APPENDIX C: REVISED OFFSITE DOSE CALCULATION MANUAL

9303030116 930226
PDR ADOCK 05000341
R PDR

LICENSING CHANGE REQUEST

LCR 91-104-ODM

Revision 0 Page 1 of 12

PART 1: UFSAR, PLAN, OR PROGRAM REVISION [ ]NA

A) Document Offsite Dose Calculation Manual

B) Section(s), Table(s), Figure(s), etc. Affected
Sections 1.0 through 8.12, 10.0; Tables 3.3.7.12-1, 4.3.7.12-1, 4.11.1.1.1-1, Tables 7.0-1, 7.0-3, 8.0-1, 10.0-1

C) Reason for Change
Relocation of effluent and environmental technical specifications to ODCM (Generic Letter 89-01) and periodic updates

D) Reference and Source Documents (Identify)

EDP ______ Tech Spec ______
PDC ______ Procedure ______
ABN ______ SE (Attached) ______
DER ______ PE (Attached) ______
Test ______ Drawing No. ______
Effectiveness Review (Attached) [ ]Yes [ ]No
Other DECo letter NRC-91-0131, LCR 91-141-OPL
Drawings, Design Calculations, Correspondence, etc.

PART 2: OPERATING LICENSE CHANGES [X]NA

A) Document
[ ] Operating License [ ] Tech Specs [ ] Environmental Protection Plan

B) Section(s), Table(s), Figure(s), etc. Affected

C) Reference and Source Documents Attached
[ ] NA [ ] Other [ ] Marked-up pages
[ ] Significant Hazards Consideration [ ] Environmental Evaluation
[ ] Enviromental Impact/Categorical Exclusion [ ] Justification

D) Is change to UFSAR and/or approved plans/programs required?
[ ] Yes [ ] No LCR No(s)

E) Priority [ ]NA
NRC approval required by (date):

Explanation

F) NRC Letter No. | G) Amendment No. -

PART 3: APPROVALS

A) Originator Thomas J. Vanderbilt [signature] Date 7-11-92

B) Technical Expert [signature] Date 7-16-92

C) Nuclear Generation Unit Head [signature] Date 7-17-92

D) General Director, Nuclear Engineering
[X]NA [ ]Att Management Review Sheet Date

E) Plant Manager R McKeon
[ ]NA [ ]Att Management Review Sheet Date 7/28/92

F) Other Date

DHB 7/28/92 G) Director, Nuclear Licensing
[ ]Att Management Review Sheet [signature] Date 7/28/92

H) OSRO (Fire Protection, RERP, PCP, ODCM, SEP, TS)
X [ ]NA [ ]Att Management Review Sheet Robert J Szkotnicki Date 7/30/92

I) NSRG (OL, TS, EPP)
[X]NA [ ]Att Management Review Sheet Date

Form FIP-RA2-01 Att 1 P1/1 102891

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File: [ ] 1701.03 [ ] 1735 [ ] [illegible]

EFFECTIVENESS REVIEW

Reference LCR 9 1 - 1 0 4 - 0 D M

Revision 0 Page 2 of 12

** PART 1: UFSAR [X] NA **

A) Quality Assurance Program

[ ]Yes [ ]No [ ]NA — Does the change(s) cease to satisfy the criteria of 10CFR50, Appendix B or reduce UFSAR program commitments previously accepted by the NRC?

Provide the basis for each change on Attachment 2, Page 2.

B) Fire Protection Program

[ ]Yes [ ]No [ ]NA — Does the change(s) adversely affect the ability to achieve and maintain safe shutdown in the event of a fire?

Provide the basis for each change on Attachment 2, Page 2.

***** PART 2: RADIOLOGICAL EMERGENCY RESPONSE PREPAREDNES PLAN [X] NA *****

A) [ ] Yes [ ] No — Does the change(s) decrease the effectiveness of the RERP Plan?

[ ] Yes [ ] No — Does the RERP Plan, as changed, cease to meet the standards of 10CFR50.47(b) and 10CFR50 Appendix E?

Provide the basis for each change on Attachment 2, Page 2.

****************************** PART 3: SECURITY PLANS [X] NA ******************************

A) Document

B) [ ] Yes [ ] No — Does the change(s) decrease the effectiveness of the Physical Security Plan or Security Personnel Training and Qualification Plan prepared pursuant to 10CFR50.34(c) or 10CFR73?

[ ] Yes [ ] No — Does the change(s) decrease the effectiveness of the first four categories of Informational Background, Generic Planning Base, Licensee Planning Base, and/or responsiblity matrix of the Safeguards Contingency Plan prepared pursuant to 10CFR50.34(d) or 10CFR73?

Provide the basis for each change on Attachment 2, Page 2.

****************************** PART 4: PROCESS CONTROL PROGRAM [X] NA ******************************

A) [ ] Yes [ ] No — Does the change(s) reduce the overall conformance of the solidified waste product to existing requirements of Federal, State, or other applicable regulations? (Technical Specification 6.13)

Provide the basis for each change on Attachment 2, Page 2.

** PART 5: ODCM [ ] NA **

A) [ ] Yes [X] No — Does the change(s) reduce the level of radioactive effluent control required by 10CFR20.106, 40CFR Part 190, 10CFR50.36a, and Appendix I to 10CFR Part 50? (Technical Specification 6.14)

[ ] Yes [X] No — Does the change(s) adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations? (Technical Specifications 6.14)

Provide the basis for each change on Attachment 2, Page 2.

** PART 6: APPROVALS **

A) Originator Thomas J. [signature] — Date 7-11-92

B) Technical Expert [signature] — Date 7/28/92

C) Quality Assurance (Security Plans, QA Program) N/A — Date

D) OSRO (Fire Protection Program, RERP Plan, Security Plans, PCP, ODCM)

x Robert J. Szkotnicki — Date 7/30/92

Form FIP-RA2-01 Att 2 P1/2 060992

DTC: [ ] TDLCR [ ] TCLCR [ ] TMPLAN

File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 91-1041-0DM

Revision 0 Page 3 of 12

Document: Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
2.0 through 5.0 / 2.0-1 through 5.0-5	Relocate effluent Technical Specifications to ODCM as prescribed in Detroit Edison letter NRC-91-0131	NRC Generic Letter 89-01 as implemented by LCR # 91-141-0PL
6.0 through 10.0; Appendix A and B / 6.0-1 through B-4 (formerly 2.0 through 6.0; App. A and B)	Replace "Technical Specification" references with "ODCM" or "ODCM Control" references	NRC Generic Letter 89-01 as implemented by LCR # 91-141-0PL
1.0 / 1.0-1	Added introduction to ODCM Control section; clarified criteria for use of different calculational methods and values	Effluent Technical Specifications are being relocated to ODCM as ODCM Controls; alternate methods must be at least as conservative as ODCM methods
Table 3.3.7.12-1 and Table 4.3.7.12-1 / 3.0-10, 11, 12 and 3.0-14, 15, 16	Specify that operability requirements apply to low (not mid or high) range noble gas channels of ventilation exhaust monitors	Implements Technical Specification Clarification 89-017

Form FIP-RA2-01 Att 2 P2/2 060992

DTC: [ ] TDLCR [ ] TCLCR [ ] TMPLAN

File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 91-104-ODM

Revision 0 Page 4 of 12

Document Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
Table 4.11.1.1.1-1/ 3.0-19	Substitute "Circulating Water System" for "General Service Water System" in Part B	Continuous releases, should they occur, would not be from the GSW system but from the circulating water system via the circulating water decant line with a radiation monitor in place for control
4.11.2.8.3/3.0-32	Add requirement to sample torus prior to venting or purging	Incorporates Technical Specification Clarification 89-024 and conforms to current procedures
3.12.1.b/3.0-34	Change "Table 3.12-2" to "Table 3.12.1-2" (in second paragraph)	Table 3.12.1-2 is correct reference; "Table 3.12-2" does not exist.
2.32/2.0-5	Revise definition of rated thermal power to refer to Technical Specification definition instead of a specific MWT value.	Ensures consistency with Technical Specifications; avoids need to revise ODCM due to power uprate.

Form FIP-RA2-01 Att 2 P2/2 060992

DTC: [ ] TDLCR
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File: [ ] 1701.03
[ ] 1735
[ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 91-104-ODM

Revision 0 Page 5 of 12

Document Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
Table 3.12.1-1/ 3.0-37	Delete "if ground water flow reversal is noted" from ground water analysis requirements	Gamma isotopic and tritium analysis are always done on these samples—change conforms to current practices
Table 3.12.1-1 footnote g/3.0-41	Revise footnote to require monitoring as specified by NRC Radiological Assessment Branch Technical Position on An Acceptable Radiological Environmental Monitoring Program, Rev. 1, November '89	Branch Technical Position is given as the basis of the environmental monitoring program in Standard Radiological Effluent Technical Specifications for Boiling Water Reactors, September 1982 – draft (latest version)
6.2.1/6.0-4 (formerly 2.2.1/ 2.0-3)	Added paragraph describing method of mixing Waste Sample Tank contents prior to sampling	Conforms to ODCM Table 4.11.1.1.1-1 footnote b
6.3.1/6.0-6 (formerly 2.3.1/ 2.0-5)	Revise maximum release rate formula and associated parameters to account for pure beta emitters.	Pure beta emitters are not analyzed for each batch release, so concentrations must be estimated. Introducing estimated pure beta concentrations makes formula more conservative.

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File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 91 - 104 - ODM

Revision ~~7~~ 0 Page ~~7~~ 6 of 12

Document: Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
6.3.1 / 6.0-7 (formerly 2.3.1 / 2.0-6)	Revise liquid radwaste effluent monitor setpoint formula and associated parameters to account for pure beta emitters.	Pure beta emitter concentrations for a batch to be released must be estimated from monthly or quarterly composites. Introducing such estimates makes the setpoint formula more conservative.
6.3.2 / 6.0-8 (formerly 2.3.2 / 2.0-7)	Added sentence explaining that, unlike the liquid radwaste effluent monitor setpoint, the circulating water decant monitor setpoint need not be changed prior to each release	The CWD setpoint is evaluated using a nuclide release mix which results in a conservative setpoint. A safety factor is also introduced so that the setpoint remains conservative for all subsequent release mixes.
6.3.2 / 6.0-8 (formerly 2.3.2 / 2.0-7)	Revised CWD setpoint formula and parameters so that setpoint is in cpm units and can be installed without conversion. Also background is included in formula.	This change makes the CWD monitor setpoint formula consistent with the liquid radwaste effluent monitor setpoint formula.

Form FIP-RA2-01 Att 2 P2/2 060992

DTC: [ ] TDLCR [ ] TCLCR [ ] TMPLAN

File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 91 - 104 - ODM

Revision ~~4~~ 0 Page ~~5~~ 7 of 12

Document Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
6.6 / 6.0-16 (formerly 2.61 / 2.0-14, 15)	Clarify when dose projection is to be based on previous quarter's data; state that reference period is to extend to evaluation date.	If liquid releases have occurred in the current quarter, projection should be based on these releases, and the reference period should extend to the evaluation date so that time between latest release and evaluation date is accounted for.
7.3.1 / 7.0-4 (formerly 3.3.1 / 3.0-4)	Add option of referencing plant procedures for X/Q values	Effluent procedures will reference a new procedure which will contain parameter values.
7.3.1 / 7.0-4 (formerly 3.3.1 / 3.0-4)	Revise definition of C_i to allow determination of release point concentration by applying a dilution factor to Offgas Vent Pipe concentration	Present methods allow determination of noble gas release quantities by Offgas Vent Pipe sampling when release point concentrations cannot be directly determined.

Form FIP-RA2-01 Att 2 P2/2 060992

DTC: [ ] TDLCR [ ] TCLCR [ ] TMPLAN

File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 9 1 - 1 0 4 - 0 0 M

Revision ~~4~~ 0 (TJ 7-11-92) Page ~~6~~ 8 of 12

Document Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
7.3.1 / 7.0-4 (formerly 3.3.1 / 3.0-4)	Revise ventilation exhaust release point monitor setpoint formula: change "=" to "≤"	Allows use of safety factors to calculate a more conservative setpoint
7.3.1 / 7.0-5 (formerly 3.3.1 / 3.0-5)	Add sentence to allow calibration constants to be based on actual monitor response	If adequate data exist, actual monitor response to measured gas concentrations is the best way to determine the calibration constant
7.3.2 / 7.0-5 (formerly 3.3.2 / 3.0-5)	Revise section and title to address setpoint determination with no nuclides detected	Previous discussion of "conservative generic alarm setpoints" is obsolete: Current setpoints are based either on multiples of background or on the source term of UFSAR Appendix 11A, Table IV-1. Also, safety factors can be applied to setpoints based on current nuclide analyses so ~~that~~ (TJ 7-24-92) that continual setpoint adjustment is not necessary.

Form FIP-RA2-01 Att 2 P2/2 060992

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File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 91-1104-ODM

Revision 0 Page 9 of 12

Document Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
7.6 / 7.0-9 (formerly 3.6 / 3.0-9)	Revise site boundary organ dose rate formula and parameters to use I-131 child inhalation dose factor only	The purpose of this formula is to evaluate compliance with the 1500 mrem/yr limit, not to calculate the precise dose rate. Using the highest dose factor (for I-131) ensures conservatism and eliminates the need to evaluate all pathways and age groups.
7.6 / 7.0-10 (formerly 3.6 / 3.0-10)	Revise definition of C_i	Allows use of nuclide concentrations not determined by gamma spectroscopy, eg tritium
7.6 / 7.0-10 (formerly 3.6 / 3.0-10)	Eliminate previous section 7.6.1 and substitute alternate method for dose rate calculation which evaluates multiple pathways and age groups.	Formula using I-131 dose factor only is already simplified; new paragraph provides alternate more complex calculation to be used as circumstances require.

Form FIP-RA2-01 Att 2 P2/2 060992

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File: [ ] 1701.13 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 9 1 - 1 0 4 - 0 D M

Revision ~~1~~ 0 (OTM 7-11-92) Page ~~8~~ 10 of 12

Document: Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
7.8.1 / 7.0-11 (formerly 3.8.1 / 3.0-11)	Add option of referencing plant procedures for dispersion factors	Effluent procedures will reference a new procedure which will contain parameter values.
7.8.1 / 7.0-12 (formerly 3.8.1 / 3.0-12)	Add reference to use of C-14 χ/Q values for all pathways	Conforms to Table 7.0-4
7.8.1 / 7.0-12 (formerly 3.8.1 / 3.0-12)	Add reference to I-133 and tritium as Q_i values	Conforms to ODCM Control 3.11.2.3
Table 3.0-1 / NA (OTM 7-11-92) (would have become Table 7.0-1)	Delete table	Future setpoint calculations would likely be based on actual plant noble gas source term; current setpoints are not based on this table — see change to section 7.3.2
3.0.4 / 3.0-2	Revise section in accordance with License Amendment 83	Ensure that section 3.0.4 in ODCM will conform to 3.0.4 in Technical Specifications.

Form FIP-RA2-01 Att 2 P2/2 060992

DTC: [ ] TDLCR [ ] TCLCR [ ] TMPLAN

File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

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Revision 0 ~~4~~ Page 1 of 12 ~~11~~

Document: Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
Table 7.0-1/7.0-15 (formerly Table 3.0-2/13.0-16)	Delete generic alarm setpoints and sentence in footnote referring to setpoints.	The "generic alarm setpoints" listed are no longer used
	Revise allocated dose rate limits.	Conform to allocation factor multiplied by limit.
	Add phrase "in plant procedures" to footnote.	Effluent procedures will reference parameter values in a new procedure.
Table 7.0-3/7.0-17 (formerly Table 3.0-4/3.0-18)	Revise locations, distances, and dispersion factors and footnote concerning them.	Revised site boundary location is the highest X/Q point within the gaseous site boundary as defined by Figure 3.0-1; distances have been revised by cartography; listed dispersion factor values are the highest annual average values between 1984 and 1991, as explained in footnote.
Table 10.0-1/10.0-11 (formerly Table 6.0-1/6.0-10)	Correct description of location of API-5	REMP audit noted incorrect location description

Form FIP-RA2-01 Att 2 P2/2 060992

DTC: [ ] TDLCR [ ] TCLCR [ ] TMPLAN

File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

EFFECTIVENESS REVIEW DOCUMENTATION

Reference LCR 9 1 - 1 0 4 - 0 D M

Revision ~~1~~ 0 (7-11-92) Page ~~10~~ 12 of 12

Document Offsite Dose Calculation Manual

Listed below is each change by section and page; the reason for the change; and the basis for concluding that the revised plan or program continues to satisfy the criteria for that plan or program. Attach all appropriate analyses or evaluations justifying the change(s).

