0133)

Y_s = agricultural productivity by unit area of stored feed, 2.0 kg/m^2 (NUREG-0133)

F_m = stable element transfer coefficient (Table E-1, Reg. Guide 1.109, Rev. 1)

r = fraction of deposited activity retained in cow's feed grass, 0.2 for particulates, 1.0 for radioiodine (Table E-15, Reg. Guide 1.109, Rev. 1)

$DFL_{i,a,o}$ = the ingestion dose factor for organ, o, and the ith radionuclide for each respective age group, a (Tables E-11 to E-14, Reg. Guide 1.109, Rev. 1)

λ_i = decay constant for the ith radionuclide, sec^{-1}

λ_w = decay constant for weathering, 5.73×10^{-7} sec^{-1} (NUREG-0133); based on a 14 day half life

t_f = 1.73×10^5 sec, the transport time from pasture to cow to milk to receptor (Table E-15, Reg. Guide 1.109, Rev. 1), or 2 days

t_h = 7.78×10^6 sec, the transport time from pasture to harvest to cow to milk to receptor (Table E-15, Reg. Guide 1.109, Rev. 1), or 90 days

f_p = 1.0, the fraction of the year that the cow is on pasture

f_s = 1.0, the fraction of the cow feed that is pasture grass while the cow is on pasture

APPENDIX D (Cont'd)

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, R_i is based on (X/Q):

$$R^{C}_{t,a,o} = k'k''' F_m Q_F U_{AP} DFL_{t,a,o} (.75 [.5/H]) \quad \text{(Eq D-2)}$$

Where:

- k''' = 1E3 grams/kg
- H = 8 grams/m^3, absolute humidity of the atmosphere
- .75 = fraction of the total feed grass mass that is water
- .5 = ratio of the specific activity of the feed grass water to the atmospheric water (NUREG-0133)
- $DFL_{t,a,o}$ = the ingestion dose factor for tritium and organ, o, for each respective age group, a (Tables E-11 to E-14, Reg. Guide 1.109, Rev. 1)

All other parameters and values are as given above.

NOTE: Goat-milk pathway factor, R_i, will be computed using the cow-milk pathway factor equation. F_m factor for goat-milk will be from Table E-2 Reg. Guide 1.109, Rev. 1.

Reference: CDCM Part I Tables 5.4.1 to 5.4.4

APPENDIX E

Ri - COW-MEAT PATHWAY DOSE FACTOR

$$R_i = k' \left[(Q_F \times U_{AP}) / (\lambda_i + \lambda_w)\right] \times (F_f) \times (r) \times (DFL_{i,a,o}) \times \left[\left((f_p \times f_s)/Y_p\right) + \left((1-f_p f_s)\, e^{-\lambda_i t_h}\right)/Y_s\right] \times e^{-\lambda_i t_f} \qquad \text{(Eq E-1)}$$

Where:

k' = conversion factor, 1E6 picocurie/microcurie (pCi/μci)

Q_F = cow consumption rate, 50 kg/day, (Reg. Guide 1.109, Rev. 1)

U_{AP} = Receptor's meat consumption rate; 0, 41, 65, 110 kg/yr for infant, child, teenager, and adult age groups, respectively (Reg. Guide 1.109, Rev. 1)

F_f = the stable element transfer coefficients, days/kg (Table E-1, Reg. Guide 1.109, Rev. 1)

r = fraction of deposited activity retained in cow's feed grass, 0.2 for particulates, 1.0 for radioiodine (Table E-15, Reg. Guide 1.109, Rev. 1)

$DFL_{i,a,o}$ = the ingestion dose factor for organ, o, and the ith radionuclide for each respective age group, a (Tables E-11 to E-14, Reg. Guide 1.109, Rev. 1)

λ_i = decay constant for the radionuclide i, sec^{-1}

λ_w = decay constant for weathering, 5.73×10^{-7} sec^{-1} (NUREG-0133), based on a 14 day half life

t_f = 1.73×10^6 sec, the transport time from pasture to receptor (NUREG-0133)

t_h = 7.78×10^6 sec, the transport time from crop to receptor (NUREG-0133)

Y_p = agricultural productivity by unit area of pasture feed grass, 0.7 kg/m^2 (NUREG-0133)

Y_s = agricultural productivity by unit area of stored feed, 2.0 kg/m^2 (NUREG-0133)

f_p = 1.0, the fraction of the year that the cow is on pasture

f_s = 1.0, the fraction of the cow feed that is pasture grass while the cow is on pasture

APPENDIX E (Cont'd)

The concentration of tritium in meat is based on the airborne concentration rather than the deposition. Therefore, R_i is based on (χ/Q):

$$R_{t,a,o} = k'k''' F_f Q_F U_{AP} (DFL_{t,a,o}) \times 0.75 \times (0.5/H]) \quad \text{(Eq E-2)}$$

Where:

All terms are as defined above and in Appendix D.