Section/Page	Change	Basis
Table 8.0-1/8.0-7 (formerly Table 4.0-1/4.0-7)	Revise X/Q values	Revised values are based on most recent dispersion factor calculation report (annual averages)
10.0/10.0-1 (formerly 6.0/6.0-1)	Add date and revision number of Branch Technical Position	Provides more specific program basis.
10.1/10.0-1	Added reference to Table 10.0-2	Consistent with first sentence in 10.1.
10.1 NOTE/10.0-1 (formerly 6.1 NOTE/6.0-1)	Add section allowing sampling locations to be changed for reasons other than land use census findings and state where changes are to be reported and how they are to be evaluated.	Many contingencies may necessitate changing sampling location - provides needed flexibility while ensuring evaluation if change could affect identity of critical receptor.
Table 10.0-1/10.0-4,5 (formerly Table 6.0-1/6.0-4,5)	Change location of TLD #T11; correct description of TLD locations T2, T8, T24, and T30	High vandalism rate necessitated relocation; REMP audit noted incorrect location descriptions
Table 10.0-1/10.0-7 (formerly Table 6.0-1 after 6.0-6)	Added 17 TLD locations (new page)	Provide better coverage of area.

Form FIP-RA2-01 Att 2 P2/2 060992

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File: [ ] 1701.03 [ ] 1735 [ ] 1715.03

PRELIMINARY EVALUATION

PART 1: DESCRIPTION OF CHANGE (Preparer)

A) Document Identification	B) Revision if Approved	C) PIS Number
Offsite Dose Calculation Manual	4	NA

D) Description of Change

Relocate effluent/environmental technical specifications to ODCM (plus miscellaneous updates) in accordance with License Amendment No. 82.

PART 2: PRELIMINARY EVALUATION (Preparer, Approver)

A) Review of Commitments [ ] N/A. Meets Exemption Criteria 6.1.4.5.____ Approved by:____________

[ ] No commitments

[X] Commitments exist (list) DER 89-0210

[X] Commitments met – none negated

[ ] Commitments need changing (explain) ____________

[ ] Plant Safety and/or Licensing have been contacted to make changes

B) Impact on License, Plans, or Programs

[ ] No change to the Operating License (including the Technical Specifications, the Environmental Protection Plan, and the Technical Specification Bases), the Core Operating Limits Report (COLR), the UFSAR, Fire Protection Program, Quality Assurance Program, Radiological Emergency Response Preparedness Plan, Physical Security Plan, Safeguards Contingency Plan, Security Personnel Training and Qualification Plan, Offsite Dose Calculation Manual, Process Control Program, or the Inservice Inspection or Inservice Testing Programs.

[X] License Change Request (LCR) required: LCR 91-104-ODM

C) Effect on Environment

[X] No effect on environment

[ ] Environment affected – contact Fermi Environmental Programs Coordinator and indicate resolution ____________

D) Need for Safety Evaluation (check appropriate answer)

Yes	No		
[ ]	[X]	1.	Is this a change to the facility, including assumptions, as described in the UFSAR?
[ ]	[X]	2.	Is this a change to a procedure, including assumptions, as described in the UFSAR?
[ ]	[X]	3.	Does this change constitute a Special Test?

If any are "Yes," initiate a Safety Evaluation. If all are "No," provide the basis to support the determination on the continuation sheet as required by steps 6.1.7.5 and 6.1.7.6.

E) Prepared by		F) Approved by	N/A[ ]
[signature]	Date 7-11-92	[signature]	Date 7/13/92
		DTC:	File:

PRELIMINARY EVALUATION CONTINUATION SHEET

A) Documen. .dentification: Offsite Dose Calculation Manual | B) Revision if Approved: 4

Comments

1. This is a change to specifications for compliance with federal regulations and to calculational methods; it is not a change to the facility.

2. The UFSAR describes systems for effluent discharge but does not describe routine methods for determining compliance or calculating releases or doses; the UFSAR does not describe the environmental monitoring program.

3. The ODCM describes routine calculational procedures, not any Special Test.

4. This ODCM revision conforms to the attached safety evaluation for License Amendment No. 82.

DETROIT EDISON - FERMI 2
OFFSITE DOSE CALCULATION MANUAL

ARMS - INFORMATION SERVICES

Date approved: 7-30-92 Release authorized by: B. Kupp for Tom Vanderm...

Change numbers incorporated: 91-104-ODM

DSN ODCM-0.0 Rev 4 Date August 7, 1992

DTC TMPLAN File 1715.02 Recipient

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

APPENDICES

TABLES

TABLE OF CONTENTS (continued)

END OF SECTION 0.0

1.0 INTRODUCTION

Part I of the Fermi 2 Offsite Dose Calculation Manual (ODCM), which includes Sections 2.0 through 5.0, contains the controls and surveillance requirements for radioactive effluents and radiological environmental monitoring. It also contains requirements for the Annual Radiological Environmental Operating Report and the Semiannual Radioactive Effluent Release Report.

Part II of the ODCM describes the methodology and parameters used in a) determining radioactive material release rates and cumulative releases, b) calculating radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints, and c) calculating the corresponding dose rates and cumulative quarterly and yearly doses. Calculational methods different from those provided in the ODCM may be used only if they lead to more conservative results than would be obtained using ODCM methods. ODCM data for dispersion factors, receptor locations, exposure pathways, ventilation flow rates, etc. are intended to lead to conservative results. However, it is permissible to use plant procedures which implement the ODCM and which contain different data due to changes in environmental and plant conditions.

The methodology provided in Part II of this manual is acceptable for use in demonstrating compliance with the concentration limits of 10 CFR 20, the cumulative dose critaria of 10 CFR 50, Appendix I, and 40 CFR 190, and the controls in Part I of this manual.

Part II, Section 6.0 of the ODCM describes equipment for monitoring and controlling liquid effluents, sampling requirements, and dose evaluation methods. Section 7.0 provides similar information on gaseous effluent controls, sampling, and dose evaluation. Section 8.0 describes special dose analyses required for compliance with Fermi 2 Offsite Dose Calculation Manual and 40 CFR 190. Section 9.0 describes the role of the annual land use census in identifying the controlling pathways and locations of exposure for assessing potential off-site doses. Section 10.0 describes the Radiological Environmental Monitoring Program.

The ODCM will be maintained at Fermi 2 for use as a reference guide and training document of accepted methodologies and calculations. Changes to the ODCM calculational methodologies and parameters will be made as necessary to ensure reasonable conservatism in keeping with the principles of 10 CFR 50.36a and Appendix I for demonstrating radioactive effluents are "As Low As Reasonably Achievable."

NOTE: Throughout this document words appearing all capitalized denote either definitions specified in the Fermi 2 Controls or common acronyms.

END OF SECTION 1.0

ARMS - INFORMATION SERVICES

Date approved: 7-30-92 Release authorized by: B Kuzzofer T. Vanlsieme
Change numbers incorporated: 91-104-ODM
DSN ODCM-1.0 Rev 4 Date August 27, 1992
DTC TMPLAN File 1715.02 Recipient

PART I

RADIOLOGICAL EFFLUENT CONTROLS

SECTION 2.0

DEFINITIONS

ARMS - INFORMATION SERVICES

Date approved: 7.30.92 Release authorized by: B. Kemp for T. Vanderney

Change numbers incorporated: 91-104-ODM

DSN ODCM-2.0 Rev 4 Date August 7/31 1992

DTC TMPLAN File 1715.02 Recipient

2.0 DEFINITIONS

ACTION

2.1 ACTION shall be that part of a specification which prescribes remedial measures required under designated conditions.

CHANNEL CALIBRATION

2.4 A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the 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. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated. Calibration of instrument channels with resistance temperature detectors (RTD) or thermocouple sensors shall consist of verification of operability of the sensing element and adjustment, as necessary, of the remaining adjustable devices in the channel.

CHANNEL CHECK

2.5 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.

CHANNEL FUNCTIONAL TEST

2.6 A CHANNEL FUNCTIONAL TEST shall be:

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

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

The CHANNEL FUNCTIONAL TEST may be performed by any sequential, overlapping, or total channel steps such that the entire channel is tested.

DOSE EQUIVALENT I-131

2.9 DOSE EQUIVALENT I-131 shall be that concentration of I-131, microcuries per 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."

FREQUENCY NOTATION

2.14 The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 2.1.

2.0 DEFINITIONS

MEMBER(S) OF THE PUBLIC

2.21 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 utility, its contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

OFF-GAS TREATMENT SYSTEM

2.23 An OFF-GAS TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting reactor coolant system offgases from the reactor coolant and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

OFFSITE DOSE CALCULATIONAL MANUAL

2.24 The OFFSITE DOSE CALCULATIONAL 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 radiological environmental monitoring program. The ODCM shall also contain (1) the Radiological Effluent Controls and Radiological Environmental Monitoring Program Controls required by Technical Specification 6.8.5, and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Semiannual Radioactive Effluent Reports required by Controls 5.9.1.7 and 5.9.1.8.

OPERABLE - OPERABILITY

2.25 A system, subsystem, train, component, or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxilliary 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).

OPERATIONAL CONDITION - CONDITION

2.26 An OPERATIONAL CONDITION, i.e., CONDITION, shall be any one inclusive combination of mode switch position and average reactor coolant temperature as specified in Table 2.2.

PURGE - PURGING

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

2.0 DEFINITIONS

RATED THERMAL POWER

2.32 RATED THERMAL POWER shall be a total reactor core heat transfer rate to the reactor coolant equivalent to that stated in the Technical Specification definition of RATED THERMAL POWER.

REPORTABLE EVENT

2.34 A REPORTABLE EVENT shall be any of those conditions specified in Section 50.73 to 10 CFR Part 50.

SITE BOUNDARY

2.38 The SITE BOUNDARY shall be that line beyond which the land is neither owned, nor leased, nor otherwise controlled, by the licensee.

SOURCE CHECK

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

THERMAL POWER

2.42 THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

UNRESTRICTED AREA

2.45 An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.

VENTILATION EXHAUST TREATMENT SYSTEM

2.46 A VENTILATION EXHAUST TREATMENT SYSTEM shall be any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

VENTING

2.47 VENTING shall be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

TABLE 2.1

SURVEILLANCE FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days.
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
A	At least once per 366 days.
R	At least once per 18 months (550 days).
S/U	Prior to each reactor startup.
P	Prior to each radioactive release.
N.A.	Not applicable.

2.0 DEFINITIONS

TABLE 2.2

OPERATIONAL CONDITIONS

CONDITION		MODE SWITCH POSITION	AVERAGE REACTOR COOLANT TEMPERATURE
1.	POWER OPERATION	Run	Any temperature
2.	STARTUP	Startup/Hot Standby	Any temperature
3.	HOT SHUTDOWN	Shutdown#, ***	> 200 degrees F
4.	COLD SHUTDOWN	Shutdown#, ##, ***	≤ 200 degrees F
5.	REFUELING*	Shutdown or refuel**,#	≤ 140 degrees F

\# The reactor mode switch may be placed in the Run, Startup/Hot Standby, or Refuel position to test the switch interlock functions and related instrumentation provided that the control rods are verified to remain fully inserted by a second licensed operator or other technically qualified member of the unit technical staff.

\## The reactor mode switch may be placed in the Refuel position while a single control rod drive is being removed from the reactor pressure vessel per Technical Specification 3.9.10.1.

* Fuel in the reactor vessel with the vessel head closure bolts less than fully tensioned or with the head removed.

** See Special Test Exceptions 3.10.1 and 3.10.3 of Technical Specifications.

*** The reactor mode switch may be placed in the Refuel position while a single control rod is being recoupled or withdrawn provided that the one-rod-out interlock is OPERABLE.

END OF SECTION 2.0

SECTION 3.0

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

ARMS - INFORMATION SERVICES

Date approved: 7-30-92 Release authorized by: B. Kreyga for T. Vendermay

Change numbers incorporated: 91-104-ODM

DSN ODCM-3.0 Rev 4 Date AUGUST 7/31/32 1992

DTC TMPLAN File 1715.02 Recipient

3/4 CONTROLS AND SURVEILLANCE REQUIREMENTS

3/4.0 APPLICABILITY

CONTROLS

3.0.1 Compliance with the succeeding Controls is required during the OPERATIONAL CONDITIONS or other conditions specified therein; except that upon failure to meet the control, the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a Control shall exist when the requirements of the control and associated ACTION requirements are not met within the specified time intervals. If the Control is restored prior to expiration of the specified time intervals, completion of the Action requirements is not required.

3.0.3 When a Control is not met, except as provided in the associated ACTION requirements, within one hour action shall be initiated to place the unit in an OPERATIONAL CONDITION in which the control does not apply by placing it, as applicable, in:

1. At least STARTUP within the next 6 hours,
2. At least HOT SHUTDOWN within the following 6 hours, and
3. At least COLD SHUTDOWN within the subsequent 24 hours.

Where corrective measures are completed that permit operation under the ACTION requirements, the ACTION may be taken in accordance with the specified time limits as measured from the time of failure to meet the Control. Exceptions to these requirements are stated in the individual Controls.

This Control is not applicable in OPERATIONAL CONDITIONS 4 or 5.

3.0.4 Entry into an OPERATIONAL CONDITION or other specified condition shall not be made when the conditions for the Controls are not met and the associated ACTION requires a shutdown if they are not met within a specified time interval. Entry into an OPERATIONAL CONDITION or other specified condition may be made in accordance with the ACTION requirements when conformance to them permits continued operation of the facility for an unlimited period of time. This provision shall not prevent passage through or to OPERATIONAL CONDITIONS as required to comply with ACTION requirements. . eptions to these requirements are stated in the individual Controls.

APPLICABILITY

SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the OPERATIONAL CONDITIONS or other conditions specified for individual Controls unless otherwise stated in an individual Surveillance Requirement.

4.0.2 Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25 percent of the specified surveillance interval.

4.0.3 Failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by Surveillance 4.0.2, shall constitute noncompliance with the OPERABILITY requirements for a Control. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. The ACTION requirements may be delayed for up to 24 hours to permit the completion of the surveillance when the allowable outage time limits of the ACTION requirements are less than 24 hours. Surveillance Requirements do not have to be performed on inoperable equipment.

4.0.4 Entry into an OPERATIONAL CONDITION or other specified applicable condition shall not be made unless the Surveillance Requirement(s) associated with the Control have been performed within the applicable surveillance interval or as otherwise specified. This provision shall not prevent passage through or to OPERATIONAL CONDITIONS as required to comply with ACTION requirements.

INSTRUMENTATION

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.7.11 The radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3.7.11-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 3.11.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATIONAL MANUAL (ODCM).

APPLICABILITY: At all times.

ACTION:

a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above control, immediately suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3.7.11-1. Restore the inoperable instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain why this inoperability was not corrected in a timely manner in the next Semiannual Radioactive Effluent Release Report.

c. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.7.11 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.11-1.

TABLE 3.3.7.11-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE		
a. Liquid Radwaste Effluent Line D11-N007	1	110
2. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE		
a. Circulating Water Reservoir Decant Line D11-N402	1	111
3. FLOW RATE MEASUREMENT DEVICES		
a. Liquid Radwaste Effluent Line G11-R703	1	112
b. Circulating Water Reservoir Decant Line N71-R802	1	112

TABLE 3.3.7.11.1 (Continued)

TABLE NOTATIONS

ACTION 110 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases from this pathway may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Control 4.11.1.1.1, and

b. At least two technically qualified individuals independently verify the release rate calculations and discharge line valving;

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 111 - With the number of channels OPERABLE less than the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that grab samples are collected and analyzed at least once per 12 hours for gross radioactivity (beta or gamma) at a lower limit of detection of at least 10^{-7} microcurie/ml, for Cs-137. Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 112 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow. Otherwise, suspend release of radioactive effluents via this pathway.

TABLE 4.3.7.11-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
a. Liquid Radwaste Effluent Line	P	P	R(3)	Q(1)(2)
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE				
a. Circulating Water Reservoir Decant Line D11-N402	D	M	R(3)	Q(5)
3. FLOW RATE MEASUREMENT DEVICES (4)				
a. Liquid Radwaste Effluent Line	D(4)	N.A.	R	Q
b. Circulating Water Reservoir Decant Line	D(4)	N.A.	R	Q

TABLE 4.3.7.11-1 (Continued)

TABLE NOTATIONS

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway occurs if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm/trip setpoint.
2. Circuit failure.

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

1. Instrument indicates measured levels above the alarm setpoint.
2. Circuit failure.
3. Instrument indicates a downscale failure.
4. Instrument controls not set in operate mode.

(3) The initial CHANNEL CALIBRATION shall be performed using National Bureau of Standards traceable sources. These standards shall permit calibrating the system over the range of energy and measurement expected during normal operation and anticipated operational occurrences. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration or are National Bureau of Standards traceable shall be used.

(4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continous, periodic, or batch releases are made.

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

1. Instrument indicates measured levels above the alarm setpoint.
2. Circuit failure.
3. Instrument indicates a downscale failure.

INSTRUMENTATION

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.7.12 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3.7.12-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 3.11.2.1 are not exceeded. The alarm/trip setpoints of these channels, with the exception of the offgas monitoring system, shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: As shown in Table 3.3.7.12-1

ACTION:

a. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above Control, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3.7.12-1. Restore the inoperable instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain why this inoperability was not corrected in a timely manner in the next Semiannual Radioactive Effluent Release Report.

c. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.7.12 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.12-1.

TABLE 3.3.7.12-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. REACTOR BUILDING EXHAUST PLENUM EFFLUENT MONITORING SYSTEM			
a. Low Range Noble Gas Activity Monitor - Providing Alarm	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Sampler Flow Rate Monitor	1	*	123
2. OFFGAS MONITORING SYSTEM (At the 2.2 minute delay piping)			
a. Noble Gas Activity Monitor	1	***	126
3. STANDBY GAS TREATMENT SYSTEM			
a. Low Range Noble Gas Activity Monitor - Providing Alarm	1	#	125
b. Iodine Sampler	1	#	122
c. Particulate Sampler	1	#	122
d. Sampler Flow Rate Monitor	1	#	123

TABLE 3.3.7.12-1 (Continued)

RADIOACTIVITY GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
4. TURBINE BLDG. VENTILATION MONITORING SYSTEM			
a. Low Range Noble Gas Activity Monitor	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Sampler Flow Rate Monitor	1	*	123
5. SERVICE BUILDING VENTILATION MONITORING SYSTEM			
a. Low Range Noble Gas Activity Monitor	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Sampler Flow Rate Monitor	1	*	123

TABLE 3.3.7.12-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
6. RADWASTE BUILDING VENTILATION MONITORING SYSTEM			
a. Low Range Noble Gas Activity Monitor	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Sampler Flow Rate Monitor	1	*	123
7. ONSITE STORAGE BUILDING VENTILATION EXHAUST RADIATION MONITOR			
a. Low Range Noble Gas Activity Monitor	1	*	121
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Sampler Flow Rate Monitor	1	*	123

TABLE 3.3.7.12-1 (Continued)

TABLE NOTATIONS

* At all times.
** Not used.
*** During operation of the main condenser air ejector.
\# During operation of the standby gas treatment system.
\#\# Also included in Technical Specifications Table 3.3.7.5.1 Item 13.a.

ACTION STATEMENTS

ACTION 121 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity within 24 hours. Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 122 - With the number of channels OPERABLE one less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that within 8 hours samples are continuously collected with auxiliary sampling equipment as required in Table 4.11.2.1.2-1.

ACTION 123 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours. Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 124 - Not used.

ACTION 125 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 4 hours and these samples are analyzed for gross activity within 24 hours. Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 126 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, releases via this pathway to the environment may continue for up to 7 days provided that:

a. The offgas system is not bypassed, and

b. The reactor building exhaust plenum noble gas effluent (downstream) monitor is OPERABLE;

Otherwise, be in at least HOT STANDBY within 12 hours.

TABLE 4.3.7.12-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES IN WHICH SURVEILLANCE REQUIRED
1. REACTOR BUILDING EXHAUST PLENUM					
a. Low Range Noble Gas Activity Monitor - Providing alarm	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
2. OFFGAS MONITORING SYSTEM (At the 2.2 minute delay piping)					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	***
3. STANDBY GAS TREATMENT MONITORING SYSTEM					
a. Low Range Noble Gas Activity Monitor	D	M	R(2)	Q(1)	#
b. Iodine Sampler	W	N.A.	N.A.	N.A.	#
c. Particulate Sampler	W	N.A.	N.A.	N.A.	#
d. Sampler Flow Rate Monitor	D	N.A.	R	Q	#

TABLE 4.3.7.12-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES IN WHICH SURVEILLANCE REQUIRED
4. TURBINE BLDG. VENTILATION MONITORING SYSTEM					
a. Low Range Noble Gas Activity Monitor	D	M	R(2)	Q(4)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
5. SERVICE BUILDING VENTILATION MONITORING SYSTEM					
a. Low Range Noble Gas Activity Monitor	D	M	R(2)	Q(4)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Sampler Flow Rate Monitor	D	N.A.	R	Q	*

TABLE 4.3.7.12-1 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES IN WHICH SURVEILLANCE REQUIRED
6. RADWASTE BUILDING VENTILATION MONITORING SYSTEM					
a. Low Range Noble Gas Activity Monitor	D	M	R(2)	Q(4)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
7. ONSITE STORAGE BUILDING VENTILATION EXHAUST RADIATION MONITOR					
a. Low Range Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Sampler Flow Rate Monitor	D	N.A.	R	Q	*

TABLE 4.3.7.12-1 (Continued)

TABLE NOTATIONS

* At all times.

** Not used.

*** During operation of the main condenser air ejector.

During operation of the standby gas treatment system.

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

1. Instrument indicates measured levels above the alarm setpoint.
2. Circuit failure.
3. Instrument indicates a downscale failure.
4. Instrument controls not set in operate mode (alarm or type).

(2) The initial CHANNEL CALIBRATION shall be performed using National Bureau of Standards traceable sources. These standards shall permit calibrating the system over the range of energy and measurement expected during normal operation and anticipated operational occurrences. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration or are National Bureau of Standards traceable shall be used.

(3) Not used.

(4) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation occurs on high level and that control room alarm annunciation occurs if any of the following conditions exists:

1. Instrument indicates measured levels above the alarm setpoints.
2. Circuit failure.
3. Instrument indicates a downscale failure.
4. Instrument controls not set in the operate mode (alarm or type).

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

CONCENTRATION

CONTROLS

3.11.1.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 3.0-1) shall be limited to the concentrations specified in 10 CFR 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 2×10^{-4} microcuries/ml total activity.

APPLICABILITY: At all times.

ACTION:

With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.

SURVEILLANCE REQUIREMENTS

4.11.1.1.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 4.11.1.1.1-1.

4.11.1.1.2 The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of Control 3.11.1.1.

TABLE 4.11.1.1.1-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (uCi/ml)
A. Batch Waste Release[b] Sample Tanks (3)	P Each Batch	P Each Batch	Principal Gamma Emitters[c]	5×10^{-7}
			I-131	1×10^{-6}
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	P	M	H-3	1×10^{-5}
	Each Batch	Composite[d]	Gross Alpha	1×10^{-7}
	P	Q	Sr-89, Sr-90	5×10^{-8}
	Each Batch	Composite[d]	Fe-55	1×10^{-6}
B Continuous Releases[e] Circulating Water System (if contaminated)	NA	M Composite[d]	Principal Gamma Emitters[c]	5×10^{-7}
			I-131	1×10^{-6}
	W Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	NA	M	H-3	1×10^{-5}
		Composite[d]	Gross Alpha	1×10^{-7}
	NA	Q	Sr-89, Sr-90	5×10^{-8}
		Composite[d]	Fe-55	1×10^{-6}

TABLE 4.11.1.1.1-1 (Continued)

TABLE NOTATION

[a]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:

$$LLD = \frac{4.66\ s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above, as microcuries 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,

2.22×10^6 is the number of disintegrations per minute per microcurie,

Y is the fractional radiochemical yield, when applicable,

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

Δt for plant effluents is the elapsed time between the midpoint of sample collection 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.

[b]A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed by a method described in the ODCM to assure representative sampling.

TABLE 4.11.1.1.1-1 (Continued)

TABLE NOTATION

[c]The principal gamma emitters for which the LLD specification applies exclusively are: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Semiannual Radioactive Effluent Release Report pursuant to Control 5.9.1.8.

[d]A composite sample is one in which the quantity of liquid samples is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released. This may be accomplished through composites of grab samples obtained prior to discharge after the tanks have been recirculated.

[e]A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume of a system that has an input flow during the continuous release.

RADIOACTIVE EFFLUENTS

DOSE

CONTROLS

3.11.1.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit, to UNRESTRICTED AREAS (see Figure 3.0-1) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrems to the total body and to less than or equal to 5 mrems to any organ, and

b. During any calendar year to less than or equal to 3 mrems to the total body and to less than or equal to 10 mrems to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits. This Special Report shall also include (1) the results of radiological analyses of the drinking water source and (2) the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR Part 141, Safe Drinking Water Act.*

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.2 Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

*Applicable only if drinking water supply is taken from the receiving water body within 3 miles of the plant discharge.

RADIOACTIVE EFFLUENTS

LIQUID WASTE TREATMENT

CONTROLS

3.11.1.3 The liquid radwaste treatment system shall be OPERABLE and appropriate portions of the system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected doses due to the liquid effluent, from each reactor unit, to UNRESTRICTED AREAS (see Figure 3.0-1) would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in any 31-day period.

APPLICABILITY: At all times.

ACTION:

a. With radioactive liquid waste being discharged and in excess of the above limits and any portion of the liquid radwaste treatment system not in operation, prepare and submit to the Commission within 30 days pursuant to Technical Specification 6.9.2 a Special Report that includes the following information:

   1. Explanation of why liquid radwaste was being discharged without complete treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability.

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.3.1 Doses due to liquid releases from each reactor unit to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM.

4.11.1.3.2 The installed liquid radwaste treatment system shall be demonstrated OPERABLE by meeting Controls 3.11.1.1 and 3.11.1.2.

RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

DOSE RATE

CONTROLS

3.11.2.1 The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 3.0-1) shall be limited to the following:

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

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

APPLICABILITY: At all times.

ACTION:

With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).

SURVEILLANCE REQUIREMENTS

4.11.2.1.1 The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.

4.11.2.1.2 The dose rate due to iodine-131, iodine-133, tritium, and all other radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 4.11.2.1.2-1.

TABLE 4.11.2.1.2-1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (uCi/ml)
A. Containment PURGE (Pre Treatment)	P, S[i] Each PURGE Grab Sample	P, S[i] Each PURGE P	Principal Gamma Emitters[b] H-3	1×10^{-4} 1×10^{-6}
B. Reactor Building Exhaust Plenum Standby Gas Treatment System[h]	M[c,d,e] Grab Sample	M[c] M[c]	Principal Gamma Emitters[b] H-3	1×10^{-4} 1×10^{-6}
C. Radwaste Building Turbine Building Service Building On-Site Storage Facility	M Grab Sample	M M	Principal Gamma Emitters[b] H-3	1×10^{-4} 1×10^{-6}
D. All Release Types as listed in B and C above.	Continuous[f]	W[g] Adsorbent Sample	I-131 I-133	1×10^{-12} 1×10^{-10}
	Con. uous[f]	W[g] Particulate Sample	Principal Gamma Emitters[b] (I-131, others)	1×10^{-11}
	Continuous[f]	M Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous[f]	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continuous[f]	Noble Gas Monitor	Noble Gas Gross Beta or Gamma	1×10^{-6}

TABLE 4.11.2.1.2-1 (Continued)

TABLE NOTATION

[a]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:

$$LLD = \frac{4.66\ s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above, as microcuries 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,

2.22×10^6 is the number of disintegrations per minute per microcurie,

Y is the fractional radiochemical yield, when applicable,

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

Δt for plant effluents is the elapsed time between the midpoint of sample collection 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.

TABLE 4.11.2.1.2-1 (Continued)

TABLE NOTATION

[b]The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144 in iodine and particulate releases. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Semiannual Radiactive Effluent Release Report pursuant to Control 5.9.1.8.

[c]Sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period. This requirement does not apply if (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

[d]Tritium grab samples shall be taken at least once per 24 hours when either the reactor well or the dryer-separator storage pool is flooded.

[e]Tritium grab samples shall be taken at least once per 7 days from the ventilation exhaust from the spent fuel pool area, whenever spent fuel is in the spent fuel pool.

[f]The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Controls 3.11.2.1, 3.11.2.2, and 3.11.2.3.

[g]Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15% of RATED THERMAL POWER in 1 hour and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

[h]Required when the SGTS is in operation.

[i]The containment shall be sampled and analyzed within 8 hours prior to the start of any VENTING or PURGING and at least once per 12 hours during VENTING or PURGING of the drywell through other than SGTS.

RADIOACTIVE EFFLUENTS

DOSE - NOBLE GASES

CONTROLS

3.11.2.2 The air dose due to noble gases released in gaseous effluents, from each reactor unit, to areas at and beyond the SITE BOUNDARY (see Figure 3.0-1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation and,

b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation.

APPLICABILITY: At all times.

ACTION:

a. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.2 Cumulative dose contributions for the current calendar quarter and current calendar year for noble gases shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

GASEOUS EFFLUENTS

DOSE - IODINE-131, IODINE-133, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM

CONTROLS

3.11.2.3 The dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each reactor unit, to areas at and beyond the SITE BOUNDARY (see Figure 3.0-1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrems to any organ and,

b. During any calendar year: Less than or equal to 15 mrems to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.3 Cumulative dose contributions for the current calendar quarter and current calendar year for iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

OFF-GAS TREATMENT SYSTEM

CONTROLS

3.11.2.4 The OFF-GAS TREATMENT SYSTEM shall be OPERABLE and shall be in operation.

APPLICABILITY: Whenever the main condenser steam jet air ejectors are in operation.

ACTION:

a. With the OFF-GAS TREATMENT SYSTEM inoperable for more than 7 days, prepare and submit to the commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:

   1. Identification of the inoperable equipment or subsystems and the reason for the inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

c. The provisions of Control 4.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.4 The OFF-GAS TREATMENT SYSTEM shall be demonstrated OPERABLE by meeting Controls 3.11.2.1, 3.11.2.2, and 3.11.2.3.

RADIOACTIVE EFFLUENTS

VENTILATION EXHAUST TREATMENT SYSTEM

CONTROLS

3.11.2.5 The VENTILATION EXHAUST TREATMENT SYSTEM as described in the ODCM shall be OPERABLE and appropriate portions of the system shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected doses due to gaseous effluent releases from the site to UNRESTRICTED AREAS (see Figure 3.0-1) would exceed 0.3 mrem to any organ in any 31-day period.

APPLICABILITY: At all times.

ACTION:

a. With radioactive gaseous waste being discharged in excess of the above limits and any portion of the VENTILATION EXHAUST TREATMENT SYSTEM not in operation, prepare and submit to the Commission within 30 days pursuant to Technical Specification 6.9.2 a Special Report that includes the following information:

   1. Identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.5.1 Doses due to gaseous releases from the site shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM, when any portion of the VENTILATION EXHAUST TREATMENT SYSTEM is not in use.

4.11.2.5.2 The VENTILATION EXHAUST TREATMENT SYSTEM shall be demonstrated OPERABLE by meeting Controls 3.11.2.1, 3.11.2.2, and 3.11.2.3.

RADIOACTIVE EFFLUENTS

VENTING OR PURGING

CONTROLS

3.11.2.8 VENTING or PURGING of the Mark I containment shall be through the standby gas treatment system or the reactor building ventilation system.