Reference: ODCM Part I, Tables 5.6.1 to 5.6.4

APPENDIX F

Ri - VEGETATION PATHWAY DOSE FACTOR

$$R_i = k' \times [r/ (Y_v (\lambda_i + \lambda_w))] \times (DFL_{i,a,o}) \times [(U^L_A) f_L e^{-\lambda i t L} + U^S_A f_g e^{-\lambda i t h}] \quad \text{(Eq F-1)}$$

Where:

k' = 1E6 picocurie/microcurie (pCi/µci)

U^L_A = the consumption rate of fresh leafy vegetation, 0, 26, 42, 64 kg/yr for infant, child, teenager, or adult age groups, respectively (Reg. Guide 1.109, Rev. 1)

U^S_A = the consumption rate of stored vegetation, 0, 520, 630, 520 kg/yr for infant, child, teenager, or adult age groups respectively (Reg. Guide 1.109, Rev. 1)

f_L = the fraction of the annual intake of fresh leafy vegetation grown locally, = 1.0 (NUREG-0133)

f_g = the fraction of the stored vegetation grown locally = 0.76 (NUREG-0133)

t_L = the average time between harvest of leafy vegetation and its consumption, 8.6×10^4 seconds [Table E-15, Reg. Guide 1.109, Rev. 1 (24 hrs)]

t_h = the average time between harvest of stored leafy vegetation and its consumption, 5.18×10^6 seconds, [Table E-15, Reg. Guide 1.109, Rev. 1 (60 days)]

y_v = the vegetation area density, 2.0 kg/m^2 (Table E-15, Reg. Guide 1.109, Rev. 1)

All other parameters are as previously defined.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, R_i is based on (X/Q)

$$R_{t,a,o} = k'k''' [U^L_A f_L + U^S_A f_g] (DFL_{t,a,o}) (.75 [.5/H]) \quad \text{(Eq F-2)}$$

Where:

All terms are as defined above and in Appendix D.

Reference: ODCM Part I, Tables 5.7.1 to 5.7.4

APPENDIX A-F REFERENCES

(Page 1 of 4)

PARAMETERS USED IN DOSE FACTOR CALCULATIONS

Parameter	Value	Origin of Value		
		Table in R.G. 1.109	Section of NUREG-0133	Site-Specific
	*** For P_i ***			
DFA_i	Each radionuclide	E-9		Note 1
BR	1400 m^3/yr (infant)	E-5		
	For Ri (Vegetation)			
r	Each element type	E-1		
Y_v	2.0 kg/m^2	E-15		
λw	5.73 E-7 sec^{-1}		5.3.1.3	
DFL_i	Each age group and radionuclide	E-11 thru E-14		Note 1
U_a^L	Each age group	E-5		
f_L	1.0		5.3.1.5	
t_L	8.6 E + 4 seconds	E-15		
U_a^S	Each age group	E-5		
f_g	0.76		5.3.1.5	
t_h	5.18 E + 6 seconds	E-15		
H	8.0 grams/kg		5.2.1.3	
	For Ri (Inhalation)			
BR	Each age group	E-5		
DFA_i	Each age group and nuclide	E-7 thru E-10		Note 1

APPENDIX A-F REFERENCES

(Page 2 of 4)

PARAMETERS USED IN DOSE FACTOR CALCULATIONS

Parameter	Value	Origin of Value		
		Table in R.G. 1.109	Section of NUREG-0133	Site-Specific
	*** For R_i (Ground Plane) ***			
SF	0.7	E-15		
DFG_i	Each radionuclide	E-6		
t	4.73 E + 8 sec		5.3.1.2	
	*** For Ri (Grass/Animal/Meat) ***			
Q_F (Cow)	50 kg/day	E-3		
Q_F (Goat)	6 kg/day	E-3		Ref. Only
U_{ap}	Each age group	E-5		
λ_W	5.73 E-7 sec^{-1}		5.3.1.3	
F_f (Both)	Each element	E-1		
r	Each element type	E-15		
DFL_i	Each age group and nuclide	E-11 thru E-14		Note 1
f_p	1.0		5.3.1.3	Note 2
f_s	1.0		5.3.1.3	Note 2
Y_p	0.7 kg/m^3	E-15		
t_p	7.78 E + 6 sec	E-15		
Y_s	2.0 kg/m^2	E-15		
t_f	1.73 E + 6 sec	E-15		
H	8.0 grams/kg		5.2.1.3	

APPENDIX A-F REFERENCES

(Page 3 of 4)

PARAMETERS USED IN DOSE FACTOR CALCULATIONS

Parameter	Value	Origin of Value		
		Table in R.G. 1.109	Section of NUREG-0133	Site-Specific
	*** For R_i (Grass/Cow/Milk) ***			
Q_f	50 kg/day	E-3		
U_{ap}	Each age group	E-5		
λw	5.73 E-7 sec^{-1}		5.3.1.3	
F_p	Each element	E-1		
r	Each element type	E-15		
DFL_i	Each age group and nuclide	E-11 thru E-14		Note 1
Y_p	0.7 kg/m^2	E-15		
t_h	7.78 E + 6 sec	E-15		
Y_s	2.0 kg/m^2	E-15		
t_f	1.73 E + 5 sec	E-15		
f_p	1.0		5.3.1.3	
f_s	1.0		5.3.1.3	
H	8.0 grams/kg		5.2.1.3	

APPENDIX A-F REFERENCES

(Page 4 of 4)

NOTES

1. Inhalation and ingestion dose factors were taken from the indicated source. For each age group, for each nuclide, the organ dose factor used was the highest dose factor for that nuclide and age group in the referenced table.

2. Typically beef cattle are raised all year on pasture. Annual land surveys have indicated that the small number of goats raised within 5 miles typically are used for grass control and not food or milk. Nevertheless, the goats can be treated as full meat sources where present, despite the fact that their numbers cannot sustain the meat consumption rates of Table E-5, NUREG-0133.

REFERENCES

1. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

2. TMI-1 Technical Specifications, attached to Facility Operating License No. DPR-50.

3. NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978.