APPLICABILITY: Whenever the containment is vented or purged.

ACTION:

a. With the requirements of the above control not satisfied, suspend all VENTING or PURGING of the drywell.

b. The provision of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.8.1 The containment shall be determined to be aligned for VENTING or PURGING through the standby gas treatment system or the reactor building ventilation system within 4 hours prior to start of and at least once per 12 hours during VENTING or PURGING of the containment.

4.11.2.8.2 Prior to use of the purge system through the standby gas treatment system assure that:

a. Both standby gas treatment system trains are OPERABLE whenever the purge system is in use, and

b. Whenever the purge system is in use during OPERATIONAL CONDITION 1 or 2 or 3, only one of the standby gas treatment system trains may be used.

4.11.2.8.3 The containment drywell (or torus) shall be sampled and analyzed per Table 4.11.2.1.2-1 of Control 3.11.2.1 within 8 hours prior to the start of and at least once per 12 hours during VENTING or PURGING of the drywell (or torus) through other than the standby gas treatment system.

RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE

CONTROLS

3.11.4 The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrems to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

APPLICABILITY: At all times.

ACTION:

a. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Controls 3.11.1.2a., 3.11.1.2b., 3.11.2.2a., 3.11.2.2b., 3.11.2.3a., or 3.11.2.3b., calculations should be made including direct radiation contributions from the reactor units and from outside storage tanks to determine whether the above limits of Control 3.11.4 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR 20.405c, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.4.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Controls 4.11.1.2, 4.11.2.2, and 4.11.2.3, and in accordance with the methodology and parameters in the ODCM.

4.11.4.2 Cumulative dose contributions from direct radiation from the reactor units and from outside storage tanks shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in Control 3.11.4, ACTION a.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

3.12.1 The radiological environmental monitoring program shall be conducted as specified in Table 3.12.1-1.

APPLICABILITY: At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Table 3.12.1-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Control 5.9.1.7, 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 at a specified location exceeding the reporting levels of Table 3.12.1-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, 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 Controls 3.11.1.2, 3.11.2.2, and 3.11.2.3. When more than one of the radionuclides in Table 3.12.1-2 are detected 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 3.12.1-2 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 from all radionuclides is equal to or greater than the calendar year limits of Controls 3.11.1.2, 3.11.2.2, and 3.11.2.3. 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 pursuant to Control 5.9.1.7.

c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 3.12.1-1, identify specific locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then

*The methodology used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

RADIOLOGICAL ENVIRONMENTAL MONITORING

CONTROLS (Continued)

be deleted from the monitoring program. Pursuant to Control 5.9.1.8, identify the cause of the unavailability of samples and identify the new location(s) for obtaining replacement samples in the next Semiannual Radioactive Effluent Release Report pursuant to Control 5.9.1.8 and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

d. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.1 The radiological environmental monitoring samples shall be collected pursuant to Table 3.12.1-1 from the specific locations given in the table and figure(s) in the ODCM, and shall be analyzed pursuant to the requirements of Table 3.12.1-1 and the detection capabilities required by Table 4.12.1-1.

TABLE 3.12.1-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency Of Analysis
1. DIRECT RADIATION[b]	37 routine monitoring stations, with two or more dosimeters placed as follows: 1) an inner ring of stations in the general area of the SITE BOUNDARY and additional rings at approximately 2, 5, and 10 miles, with a station in at least every other meteorological sector for each ring with the exception of those sectors over Lake Erie. The balance of the stations, 8, should be placed in special interest areas such as population centers, nearby residences, schools, and in 2 or 3 areas to serve as control stations.	Quarterly	Gamma dose quarterly.
2. AIRBORNE Radioiodine and Particulates	Samples from 5 locations. a. 3 samples from close to the 3 SITE BOUNDARY locations, in different sectors, of the highest calculated annual average groundlevel D/Q. b. 1 sample from the vicinity of a community having the highest calculated annual average groundlevel D/Q.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine Cannister: I-131 analysis weekly. Particulate Sampler: Gross beta radioactivity analysis following filter change;[d] Gamma isotopic analysis[e] of composite (by location) quarterly.

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
	c. 1 sample from a control location, as for example 15-30 km distant and in the least prevalent wind direction.		
3. WATERBORNE a. Surface[f]	a. 1 sample upstream. b. 1 sample downstream.	Composite sample over 1-month period[g]	Gamma isotopic analysis[e] monthly. Composite for tritium analysis quarterly
b. Ground	Samples from 1 or 2 sources only if likely to be affected[h].	Quarterly	Gamma isotopic[e] and tritium analysis quarterly.
c. Drinking	a. 1 sample of each of 1 to 3 of the nearest water supplies that could be affected by its discharge. b. 1 sample from a control location	Composite sample over 2-week period[g] when I-131 analysis is performed, monthly composite otherwise	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year.[i] Composite for gross beta and gamma isotopic analyses[e] monthly. Composite for tritium analysis quarterly
d. Sediment from shoreline	1 sample from downstream area with existing or potential recreational value.	Semiannually	Gamma isotopic analysis[e] semiannually.

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
4. INGESTION a. Milk	a. Samples from milking animals in 3 locations within 5 km distance having the highest dose potential. If there are none, then, 1 sample from milking animals in each of 3 areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr[i].	Semimonthly when animals are on pasture, monthly at other times	Gamma isotopic[e] and I-131 analysis semimonthly when animals are on pasture; monthly at other times.
	b. 1 sample from milking animals at a control location 15-30 km distant and in the least prevalent wind direction		
b. Fish and Invertebrates	a. 1 sample of each commercially and recreationally important species in vicinity of plant discharge area.	Sample in season, or semiannually if they are not seasonal	Gamma isotopic analysis[e] on edible portions.
	b. 1 sample of same species in areas not influenced by plant discharge.		
c. Food Products	a. 1 sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest[j]	Gamma isotopic analyses[e] on edible portions.

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
c. Food Products (cont'd)	b. Samples of 3 different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average level D/Q if milk sampling is not performed.	Monthly when available	Gamma isotopic[e] and I-131 analysis.
	c. 1 sample of each of the similar broad leaf vegetation grown 15-30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly when available	Gamma isotopic[e] and I-131 analysis.

TABLE 3.12.1-1 (Continued)

TABLE NOTATIONS

[a]Specific parameters of distance and direction sector from the centerline of one reactor, and additional description where pertinent, shall be provided for each and every sample location in Table 3.12.1-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. 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. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Contol 5.9.1.7. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable specific alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. Pursuant to Control 5.9.1.8, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Semiannual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

[b]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. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

[c]The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that have valid background data may be substituted.

[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 air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

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

TABLE 3.12.1-1 (Continued)

TABLE NOTATION

[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. "Upstream" samples in an estuary must be taken far enough upstream to be beyond the plant influence.

[g]Composite samples should be collected with equipment (or equivalent) which is capable of collecting an aliquot at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly).

[h]Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

[i]The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

[j]If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

TABLE 3.12.1-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg,wet)	Milk (pCi/l)	Food Products (pCi/kg,wet)
H-3	20,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

*For drinking water samples. This is 40 CFR Part 141 value.

TABLE 4.12.1-1

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[a]

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

Analysis	Water (pCi/l)	Airborne Particulate or Gases (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-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	18	80	180
Ba-La-140	15			15		

TABLE 4.12.1-1 (Continued)

TABLE NOTATIONS

[a]This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Control 5.9.1.7.

[b]Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

[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.

TABLE 4.12.1-1 (Continued)

TABLE NOTATIONS

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 sample 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 pursuant to Control 5.9.1.7.

[d]LLD for drinking water samples.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.2 LAND USE CENSUS

CONTROLS

3.12.2 A land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden* of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation.

APPLICABILITY: At all times.

ACTION:

a. With a land use census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in Control 4.11.2.3, identify the new location(s) in the next Semiannual Radioactive Effluent Release Report, pursuant to Control 5.9.1.8.

b. With a land use census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with Control 3.12.1, add the new location(s) to the radiological environmental monitoring program within 30 days. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted. Pursuant to Control 5.9.1.8, identify the new location(s) in the next Semiannual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

c. The provisions of Control 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.2 The land use census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, visual survey, aerial survey, or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 5.9.1.7.

*Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Controls for broad leaf vegetation sampling in Table 3.12.1-1, Part 4.c, shall be followed, including analysis of control samples.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

3.12.3 Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission.

APPLICABILITY: At all times.

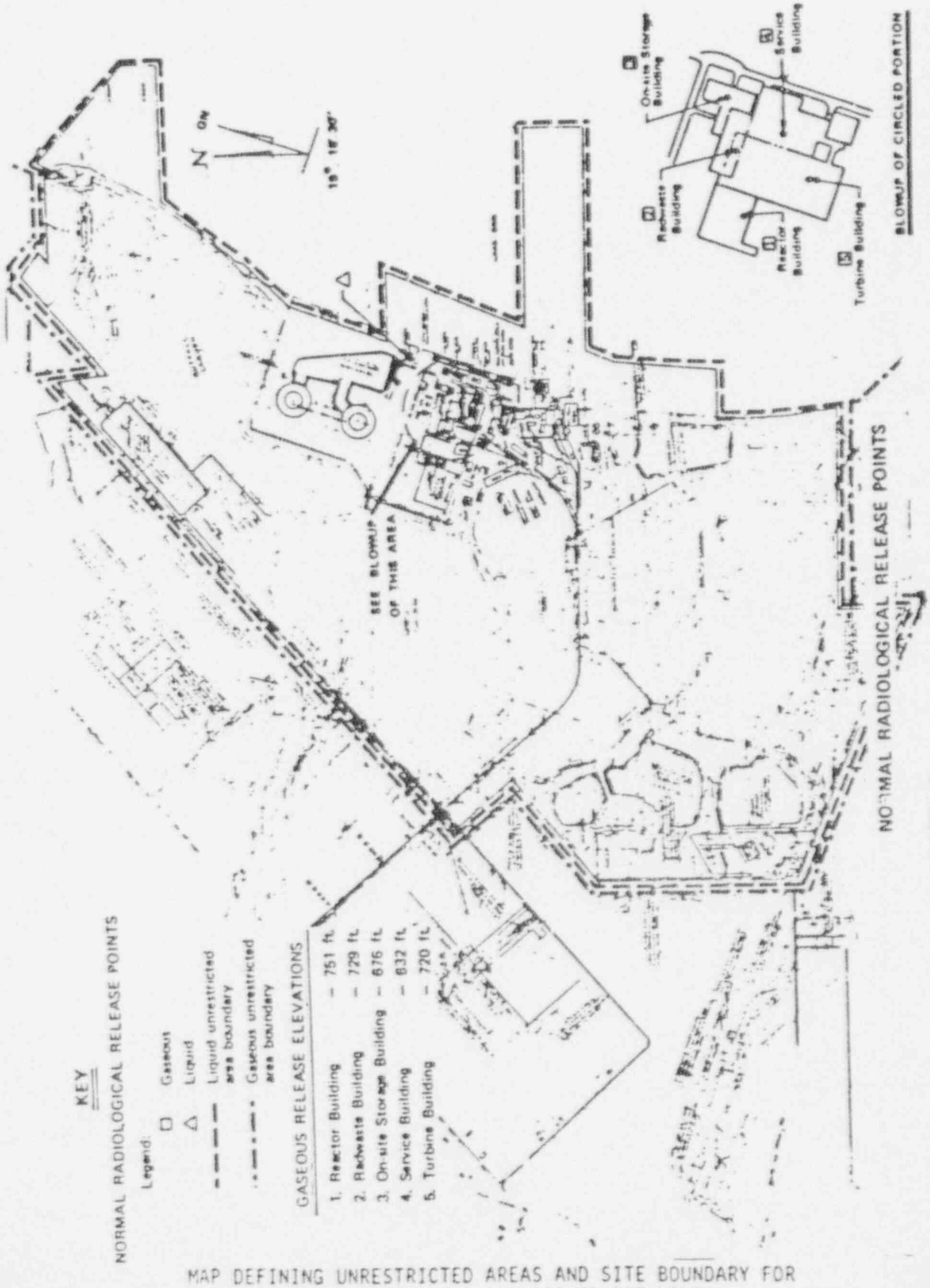
ACTION:

a. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to Control 5.9.1.7.

b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.3 The Interlaboratory Comparison Program shall be described in the ODCM. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 5.9.1.7.



MAP DEFINING UNRESTRICTED AREAS AND SITE BOUNDARY FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS

Figure 3.0-1

END OF SECTION 3.0

SECTION 4.0

BASES

ARMS - INFORMATION SERVICES

Date approved: 7-30-92 Release authorized by: B Kupp fo. Tom Vanbinney
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DSN ODCM -4.0 Rev 4 Date AUGUST 28, 1992
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INSTRUMENTATION

BASES

3/4.3.7.11 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

The radioactive liquid effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

3/4.3.7.12 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

The radioactive gaseous effluent monitoring 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 alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM utilizing the system design flow rates as specified in the ODCM. This conservative method is used because the Fermi 2 design does not include flow rate measurement devices. This will ensure the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 CONCENTRATION

This control is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table II, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (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 dissolved or entrained noble gases is based upon the assumption that 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.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedure Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

RADIOACTIVE EFFLUENTS

BASES

3/4.11.1.2 DOSE

This control is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. The control implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in 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 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

3/4.11.1.3 LIQUID RADWASTE TREATMENT SYSTEM

The OPERABILITY of the liquid radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to their release to the environment. The requirement that the appropriate portions of this system be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This specification implements the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1 DOSE RATE

This control is provided to ensure that the dose at any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 to 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

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.1 DOSE RATE (Continued)

assurance that radioactive material discharged in gaseous effluents 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 that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. Examples of calculations for such MEMBERS OF THE PUBLIC, with the appropriate occupancy factors, shall be given in the ODCM. 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 mrems/year to the total body or to less than or equal to 3000 mrems/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate limits above background to a child via the inhalation pathway to less than or equal to 1500 mrems/year.

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

3/4.11.2.2 DOSE - NOBLE GASES

This control is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I, 10 CFR Part 50. The control implements the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in 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 and 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. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.3 DOSE - IODINE-131, IODINE-133, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM

This control is provided to implement the requirements of Sections II.C, III.A, and IV.A of Appendix I, 10 CFR Part 50. The controls are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in 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 and 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. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate controls for iodine-131, iodine-133, tritium, and radionuclides in particulate form with half lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of these calculations were: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

3/4.11.2.4 OFF-GAS TREATMENT SYSTEM

The OPERABILITY of the OFF-GAS TREATMENT SYSTEM ensures that the system will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This control implements the requirements of General Design Criteria 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.5 VENTILATION EXHAUST TREATMENT SYSTEM

The requirement that the appropriate portions of this system be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

3/4.11.2.8 VENTING OR PURGING

This control provides reasonable assurance that releases from drywell purging operations will not exceed the annual dose limits of 10 CFR Part 20 for UNRESTRICTED AREAS.

3/4.11.4 TOTAL DOSE

This control is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The control requires the preparation and submittal of a Special Report whenever the calculated doses from plant generated radioactive effluents and direct radiation exceed 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor units and outside storage tanks are kept small. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purpose of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other than uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.405c, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Controls 3.11.1.1 and 3.11.2.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.1 MONITORING PROGRAM

The radiological environmental monitoring program required by this control provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measureable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 4.12.1-1 are considered optimum for routine environmental measurements in industrial laboratories. 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.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedure Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

3/4.12.2 LAND USE CENSUS

This control is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey, from visual survey or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 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/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 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/m^2.

RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

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

END OF SECTION 4.0

SECTION 5.0

ADMINISTRATIVE CONTROLS

ARMS - INFORMATION SERVICES

Date approved: 7-30-92 Release authorized by: B Kuyga for Tom Vandermay
Change numbers incorporated: 91-104-ODM
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DTC TMPLAN File 1715.02 Recipient

ADMINISTRATIVE CONTROLS

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

5.9.1.7 Routine Annual Radiological Environmental Operating Reports covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year. The initial report shall be submitted prior to May 1 of the year following initial criticality.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison as appropriate, with preoperational studies, with operational controls, and with previous environmental surveillance 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 Control 3.12.2. The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the Table and Figures in the ODCM, as well as summarized and tabulated results of these analyses and measurments in the format of 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 noting and explaining the reasons for the missing results. If possible, the missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the radiological environmental monitoring program; at least two legible maps* covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor; the results of licensee participation in the Interlaboratory Comparison Program, required by Control 3.12.3; discussion of all deviations from the sampling schedule of Table 3.12.1-1; and discussion of all analyses in which the LLD required by Table 4.12.1-1 was not achievable.

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT**

5.9.1.8 Routine Semiannual Radioactive Effluent Release Reports covering the operation 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 period of the first report shall begin with the date of initial criticality.

*One map shall cover stations near the SITE BOUNDARY; a second shall include the more distant stations.

**A single submittal may be made for a mutiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

ADMINISTRATIVE CONTROLS

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

The Semiannual 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 Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Lignt-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

The Semiannual Radioactive Effluent Release Report to be submitted within 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 on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.*** This same report 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. This same report shall also 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 3.0-1) 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 assessment of radiation doses shall be performed in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

The Semiannual 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 MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operation. The assessment of radiation doses shall be performed in accordance with methodology and parameters in the ODCM.

The Semiannual Radioactive Efluent Release Reports shall include the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the report period:

a. Container volume,

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

***In lieu of submission with the first half year Semiannual Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

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

d. Source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms),

e. Type of container (e.g., LSA, Type A, Type B, Large Quantity), and

f. Solidification agent or absorbent (e.g., cement, urea formaldehyde).

The Semiannual Radioactive Effluent Release Reports shall include a list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

The Semiannual Radioactive Effluent Release Reports shall include any changes made during the reporting period to the OFFSITE DOSE CALCULATION MANUAL (ODCM) as described in Technical Specification 6.14.2.c, as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to Control 3.12.2.

The Semiannual Radioactive Effluent Release Reports shall also include the following: an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in Control 3.3.7.11 or 3.3.7.12, respectively; and description of the events leading to liquid holdup tanks exceeding the limits of Technical Specification 3.11.1.4.

5.15 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS, AND SOLID WASTE TREATMENT SYSTEMS*

5.15.1 Licensee-initiated major changes to the radioactive waste systems (liquid, gaseous, and solid):

a. Shall be reported to the Commission in the Semiannual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the OSRO. The discussion of each change shall contain:

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

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

*Licensees may choose to submit the information called for in this Control as part of the annual FSAR update.

ADMINISTRATIVE CONTROLS

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

4. 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;

5. An evaluation of the change, which shows the expected maximum exposures to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto;

6. 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;

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

8. Documentation of the fact that the change was reviewed and found acceptable by the OSRO.

b. Shall become effective upon review and acceptance by the OSRO.

END OF SECTION 5.0

PART II

CALCULATIONAL METHODS

6.0 LIQUID EFFLUENTS

This section summarizes information on the liquid effluent radiation monitoring instrumentation and controls. More detailed information is provided in the Fermi 2 UFSAR and Fermi 2 design drawings from which this summary was derived. This section also describes the sampling and analysis required by the Offsite Dose Calculation Manual. Methods for calculating alarm setpoints for the liquid effluent monitors are presented. Also, methods for evaluating doses from liquid effluents are provided.

6.1 Radiation Monitoring Instrumentation and Controls

This section summarizes the instrumentation and controls monitoring liquid effluents. This discussion focuses on the role of this equipment in assuring compliance with the Offsite Dose Calculation Manual.

6.1.1 Offsite Dose Calculation Manual (ODCM) 3.3.7.11 Requirement

Fermi 2 ODCM 3.3.7.11 prescribes the monitoring required during liquid releases and the backup sampling required when monitors are inoperable.

The liquid effluent monitoring instrumentation for controlling and monitoring radioactive effluents in accordance with the Fermi 2 ODCM 3.3.7.11 is summarized below:

1. **Radiation Alarm - Automatic Release Termination**

   a. Liquid Radwaste Effluent Line - The D11-N007 Radiation Monitor on the liquid radwaste effluent line provides the alarm and automatic termination of liquid radioactive material releases prior to exceeding 1 Maximum Permissible Concentration (MPC) (10 CFR 20, Appendix B, Table II, Column 2) required by ODCM 3.3.7.11. The monitor is located upstream of the Isolation Valve (G11-F733) on the liquid radwaste discharge line and monitors the concentration of liquid effluent before dilution by the circulating water reservoir (CWR) decant flow.

2. **Radiation Alarm (only)**

   a. Circulating Water Reservoir (CWR) Decant Line - The CWR Decant Line Radiation Monitor (D11-N402) provides indication of the concentration of radioactive material in the diluted radioactive liquid releases just before discharge to Lake Erie. As required by ODCM 3.3.7.11, the alarm setpoint is established to alarm (only) prior to exceeding one MPC.

3. **Flow Rate Measuring Devices**

a. Liquid Radwaste Effluent Line - In accordance with ODCM 3.3.7.11, the release rate of liquid radwaste discharges is monitored by G11-R703. This flow rate instrumentation is located on the radwaste discharge line prior to the junction with the CWR decant line.

b. Circulating Water Reservoir Decant Line - In accordance with ODCM 3.3.7.11, the flow rate of the CWR decant line is monitored by N71-R802. The flow rate instrumentation is located on the decant line downstream of the junction with the liquid radwaste effluent line. This instrumentation measures the total discharge flow rate from Fermi 2 to Lake Erie.

6.1.2 Non-ODCM Required Monitor

An additional monitor not required by Fermi 2 ODCM is provided by Detroit Edison to reduce the likelihood of an unmonitored release of radioactive liquids.

1. General Service Water - The General Service Water (GSW) Radiation Monitor (D11-N008) provides additional control of potential radioactive effluents. D11-N008 monitors the GSW System prior to discharge into the Main Condenser circulating water discharge line to the Circulating Water Reservoir. Although not an ODCM required monitor, D11-N008 monitors a primary liquid stream in the plant that also discharges to the environment (Lake Erie via the Circulating Water Reservoir). Indication of radioactive material contamination in the GSW System would also indicate potential CWR contamination and the need to control all discharges from the CWR as radioactive effluents.

6.2 Sampling and Analysis of Liquid Effluents

The program for sampling and analysis of liquid waste is prescribed in the Fermi 2 Offsite Dose Calculation Manual Table 4.11.1.1.1-1. This table distinguishes two types of liquid releases:

BATCH releases, defined as discrete volumes, normally processed through the radwaste system to the waste sample tanks

CONTINUOUS releases, from the Circulating Water Reservoir (CWR) System, if it becomes contaminated

Continuous releases from the CWR System are via the CWR decant line to Lake Erie. The CWR System is not expected to become contaminated. Therefore, continuous radioactive material releases are not expected. However, the General Service Water (GSW) and the CWR systems interface with radioactive systems in the plant. Also, the GSW intake is within a few hundred feet of the CWR decant line discharge to Lake Erie. For these reasons, it is prudent to consider the GSW and the CWR a potential source of radioactive effluents and to sample them regularly.

6.2.1 BATCH Releases

Fermi 2 ODCM Table 4.11.1.1.1-1 requires that a sample representative of the tank contents be obtained before it is released. The table specifies the following program:

- Prior to sampling, the tank is isolated. The tank level is determined and this value is converted to tank volume. A pump with a known recirculation flow rate is then activated to recirculate tank contents. The pump is allowed to run for at least the time required to recirculate the tank volume twice.
- Prior to each batch release, analysis for principal gamma emitters (including all peaks identified by gamma spectroscopy)
- Once per month, analysis of one batch sample for dissolved and entrained gases (gamma emitters). (See note in Section 6.2.2 below.)
- Once per month, analysis of a composite sample of all releases that month for tritium (H-3) and gross alpha activity. (The composite sample is required to be representative of the liquids released and sample quantities of the composite are to be proportional to the quantities of liquid discharged).
- Once per quarter, analysis of a composite sample of all releases that quarter for Strontium (Sr)-89, Sr-90, and Iron (Fe)-55.

6.2.2 CONTINUOUS Releases

Fermi 2 ODCM Table 4.11.1.1.1-1 requires that composite samples be collected from the CWR System, if contaminated. The table specifies the following sample analysis:

- Once per month, analysis of a composite sample for principal gamma emitters and for I-131.
- Once per month, analysis of a composite sample for H-3 and gross alpha.
- Once per month, analysis of weekly grab samples (composited) for dissolved and entrained gases (gamma emitters). (See note below.)
- Once per quarter, analysis for Sr-89, -90 and Fe-55.

NOTE: Identification of noble gases that are principal gamma emitting radionuclides are included in the gamma spectral analysis performed on all liquid radwaste effluents. Therefore, the ODCM Table 4.11.1.1.1-1 sampling and analysis for noble gases in batch releases (one batch per month) and continuous releases (monthly analysis of weekly grab samples) need not be performed as a separate program. The gamma spectral analysis on each batch release and on the CWR monthly composite meets the intent of this ODCM requirement.

6.3 Liquid Effluent Monitor Setpoints

Offsite Dose Calculation Manual 3.11.1.1 requires that the concentration of liquid radioactive effluents not exceed the unrestricted area MPC at the discharge point to Lake Erie. Dissolved or entrained noble gases in liquid effluents are limited to a concentration of 2 E-04 uCi/ml, total noble gas activity. ODCM 3.3.7.11 requires that radiation monitor setpoints be established to alarm and trip prior to exceeding the limits of ODCM 3.11.1.1.

To meet this specification, the alarm/trip setpoints for liquid effluent monitors are determined in accordance with the following equation:

$$SP \leq \frac{CL\ (DF + RR)}{RR} \qquad (6\text{-}1)$$

where:

SP = the setpoint, in uCi/ml, of the monitor measuring the radioactivity concentration in the effluent line prior to dilution. The setpoint represents a value which, if exceeded, would result in concentrations exceeding the MPC in the unrestricted area

CL = the effluent concentration limit (ODCM 3.11.1.1) implementing 10 CFR Part 20.106 (i.e., MPC at discharge point) in uCi/ml, defined in Equation (6-4)

RR = the liquid effluent release rate as measured at the radiation monitor location, in volume per unit time, but in the same units as DF, below

DF = the dilution water flow as measured prior to the release point (Lake Erie) in volume per unit time

At Fermi 2 the available Dilution Water Flow (DF) is constant for a given release, and the waste tank Release Rate (RR) and monitor Setpoint (SP) are set to meet the condition of Equation (6-1) for a given effluent Concentration Limit, CL.

NOTE: If no dilution is provided, $SP \leq CL$. Also, when DF is large compared to RR, then $(DF + RR) \simeq DF$.

6.3.1 Liquid Radwaste Effluent Line Monitor (D11-N007)

Liquid Radwaste Effluent Line Monitor D11-N007 provides alarm and automatic termination of releases prior to exceeding MPC. As required by ODCM Table 4.11.1.1.1-1 and as discussed in ODCM Section 6.2.1, a sample of the liquid radwaste to be discharged is collected and analyzed by gamma spectroscopy to identify principal gamma emitting radionuclides. From the measured individual radionuclide concentrations, the allowable release rate is determined.

The allowable release rate is inversely proportional to the ratio of the radionuclide concentrations to the MPC values. The ratio of the measured concentration to MPC values is referred to as the "MPC fraction" and is calculated by the equation:

$$MPCF = \sum \frac{C_i}{MPC_i} \quad (6\text{-}2)$$

where:

MPCF = fraction of the unrestricted area MPC for a mixture of gamma emitting radionuclides

C_i = concentration of each gamma emitting radionuclide i measured in each tank prior to release (uCi/ml)

MPC_i = unrestricted area most restrictive MPC for each radionuclide i from 10 CFR Part 20, Appendix B, Table II, Column 2. For dissolved and entrained noble gases an MPC value of 2E-04 uCi/ml shall be used.

Based on the MPCF, the maximum allowable release rate can be calculated by the following equation:

$$MAX\ RR \leq \frac{DF}{(MPCF \times (1+BF)) + H3MPCF} * SF \quad (6\text{-}3)$$

where:

MAX RR = maximum acceptable waste tank discharge rate (gal/min) (Monitor #G11-R703)

DF = dilution flow rate from the CWR as observed from the Control Room readout (gal/min) (Monitor #N71-R802)

SF = administrative safety factor to account for variations in monitor response and flow rates. A SF value of 0.5 is suggested because it provides for 100% variation caused by statistical fluctuation and/or errors in measurements.

BF = conservative estimate of the ratio of the MPC fraction of pure beta emitters other than tritium to the gamma MPC fraction (MPCF) (The value 0.15 may be used for BF.)

MPCF = As previously defined by equation (6-2)

H3MPCF = conservative estimate of MPC fraction due to tritium (The value 6E-1 may be used for H3MPCF.)

NOTE: Equation (6-3) is valid only for MPCF >1; if the MPCF ≤ 1, the waste tank concentration meets the limits of 10 CFR Part 20 without dilution, and the waste sample tank may be discharged at the maximum rate.

If MAX RR as calculated above is greater than the maximum discharge pump capacity, the pump capacity should be used in establishing the actual Release Rate RR for the radwaste discharge. For the Waste Sample Tank, the maximum discharge rate is 50 gallons per minute. The actual Release Rate RR is monitored in the Radwaste Control Room by G11-R703.

The Concentration Limit (CL) of a liquid radwaste discharge is the same as the effective MPC for the radionuclide mixture of the discharge. Simply, the CL (or effective MPC) represents the equivalent MPC value for a mixture of radionuclides evaluated collectively. The equation for determining CL is:

$$CL = \frac{C_i}{MPCF} \tag{6-4}$$

Based on the Release Rate RR and Dilution Flow DF and by substituting Equation (6-4) for CL in Equation (6-1) and introducing sensitivity factors and factors to account for the presence of pure beta emitters the alarm setpoint is calculated by the equation:

$$SP \leq \frac{(C_i * SEN_i) * DF * H3F}{MPCF * (1+BF) * RR} + Bkg \tag{6-5}$$

where:

SP = setpoint of the radiation monitor counts per second (cps)

C_i = concentration of radionuclide i as measured by gamma spectroscopy (uCi/ml)

SEN_i = monitor sensitivity for radionuclide i based on calibration curve (cps/(uCi/ml)) or single conservative value for all radionuclides (see below)

RR = actual release rate of the liquid radwaste discharge (gal/min)

BF = pure beta factor as defined for Equation (6-3)

MPCF = MPC fraction as determined by Equation (6-2)

H3F = correction factor to account for estimated tritium concentration at the discharge point (The value 0.99 may be used.)

Bkg = background reading of monitor (cps)

DF = dilution flow rate of Circulating Water Decant Line as observed from Control Room readout (gal/min) monitor #N71-R802.

A monitor sensitivity value of 1.0 E6 cps/(uCi/ml) may be used in lieu of sensitivity values for individual radionuclides. This value is the sensitivity of Cr-51 determined from the primary calibration sensitivity curve. It is a conservative value for the nuclide mixes which have been seen in actual liquid discharges from Fermi 2.

If no radionuclides are measured by gamma spectroscopy, the alarm setpoint can be established at one half the setpoint of the previous discharge.

Prior to conducting any batch liquid radwaste release, Equation (6-3) is used to determine the allowable release rate in accordance with ODCM 3.11.1.1. Equation (6-5) is used to determine the D11-N007 alarm setpoint in accordance with ODCM 3.3.7.11.

6.3.2 **Circulating Water Reservoir Decant Line Radiation Monitor (D11-N402)**

ODCM 3.3.7.11 requires that the setpoint for the CWR Decant Line Radiation Monitor D11-N402 be established to ensure the radioactive material concentration in the decant line prior to discharge to Lake Erie does not exceed MPC, unrestricted area (10 CFR 20, Appendix B, Table II, Column 2). The approach for determining the alarm setpoint for the CWR Decant Line Radiation Monitor is the same as presented in Section 6.3.1 for the Liquid Radwaste Effluent Line Monitor. However, the CWR Decant Line Radiation Monitor setpoint need not be changed prior to each release. Equation (6-1) remains valid, except that, for the CWR Decant Line Monitor, the dilution flow previously assumed for diluting the BATCH liquid radwaste effluents is now the release rate. There is no additional dilution prior to discharge to Lake Erie. Thus, Equation (6-1) simplifies to:

$$SP \leq CL \tag{6-6}$$

Substituting Equation (6-4) for CL and introducing a safety factor, sensitivity factors, and monitor background, the D11-N402 alarm setpoint can be calculated by the equation:

$$SP \leq \frac{(C_i * SEN_i) * SF}{MPCF} + Bkg \tag{6-7}$$

where:

SP = setpoint in counts per minute (cpm)

C_i = concentration of each radionuclide i in the CWR decant line effluent uCi/ml)

SEN_i = monitor sensitivity for nuclide i based on calibration curve (cpm/(uCi/ml))

MPCF = MPC fraction as determined by Equation (6-2)

SF = 0.5, administrative safety factor

Bkg = background reading of monitor (cpm)

Normally, only during periods of batch liquid radwaste discharges will there exist any plant-related radioactive material in the CWR decant line.

6.3.3 Generic, Conservative Alarm Setpoint for D11-N402

The D11-N402 setpoint could be adjusted for each BATCH release as is done for the liquid radwaste effluent line monitor. Based on the measured levels of radioactive material in a BATCH liquid release, the alarm setpoint for D11-N402 could be calculated using Equation (6-7). However, during these planned releases, the concentrations will almost always be so low (due to dilution) that the D11-N402 Monitor will not indicate measurable levels. The CWR decant line design flow is 10,000 gpm; and the maximum liquid radwaste release rate is 50 gpm, providing a 200:1 dilution. The radioactive material concentration of BATCH liquid releases is typically in the range of 10^{-7} to 10^{-4} uCi/ml. With a nominal 200:1 dilution (actual dilution has been greater since in actual releases the decant line flow rate has been about 18,000 gpm), the CWR decant line monitor would monitor diluted activity in the range of 5×10^{-10} to 5×10^{-7} uCi/ml. D11-N402 Monitor response at these levels would be 0.1 to 100 cpm, depending on the particular radionuclide mixture and corresponding instrument response. These response levels are less than the monitor background levels.

In lieu of routinely adjusting the D11-N402 setpoints, generic, conservative setpoints have been established based on an analysis of nuclides seen in actual liquid discharges and on the primary calibration sensitivity curve.

6.3.4 Alarm Setpoint for GSW and RHR System Radiation Monitors

Levels of radioactive material detectable above background at Radiation Monitor D11-N008 would be one of the first indicators of contamination of the General Service Water (GSW) System and the CWR. Likewise, for the Residual Heat Removal (RHR) System, the D11-N401 A and B Monitors would be one of the first indicators of contamination and subsequent contamination of the CWR. Therefore, to provide early indication and assure prompt attention, the alarm setpoints for these monitors should be established as close to background as possible without incurring a spurious alarm due to background fluctuations. This level is typically around three times background.

If the GSW System or RHR System becomes contaminated, it may become necessary to raise the radiation monitor setpoints. The alarm setpoints should be re-evaluated to provide the CR operator a timely indication of further increasing activity levels in the GSW or RHR System without spurious alarms. The method for this re-evaluation is the same as described above - the alarm setpoint established at three times its current reading. No regulatory limits apply for establishing a maximum value for these alarm setpoints since these monitors are located on plant systems and do not monitor final release points to the environment. However, as a practical matter, upper limits on the alarm setpoints can be evaluated using the methods of ODCM Section 6.3.1 based on the actual system flows, dilution and release paths in effect at the time.

6.3.5 Alarm Response - Evaluating Actual Release Conditions

Normally, liquid release rates are controlled and alarm setpoints are established to ensure that the release does not exceed the concentration limits of ODCM 3.11.1.1 (i.e., 10 CFR 20 MPCs at the discharge to Lake Erie). However, if either Monitor D11-N007 or D11-N402 alarms during a liquid release, it becomes necessary to re-evaluate the release conditions to determine compliance with ODCM 3.11.1.1. Following an alarm, the actual release conditions should be determined. Radioactive material concentrations should be evaluated by sampling the effluent stream or resampling the waste tank. Discharge flow and dilution water flow should be redetermined.

The following equation may be used for the evaluation:

$$\left[\sum\left(\frac{C_i}{MPC_i}\right) \quad * \quad \frac{RR}{DF + RR}\right] \leq 1 \qquad (6\text{-}8)$$

where:

C_i = measured concentration of radionuclide i in the effluent stream (uCi/ml)

MPC_i = the MPC value for radionuclide i from 10 CFR 20, Appendix B, Table II, Column 2 (uCi/ml), 2 E-04 uCi/ml for dissolved or entrained noble gases

RR = actual release rate of the liquid effluent at the time of the alarm, gpm

DF = actual dilution circulating water flow at the time of the release alarm, gpm

NOTE: For alarm on D11-N402 (CWR decant line), the Release Rate RR is the Dilution Water Flow DF and the equation simplifies to $(C_i/MPC_i) \leq 1$.

6.3.6 Liquid Radwaste Monitor Setpoint Determination with Contaminated Circulating Water Reservoir

In the event the CWR is determined to contain radioactive material, the effective dilution capacity of the CWR is reduced as a function of the MPCF. To determine the available dilution flow capacity the MPCF for the CWR is determined using equation (6-2). The MPCF of the CWR is used to determine the available dilution flow as follows:

$$\text{CWR Dilution Flow} = \text{CWR Decant Flow Rate (GPM)} * (1 - \text{CWR MPCF}) \qquad (6\text{-}9)$$

The resulting dilution flow rate is substituted in equation (6-3) to determine the maximum allowable release rate for discharges from the radwaste system. Substituting the available CWR dilution flow from equation (6-9), the Liquid Radwaste Monitor maximum release rate can be determined using equation (6-3).

Once the available dilution flow and maximum allowable release rate have been determined the radwaste monitor setpoint can be determined using equation (6-5).

6.4 Contaminated GSW or RHR System - Quantifying and Controlling Releases

The GSW Radiation Monitor (D11-N008) provides an indication of contamination of this system. The Monitors D11-N401 A and B perform this function for the RHR System. Also, the CWR Decant Line Radiation Monitor monitors all liquid releases from the plant and would record any release to Lake Erie from either of these systems if contaminated. As discussed in ODCM Section 6.2.2, sampling and analysis of the CWR System is required only if this system is contaminated, as would be indicated by D11-N402 or D11-N008. Nonetheless, periodic samples are collected from the CWR System to verify absence of contamination. Although not required by the ODCM, periodic sampling and analysis of the RHR System is also performed since it also is a potential source of contamination of the CWR and subsequent releases to Lake Erie. If contamination is found, further releases from the applicable system (GSW or RHR) via the CWR decant line must be evaluated and controlled to ensure that releases are maintained ALARA. The following actions will be considered for controlling releases.

- Sampling frequency of the applicable source (GSW or RHR System) and the CWR will be increased until the source of the contamination is found and controlled. This frequency may be relaxed after the source of contamination has been identified and isolated.

- Gamma spectral analysis will be performed on each sample.

- The measured radionuclide concentrations from the gamma spectral analysis will be compared with MPC (Equation 6-2) to ensure releases are within the limits of ODCM 3.11.1.1.

- Based on the measured concentrations, the setpoint for the CWR Decant Line Radiation Monitor (D11-N402) will be determined as specified in Section 6.3.2. If the calculated setpoint based on the measured distribution is greater than the current setpoint (see ODCM Section 6.3.3) no adjustment to the setpoint is required.

- Samples will be composited in accordance with ODCM Table 4.11.1.1.1-1 for monthly analysis for H-3 and gross alpha and for quarterly analysis for Sr-89, 90 and Fe-55.

- Each sample will be considered representative of the releases that have occurred since the previous sample. For each sample (and corresponding release period), the volume of liquid released to the lake will be determined based on the measured CWR decant line cumulative flow.

- From the sample analysis and the calculated volume released, the total radioactive material released will be determined and considered representative of the release period. Cumulative doses will be determined in accordance with ODCM Section 6.5.

6.5 Liquid Effluent Dose Calculation - 10 CFR 50

The parameters of the liquid release (or estimated parameters, for a pre-release calculation) may be used to calculate the potential dose to the public from the release (or planned release). The dose calculation provides a conservative method for estimating the impact of radioactive effluents released by Fermi 2 and for comparing that impact against limits set by the NRC in the Fermi 2 ODCM. The limits in the Fermi 2 ODCM are specified as quarterly and calendar year limits. This assures that the average over the year is kept as low as reasonably achievable.

6.5.1 MEMBER OF THE PUBLIC Dose - Liquid Effluents

ODCM 3.11.1.2 limits the dose or dose commitment to MEMBERS OF THE PUBLIC from radioactive materials in liquid effluents from Fermi 2 to:

- during any calendar quarter;
  $\leq$ 1.5 mrem to total body
  $\leq$ 5.0 mrem to any organ

- during any calendar year;
  $\leq$ 3.0 mrem to total body
  $\leq$ 10.0 mrem to any organ

The calculation of the potential doses to MEMBERS OF THE PUBLIC is a function of the radioactive material releases to the lake, the subsequent transport and dilution in the exposure pathways, and the resultant individual uptake. At Fermi 2, pre-operational evaluation of radiation exposure pathways indicated that doses from consumption of fish from Lake Erie provided the most conservative estimate of doses from releases of radioactive liquids. However, with the proximity of the water intake for the City of Monroe, it must be assumed that individuals will consume drinking water as well as fish that might contain radioactivity from discharges into Lake Erie.

Study of the currents in Lake Erie indicates that the current in the Lagoona Beach embayment carries liquid effluents from Fermi 2 north along the coast part of the time and south along the coast part of the time. When the current flows north, liquid effluents are carried away from the Monroe Water Intake, so only the fish consumption exposure pathway must be considered. When the current flows south, toward the Monroe Water Intake, both fish consumption and drinking water consumption exposure pathways must be considered. To ensure conservatism in the dose modeling, the combined fish and drinking water pathway is used for evaluating the maximum hypothetical dose to a MEMBER OF THE PUBLIC from liquid radioactive effluents. The following calculational methods may be used for determining the dose or dose commitment due to the liquid radioactive effluents from Fermi 2:

$$D_o = \frac{1.67\ E\text{-}02 * VOL}{DF * Z} * \sum (C_i * A_{io}) \qquad (6\text{-}10)$$

where:

D_o = dose or dose commitment to organ o or total body (mrem)

A_{io} = site-specific ingestion dose commitment factor to the total body or any organ o for radionuclide i (mrem/hr per uCi/ml)

C_i = average concentration of radionuclide i in undiluted liquid effluent representative of the volume VOL (uCi/ml)

VOL = total volume of liquid effluent released (gal)

DF = average dilution water flow (CWR decant line) during release period (gal/min)

Z = 5, near field dilution factor (Derived from Regulatory Guide 1.109, Rev 0)

1.67 E-02 = 1 hr/60 min

The site-specific ingestion dose/dose commitment factors (A_{io}) represents a composite dose factor for the fish and drinking water pathway. The site-specific dose factor is based on the NRC's generic maximum individual consumption rates. Values of A_{io} are presented in Table 6-1. They were derived in accordance with guidance of NUREG-0133 from the following equation:

$$A_{io} = 1.14\ E + 05\ (U_W / D_W + U_F * BF_i)\ DF_i \qquad (6\text{-}11)$$

where:

U_F = 21 kg/yr adult fish consumption

U_W = 730 liters/yr adult water consumption

D_W = 15.4, additional dilution from the near field to the water intake for the City of Monroe (Net dilution factor of 77 from discharge point to drinking water intake, Fermi 2 UFSAR, Chapter 11, Table 11.2-11)

BF_i = Bioaccumulation factor for radionuclide i in fish from Table 6-2 (pCi/kg per pCi/liter)

DF_i = dose conversion factor for nuclide i for adults in organ o from Table E-11 of Regulatory Guide 1.109 (mrem/pCi)

$$1.14\ E + 05 = \frac{10^6\ (pCi/uCi) * 10^3\ (ml/kg)}{8760\ (hr/yr)}$$

The radionuclides included in the periodic dose assessment required by ODCM 3.11.1.2 are those identified by gamma spectral analysis of the liquid waste samples collected and analyzed per the requirements of ODCM Table 4.11.1.1.1-1. In keeping with the NUREG-0133 guidance, the adult age group represents the maximum exposed individual age group. Evaluation of doses for other age groups is not required for demonstrating compliance with the dose criteria of ODCM 3.11.1.2. The dose analysis for radionuclides requiring radiochemical analysis will be performed after receipt of results of the analysis of the composite samples. In keeping with the required analytical frequencies of ODCM Table 4.11.1.1.1-1, tritium dose analyses will be performed at least monthly; Sr-89, Sr-90 and Fe-55 dose analyses will be performed at least quarterly.

6.5.2 Simplified Liquid Effluent Dose Calculation

In lieu of the individual radionuclide dose assessment presented in Section 6.5.1, the following simplified dose calculation may be used for demonstrating compliance with the dose limits of ODCM 3.11.1.2. (Refer to Appendix A for the derivation of this simplified method.)

Total Body

$$D_{tb} = \frac{9.69\ E+03 * VOL}{DF * Z} * \sum C_i \qquad (6\text{-}12)$$

Maximum Organ

$$D_{max} = \frac{1.18\ E+04 * VOL}{DF * Z} * \sum C_i \qquad (6\text{-}13)$$

where:

C_i = average concentration of radionuclide i in undiluted liquid effluent representative of the volume VOL (uCi/ml)

VOL = volume of undiluted liquid effluent released (gal)

DF = average dilution water flow (CWR decant line) during release period (gal/min)

Z = 5, near field dilution factor (derived from Regulatory Guide 1.109, Rev 0)

D_{tb} = conservatively evaluated total body dose (mrem)

D_{max} = conservatively evaluated maximum organ dose(mrem)

9.69 E + 03 = 0.0167 (hr/min) * 5.80 E + 05 (mrem/hr per uCi/ml, Cs-134 total body dose factor from Table 6.0-1)

1.18 E + 04 = 0.0167 (hr/min) * 7.09 E + 05 (mrem/hr per uCi/ml, Cs-134 liver dose factor from Table 6.0-1)

6.5.3 Contaminated CWR System - Dose Calculation

If the CWR System becomes contaminated, releases via the CWR System to Lake Erie must be included in the evaluation of the cumulative dose to a MEMBER OF THE PUBLIC as required by ODCM 3.11.1.2. ODCM Section 6.4 described the methods for quantifying and controlling releases from the CWR System.

For calculating the dose to a MEMBER OF THE PUBLIC, Equation (6-10) remains applicable for releases from the GSW System with the following assumptions:

- DF, Dilution Flow, is set equal to the average CWR decant line flow rate over the release period.
- C_i, Radionuclide Concentration, is determined as specified in ODCM Section 6.4.
- VOL, Volume Released, is set equal to the total volume of the discharges to Lake Erie via the CWR decant line as specified in Section 6.4.

6.6 Liquid Effluent Dose Projections

10 CFR 50.36a requires licensees to maintain and operate the Radwaste System to ensure releases are maintained ALARA. This requirement is implemented through ODCM 3.11.1.3. This section requires that the Liquid Radioactive Waste Processing System be used to reduce the radioactive material levels in the liquid waste prior to release when the projected dose in any 31 day period would exceed:

- 0.06 mrem to the total body, or
- 0.2 mrem to any organ

When the projected doses exceed either of the above limits, the waste must be processed by the Liquid Radwaste System prior to release. This dose criteria for processing is established at one forty eighth of the design objective rate (3 mrem/yr, total body or 10 mrem/yr any organ) in any 31 day period.

The applicable Liquid Waste Processing System for maintaining radioactive material releases ALARA is the Ion Exchange System as delineated in Figure 6-1. Alternately, the Waste Evaporator (presented in the Fermi 2 UFSAR, Section 11.2) can be used to meet the NRC ALARA design requirements. It may be used in conjunction with or in lieu of the Ion Exchange System to meet the waste processing requirements of ODCM 3.11.1.3.

Each BATCH release of liquid radwaste is evaluated to ensure that cumulative doses are maintained ALARA. In keeping with the requirements of ODCM 3.11.1.3, dose projections are made at least once per 31 days to evaluate the need for additional radwaste processing to ensure future releases are maintained ALARA.

The following equations may be used for the dose projection calculation:

$$D_{tbp} = D_{tb} (31 / d) \tag{6-14}$$

$$D_{maxp} = D_{max} (31 / d) \tag{6-15}$$

where:

D_{tbp} = the total body dose projection for the next 31 day period (mrem)

NOTE: The reference calendar quarter is normally the current calendar quarter. If there have been liquid releases in the previous quarter but not in the current quarter, the previous quarter should be used as the reference calendar quarter.

D_{tb} = the cumulative total body dose for all releases to date in the reference calendar quarter (normally the current quarter) as determined by equation (6-10) or (6-12) (mrem)

D_{maxp} = the maximum organ dose projection for the next 31 day period (mrem)

D_{max} = the cumulative maximum organ dose for all releases to date in the reference calendar quarter as determined by Equation (6-10) or (6-13) (mrem)

d = the number of days from the beginning of the reference calendar quarter to the date of the dose projection evaluation.

31 = the number of days in projection

END OF SECTION 6.0

TABLE 6.0-1

Fermi 2 Site Specific Liquid Ingestion Dose Commitment Factors
A_{io} (mrem/hr per uCi/ml)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	7.94E-1	7.94E-1	7.94E-1	7.94E-1	7.94E-1	7.94E-1
C-14	3.13E+4	6.26E+3	6.26E+3	6.26E+3	6.26E+3	6.26E+3	6.26E+3
Na-24	4.16E+2	4.16E+2	4.16E+2	4.16E+2	4.16E+2	4.16E+2	4.16E+2
P-32	1.39E+6	8.62E+4	5.36E+4	-	-	-	1.56E+5
Cr-51	-	-	1.29E+0	7.70E-1	2.84E-1	1.71E+0	3.24E+2
Mn-54	-	4.40E+3	8.40E+2	-	1.31E+3	-	1.35E+4
Mn-56	-	1.11E+2	1.96E+1	-	1.41E+2	-	3.53E+3
Fe-55	6.73E+2	4.65E+2	1.08E+2	-	-	2.59E+2	2.67E+2
Fe-59	1.06E+3	2.50E+3	9.57E+2	-	-	6.98E+2	8.32E+3
Co-57	-	2.19E+1	3.64E+1	-	-	-	5.55E+2
Co-58	-	9.32E+1	2.09E+2	-	-	-	1.89E+3
Co-60	-	2.68E+2	5.90E+2	-	-	-	5.03E+3
Ni-63	3.18E+4	2.21E+3	1.07E+3	-	-	-	4.60E+2
Ni-65	1.29E+2	1.68E+1	7.66E+0	-	-	-	4.26E+2
Cu-64	-	1.04E+1	4.89E+0	-	2.63E+1	-	8.88E+2
Zn-65	2.32E+4	7.38E+4	3.34E+4	-	4.94E+4	-	4.65E+4
Zn-69	4.94E+1	9.44E+1	6.57E+0	-	6.14E+1	-	1.42E+1
Br-82	-	-	2.28E+3	-	-	-	2.62E+3
Br-83	-	-	4.06E+1	-	-	-	5.85E+1
Br-84	-	-	5.27E+1	-	-	-	4.13E-4
Br-85	-	-	2.16E+0	-	-	-	1.01E-15
Rb-86	-	1.01E+5	4.71E+4	-	-	-	1.99E+4
Rb-88	-	2.90E+2	1.54E+2	-	-	-	4.01E-9
Rb-89	-	1.92E+2	1.35E+2	-	-	-	1.12E-11
Sr-89	2.38E+4	-	6.83E+2	-	-	-	3.81E+3
Sr-90	5.85E+5	-	1.44E+5	-	-	-	1.69E+4
Sr-91	4.38E+2	-	1.77E+1	-	-	-	2.09E+3
Sr-92	1.66E+2	-	7.18E+0	-	-	-	3.29E+3
Y-90	6.28E-1	-	1.68E-2	-	-	-	6.66E+3
Y-91m	5.93E-3	-	2.30E-4	-	-	-	1.74E-2
Y-91	9.20E+0	-	2.46E-1	-	-	-	5.06E+3
Y-92	5.51E-2	-	1.61E-3	-	-	-	9.66E+2
Y-93	1.75E-1	-	4.83E-3	-	-	-	5.55E+3
Zr-95	4.04E-1	1.30E-1	8.78E-2	-	2.04E-1	-	4.11E+2
Zr-97	2.24E-2	4.51E-3	2.06E-3	-	6.81E-3	-	1.40E+3
Nb-95	4.47E+2	2.49E+2	1.34E+2	-	2.46E+2	-	1.51E+6
Nb-97	3.75E+0	9.48E-1	3.46E-1	-	1.11E+0	-	3.50E+3
Mo-99	-	1.26E+2	2.41E+1	-	2.86E+2	-	2.93E+2
Tc-99m	1.02E-2	2.88E-2	3.67E-1	-	4.38E-1	1.41E-2	1.71E+1
Tc-101	1.05E-2	1.51E-2	1.48E-1	-	2.72E-1	7.73E-3	4.54E-14

TABLE 6.0-1

Fermi 2 Site Specific Liquid Ingestion Dose Commitment Factors
A_{io} (mrem/hr per uCi/ml)

Nuclide	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	5.43E+0	-	2.34E+0	-	2.07E+1	-	6.34E+2
Ru-105	4.52E-1	-	1.78E-1	-	5.84E+0	-	2.76E+2
Ru-106	8.07E+1	-	1.02E+1	-	1.56E+2	-	5.22E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.75E+0	1.61E+0	9.59E-1	-	3.17E+0	-	6.59E+2
Sb-124	2.18E+1	4.13E-1	8.66E+0	5.29E-2	-	1.70E+1	6.20E+2
Sb-125	1.40E+1	1.56E-1	3.32E+0	1.42E-2	-	1.08E+1	1.54E+2
Te-125m	2.58E+3	9.35E+2	3.46E+2	7.76E+2	1.05E+4	-	1.03E+4
Te-127m	6.52E+3	2.33E+3	7.94E+2	1.67E+3	2.65E+4	-	2.19E+4
Te-127	1.06E+2	3.80E+1	2.29E+1	7.85E+1	4.31E+2	-	8.36E+3
Te-129m	1.11E+4	4.13E+3	1.75E+3	3.80E+3	4.62E+4	-	5.58E+4
Te-129	3.02E+1	1.14E+1	7.37E+0	2.32E+1	1.27E+2	-	2.28E+1
Te-131m	1.67E+3	8.15E+2	6.79E+2	1.29E+3	8.25E+3	-	8.09E+4
Te-131	1.90E+1	7.93E+0	5.99E+0	1.56E+1	8.31E+1	-	2.69E+0
Te-132	2.43E+3	1.57E+3	1.47E+3	1.73E+3	1.51E+4	-	7.42E+4
I-130	3.12E+1	9.21E+1	3.64E+1	7.81E+3	1.44E+2	-	7.93E+1
I-131	1.72E+2	2.46E+2	1.41E+2	8.06E+4	4.21E+2	-	6.49E+1
I-132	8.39E+0	2.24E+1	7.85E+0	7.85E+2	3.57E+1	-	4.21E+0
I-133	5.87E+1	1.02E+2	3.11E+1	1.50E+4	1.78E+2	-	9.17E+1
I-134	4.38E+0	1.19E+1	4.26E+0	2.06E+2	1.89E+1	-	1.04E-2
I-135	1.83E+1	4.79E+1	1.77E+1	3.16E+3	7.68E+1	-	5.41E+1
Cs-134	2.98E+5	7.09E+5	5.80E+5	-	2.30E+5	7.62E+4	1.24E+4
Cs-136	3.12E+4	1.23E+5	8.87E+4	-	6.85E+4	9.40E+3	1.40E+4
Cs-137	3.82E+5	5.22E+5	3.42E+5	-	1.77E+5	5.90E+4	1.01E+4
Cs-138	2.65E+2	5.22E+2	2.59E+2	-	3.84E+2	3.79E+1	2.23E-3
Ba-139	1.45E+0	1.04E-3	4.25E-2	-	9.68E-4	5.87E-4	2.58E+0
Ba-140	3.04E+2	3.82E-1	1.99E+1	-	1.30E-1	2.19E-1	6.26E+2
Ba-141	7.06E-1	5.33E-4	2.38E-2	-	4.96E-4	3.03E-4	3.33E-10
Ba-142	3.19E-1	3.28E-4	2.01E-2	-	2.77E-4	1.86E-4	4.49E-19
La-140	1.63E-1	8.22E-2	2.17E-2	-	-	-	6.04E+3
La-142	8.35E-3	3.80E-3	9.46E-4	-	-	-	2.77E+1
Ce-141	7.30E-2	4.94E-2	5.60E-3	-	2.29E-2	-	1.89E+2
Ce-143	1.29E-2	9.51E+0	1.05E-3	-	4.19E-3	-	3.56E+2
Ce-144	3.81E+0	1.59E+0	2.04E-1	-	9.44E-1	-	1.29E+3
Pr-143	6.00E-1	2.41E-1	2.98E-2	-	1.39E-1	-	2.63E+3
Pr-144	1.96E-3	8.16E-4	9.98E-5	-	4.60E-4	-	2.83E-10
Nd-147	4.10E-1	4.74E-1	2.84E-2	-	2.77E-1	-	2.28E+3
W-187	2.96E+2	2.48E+2	8.66E-1	-	-	-	8.12E+4
Np-239	3.49E-2	3.43E-3	1.89E-3	-	1.07E-2	-	7.04E+2

TABLE 6.0-2

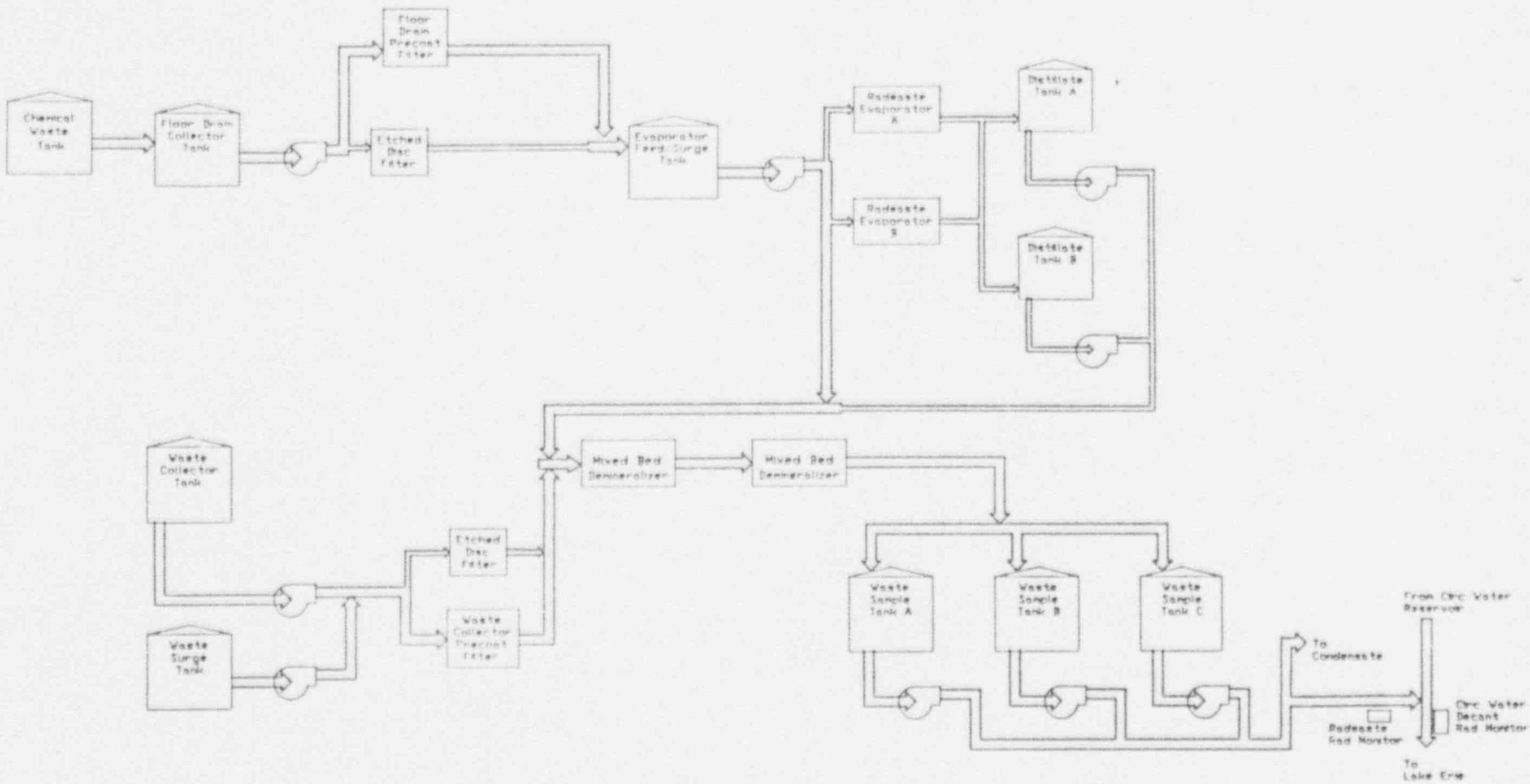
Bioaccumulation Factors (BFi)
(pCi/kg per pCi/liter)*

Element	Freshwater Fish
H	9.0E-01
C	4.6E+03
Na	1.0E+02
P	3.0E+03
Cr	2.0E+02
Mn	4.0E+02
Fe	1.0E+02
Co	5.0E+01
Ni	1.0E+02
Cu	5.0E+01
Zn	2.0E+03
Br	4.2E+02
Rb	2.0E+03
Sr	3.0E+01
Y	2.5E+01
Zr	3.3E+00
Nb	3.0E+04
Mo	1.0E+01
Tc	1.5E+01
Ru	1.0E+01
Rh	1.0E+01
Ag	2.3E+00
Sb	1.0E+00
Te	4.0E+02
I	1.5E+01
Cs	2.0E+03
Ba	4.0E+00
La	2.5E+01
Ce	1.0E+00
Pr	2.5E+01
Nd	2.5E+01
W	1.2E+03
Np	1.0E+01

* Values in this table are taken from Regulatory Guide 1.109 except for phosphorus, which is adapted from NUREG/CR-1336, and silver and antimony, which are taken from UCRL 50564, Rev 1, October 1972.

FIGURE 6.0-1

Liquid Radioactive Effluent Monitoring and Processing Diagram



END

7.0 GASEOUS EFFLUENTS

7.1 Radiation Monitoring Instrumentation and Controls

7.1.1 Effluent Monitoring - Ventilation System Releases

The gaseous effluent monitoring instrumentation required at Fermi 2 for controlling and monitoring radioactive effluents are specified in ODCM 3.3.7.12. The monitoring of each identified gaseous effluent release point must include the following:

- Noble Gas Activity Monitor
- Iodine Sampler (sample cartridge containing charcoal or silver zeolite)
- Particulate Sampler (filter paper)
- Sampler Flow Rate Monitor

Meeting these requirements, a total of seven Eberline SPING Monitoring Systems are installed on the six gaseous release points (Onsite Storage Facility, Service Building, Radwaste Building, Turbine Building, Reactor Building Exhaust Plenum, and Standby Gas Treatment System Division 1 and Division 2). The SPING Monitor outputs are recorded electronically in the CT-2B Control Terminal in the Main Control Room.

In general, a reading exceeding the High alarm setpoint of the SPING Monitors causes an alarm in the Control Room. Fermi 2 ODCM Table 3.3.7.12-1 identifies only the alarm function of the Reactor Building Exhaust Plenum Effluent Monitor, the Standby Gas Treatment System Monitors, and the Onsite Storage Facility.

7.1.2 Main Condenser Offgas Monitoring

ODCM Table 3.3.7.12-1 and Technical Specification Table 3.3.7.12-1 specify monitoring requirements for the Offgas System at the 2.2 minute delay line. The following monitors are required:

- Hydrogen Monitc - used to ensure the hydrogen concentration in the Offgas Treatment System is maintained less than 4% by volume as required by Technical Specification 3.11.2.6.
- Noble Gas Activity Monitor - used to ensure the gross activity release rate is maintained within 340 millicuries per second after 30 minute decay as required by Technical Specification 3.11.2.7.

These two monitors perform safety functions. The Hydrogen Monitor monitors the potential explosive mixtures in the Offgas System. The Noble Gas Monitor monitors the release rate from the main condenser ensuring doses at the exclusion area boundary will not exceed a small fraction of the limits of 10 CFR 100 in the event this effluent is inadvertently discharged directly to the environment bypassing the Offgas Treatment System.

7.1.3 Reactor Building Ventilation Monitors (Gulf Atomic)

The Gulf Atomic Monitors (D11-N408 and 410) on the Reactor Building Ventilation System provide on high radiation levels (above alarm setpoint) initiation of SGTS, isolation of drywell vent/purge, isolation of the RB and Control Center Ventilation Systems and initiation of Control Center recirculation mode ventilation. These monitors and functions are not required by Fermi 2 ODCM but are important in controlling containment venting/purging.

7.2 Sampling and Analysis of Gaseous Effluents

The program for sampling and analysis of gaseous waste is prescribed in Fermi 2 ODCM Table 4.11.2.1.2-1. This table distinguishes two types of gaseous releases: (1) containment PURGE, treated as BATCH releases, and (2) discharges from the Reactor Building Exhaust Plenum (including Standby Gas Treatment System (SGTS) when operating), and other building ventilation exhausts, treated as CONTINUOUS releases.

7.2.1 Containment PURGE

ODCM Table 4.11.2.1.2-1 requires that a grab sample be collected and analyzed before each containment drywell PURGE. Sampling and analysis are required within eight hours before starting a PURGE.
ODCM Table 4.11.2.1.2-1 Footnote i and ODCM 4.11.2.8.3 also require that if the PURGING or VENTING is through the Reactor Building Vent, rather than through SGTS, additional sample and analyses are required every twelve hours throughout the release period. Analysis must include principal gamma emitters and tritium prior to venting and purging.

For a planned containment PURGE, the results of the sample and analysis are used to establish the acceptable release rate and radiation monitor alarm setpoint in accordance with ODCM Section 7.3. This evaluation is necessary to ensure compliance with the dose rate limits of ODCM 3.11.2.1. The periodic samples collected throughout the PURGE/VENT period are used to ensure that release conditions over an extended period are maintained within ODCM limits.

7.2.2 Ventilation System Releases

ODCM Table 4.11.2.1.2-1 requires continuous samples of releases from the RB Exhaust Plenum, Standby Gas Treatment System, Radwaste Building, Turbine Building, Service Building, and Onsite Storage Facility. The table specifies the following program:

- Once per week, analysis of an adsorbent sample of I-131 and I-133, plus analysis of a particulate sample for principal gamma emitters.

- Once per month, analysis of a composite particulate sample of all releases (by release point) that month for gross alpha activity.

- Once per quarter, analysis of a composite particulate sample of all releases that quarter for Sr-89 and Sr-90.

- Once per month, analysis of a grab sample for principal gamma emitters (noble gases and tritium).

ODCM Table 4.11.2.1.2-1 also requires continuous monitoring for noble gases. This requirement is met by the SPING Monitors on each of the plant gaseous release points.

The ODCM requires more frequent sampling and analysis following reactor startup, shutdown, or change in thermal power exceeding 15% within one hour. The ODCM allows exceptions to this increased sampling schedule provided that neither one of the following conditions exist:

- Primary coolant dose equivalent I-131 has increased more than a factor of three.

- Reactor Building SPING noble gas monitor has increased more than a factor of three.

Grab samples of the Fuel Pool Ventilation Exhaust are required tritium analysis once per seven days whenever spent fuel is in the Spent Fuel Pool. Also, grab samples for tritium are required when either the reactor well or the dryer separator pool is filled. These samples are taken at the Reactor Building Exhaust Plenum and Standby Gas Treatment System (SGTS) when operating.

7.3 Gaseous Effluent Monitor Setpoint Determination

7.3.1 Ventilation System Monitors

Per the requirements of ODCM 3.3.7.12, alarm setpoints shall be established for the gaseous effluent monitoring instrumentation to ensure that the release rate of noble gases does not exceed the limits of ODCM 3.11.2.1. This section limits releases to a dose rate at the SITE BOUNDARY of 500 mrem/year to the total body or 3000 mrem/year to the skin. From a grab sample analysis of the applicable release (i.e., grab sample of the Drywell or Ventilation System release), the radiation monitoring alarm setpoints may be established by the following calculational method. The measured radionuclide concentrations and release rate are used to calculate the fraction of the allowable release rate, limited by ODCM 3.11.2.1, by the equation:

$$FRAC = \frac{1.67\ E+01 * X/Q * VF * \sum (C_i * K_i)}{500} \qquad (7\text{-}1)$$

$$FRAC = \frac{1.67\ E+01 * X/Q * VF * \sum (C_i * [L_i + 1.1\ M_i])}{3000} \qquad (7\text{-}2)$$

Where:

FRAC = fraction of the allowable release rate based on the identified radionuclide concentrations and the release flow rate

X/Q = annual average meterological dispersion to the controlling site boundary location from Table 7.0-3 (sec/m^3) or plant procedures

VF = Ventilation System flow rate for the applicable release point and monitor (liters/minute)

C_i = concentration of noble gas radionuclide i at release point as determined by gamma spectral analysis of grab sample (uCi/cc) (If a noble gas is not detected at the reactor building release point, its concentration at this release point may be calculated by applying a dilution factor to its concentration in an Offgas Vent Pipe sample.)

K_i = total body dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 7.0-2)

L_i = beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 7.0-2)

M_i = gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per uCi/m^3, from Table 7.0-2)

1.1 = mrem skin dose per mrad gamma air dose (mrem/mrad)

500 = total body dose rate limit (mrem/yr)

3000 = skin dose rate limit (mrem/yr)

1.67 E + 01 = 1 E + 03 (cc/liter) * (1/60) (min/sec)

Based on the more limiting (i.e., higher) value of FRAC as determined above, the alarm setpoints for the applicable monitors may be calculated by the equation:

$$SP \leq \frac{(AF \times C_t)}{FRAC} + Bkg \qquad (7\text{-}3)$$

Where:

SP = alarm setpoint corresponding to the maximum allowable release rate (uCi/cc)

Bkg = background of the monitor (uCi/cc)

AF = administrative allocation factor (Table 7.0-1) for the specific monitor and type release, which corresponds to the fraction of the total allowable release rate that is administratively allocated to the individual release points.

C_i = concentration of Noble Gas Radionuclide i as determined by gamma spectral analysis of grab sample (uCi/cc) (If a noble gas is not detected at the reactor building release point, its concentration at this release point may be calculated by applying a dilution factor to its concentration in an Offgas Vent Pipe sample.) Note: If the monitor channel in question was showing a response to the effluent at the time of the grab sample, this response minus background may be used in lieu of the summed grab sample concentrations.

The Allocation Factor (AF) is an administrative control imposed to ensure that combined releases from all release points at Fermi 2 will not exceed the regulatory limits on release rate from the site (i.e., the release rate limits of ODCM 3.11.2.1). From the Fermi 2 design evaluation of gaseous effluents presented in the UFSAR Section 11.3, representative values have been determined for AF. These values are presented in Table 7.0-1. These values may be changed in the future as warranted by operational experience, provided the site releases comply with ODCM 3.11.2.1. In addition to the allocation factor, safety factors which have the effect of lowering the calculated setpoints may be applied. When determining the Noble Gas Monitor calibration constant, the monitor sensitivity for Xe-133 may be used in lieu of the sensitivity values for the individual radionuclides. Because of its lower gamma energy and corresponding monitor response, the Xe-133 sensitivity provides a conservative value for alarm setpoint determination. Alternatively, if the monitor channel in question frequently shows a response to a mix of isotopes whose concentrations can be determined, the calibration constant may be determined from this type of data without reference to primary calibration data.

7.3.2 Setpoint Determination with No Nuclides Detected

When noble gas concentrations for a release point cannot be determined from grab samples, there are two options for setpoint determination. First, the setpoint may be set slightly above monitor background (e.g. 2 to 3 times background). This approach may be used when releases are not expected from a particular release point. Second, the equations of Section 7.3.1 may be used with noble gas concentration values based either on UFSAR tables or on values from a release point for which concentrations have been determined (e.g. reactor building exhaust plenum). When this method is used, a safety factor should be used in the setpoint calculation.

7.3.3 Gaseous Effluent Alarm Response - Evaluating Actual Release Conditions

The monitor alarm setpoint is used as the primary method for ensuring and demonstrating compliance with the release rate limits of ODCM 3.11.2.1. Not exceeding alarm setpoints constitutes a demonstration that release rates have been maintained within the ODCM limits. When an effluent Noble Gas Monitor exceeds the alarm setpoint, an evaluation of compliance with the release rate limits must be performed using actual release conditions. This evaluation requires collecting a sample of the effluent to establish actual radionuclide concentrations and permit evaluating the monitor response. The following equations may be used for evaluating compliance with the release rate limit of ODCM 3.11.2.1a:

$$D_{tb} = 1.67\ E + 01 * X/Q * VF * \sum(K_i * C_i) \tag{7-4}$$

$$D_s = 1.67\ E + 01 * X/Q * VF * \sum([L_i + 1.1\ M_i] * C_i) \tag{7-5}$$

Where:

D_{tb}	=	total body dose rate (mrem/yr)
D_s	=	skin dose rate (mrem/yr)
X/Q	=	atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m^3)
VF	=	Ventilation System release rate (liters/min)
C_i	=	concentration of radionuclide i as measured in the grab sample or as correlated from the SPING Noble Gas Monitor reading (uCi/cc)
K_i	=	total body dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 7.0-2)
L_i	=	beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 7.0-2)
M_i	=	gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per uCi/m^3, from Table 7.0-2)
1.1	=	mrem skin dose per mrad gamma air dose (mrem/mrad)
1.67 E + 01	=	1 E + 03 (cc/liter) * (1/60) (min/sec)

7.4 Containment Drywell VENTING and PURGING

7.4.1 Release Rate Evaluation

For drywell VENTING or PURGING, an evaluation of acceptable release rate should be performed prior to the release. Based on the measured noble gas concentration in the grab sample collected per the requirements of ODCM Table 4.11.2.1.2-1, the allowable release rate can be calculated by the following equation:

$$RR_{tb} = \frac{500 * AF}{1.67\ E + 01 * X/Q * \sum(K_i * C_i)} \tag{7-6}$$

or

$$RR_s = \frac{3000 * AF}{1.67\ E + 01 * X/Q * \sum([L_i + 1.1\ M_i] * C_i)} \tag{7-7}$$

Where:

RR_{tb} = allowable release rate so as not to exceed a dose rate of 500 mrem/yr, total body (liters/minute)

RR_s = allowable release rate so as not to exceed a dose rate of 3000 mrem/yr, skin (liters/minute)

AF = allocation factor for the applicable release point from Table 7.0-1 (default value is 0.5 for Reactor Building Exhaust Plenum)

500 = total body dose rate limit (mrem/yr)

3000 = skin dose rate limit (mrem/yr)

The lesser value (RR_{tb} or RR_s) as calculated above should be used for establishing the allowable release rate for the drywell PURGING or VENTING.

7.4.2 Alarm Setpoint Evaluation

For a containment drywell VENTING or PURGING, a re-evaluation of the alarm setpoint is needed to ensure compliance with the requirements of ODCM 3.3.7.12. For the identified release path (RB Exhaust Plenum or SGTS) and associated effluent Radiation Monitor, the alarm setpoint should be calculated using Equations (7-1), (7-2) and (7-3). In Equations (7-1) and (7-2), the value of the Ventilation Flow VF should be established at the total release flow rate, including the contribution from the PURGE or VENT. If the calculated alarm setpoint is greater than the current setpoint, no adjustments are necessary.

7.5 Quantifying Releases - Noble Gases

The determination of doses in the environment from releases is dependent on the mixture of the radioactive material. Also, NRC Regulatory Guide 1.21 requires reporting of individual radionuclides released in gaseous effluents. Therefore, Detroit Edison must determine the quantities of the individual radionuclides released. For noble gases, these quantities must be based on actual noble gas grab samples.

7.5.1 Sampling Protocol

As required by ODCM 3.11.2.1, a gas sample is collected at least monthly from each of the six gaseous release points (Reactor Building Exhaust Plenum, Standby Gas Treatment System, Radwaste Building, Turbine Building, Onsite Storage Facility, and Service Building). As discussed in ODCM Section 7.2.2, this gas sample is analyzed by gamma spectroscopy to identify individual radionuclides (noble gases). To date (May 1992) noble gases have been detected only in the reactor building effluent.

In addition to these monthly samples from each release point, noble gas grab samples from the Offgas Vent Pipe may be collected using the sample lines of the abandoned Offgas Vent Pipe Monitor (D11-N105 and D11-N106). Since noble gases are more concentrated at this point than at the Reactor Building Exhaust Plenum, a greater number of noble gases are detected at this point. Sampling should be performed monthly at the Offgas Vent Pipe unless the reactor is shut down or noble gas concentrations increase sufficiently to allow detection of all significant noble gas nuclides at the Reactor Building Exhaust Plenum.

For Containment PURGE/VENT, samples are collected prior to the initiation of the release and periodically throughout the release (see ODCM Section 7.2.1). These samples are evaluated using Equations (7-4) and (7-5) to ensure that the site boundary dose rate limits of ODCM 3.11.2.1 are not exceeded. For an extended PURGE/VENT period (e.g., longer than 48 hours), drywell airborne activity levels will equilibrate. After equilibrium is reached, the quantification of the PURGE/VENT can be adequately addressed by the periodic (typically weekly) sample and analysis of the Reactor Building Exhaust Plenum or Standby Gas Treatment System.

As required by ODCM Table 4.11.2.1.2-1, special samples are required of the RB Exhaust Plenum and SGTS following shutdown, startup or a THERMAL POWER change exceeding 15% within a 1 hour period. Exceptions to this special sampling are allowed as noted previously in ODCM Section 7.2.2.

7.5.2 Release Concentration Determination for Reactor Building Exhaust Plenum

In cases where both a RB Exhaust Plenum noble gas sample and an Offgas Vent Pipe (OGVP) sample have been taken, the RB Exhaust Plenum noble gas concentrations are determined as follows: First, the RB SPING channel 1-5 readings (above background) at the times the two samples were taken are compared, and the noble gas concentrations for the sample taken at the lower RB SPING channel 1-5 reading are normalized to the higher RB SPING channel 1-5 reading. Second, a dilution factor relating OGVP concentrations to RB Exhaust Plenum concentrations is calculated by dividing the RB Exhaust Plenum flow rate (nominally 9.43 E4 cfm) by the OGVP flow rate as indicated in the control room (N62-R808, blue pen). Third, the OGVP noble gas concentrations are divided by this dilution factor. Fourth, the diluted OGVP noble gas concentrations are compared to the RB Exhaust Plenum noble gas concentrations, and the higher of the the two concentration values for each nuclide is taken to be the RB Exhaust Plenum concentration for that nuclide. (For purposes of calculation, the concentrations of nuclides which are not detected are taken to be zero.) Fifth, the resulting RB Exhaust Plenum concentrations are corrected for variations during the release period by multiplying each concentration value by the average RB SPING channel 1-5 reading (above background) for the

period divided by the higher of the two RB SPING channel 1-5 sample readings (above background) at time the samples were taken. These corrected values are then used as C_i in Equation (7-8) to determine the quantity of noble gases released.

7.5.3 Calculation of Activity Released

The following equation may be used for determining the release quantities from any release point based on the grab sample analysis:

$$Q_i = 1.0\ E + 03 * VF * T * C_i \qquad (7\text{-}8)$$

Where:

Q_i = total activity released of radionuclide i (uCi)

VF = Ventilation System release rate (liters/min)

T = total time of release period (min)

1.0 E + 03 = milliliters per liter

C_i = concentration of radionuclide i as determined by gamma spectral analysis of grab sample (uCi/cc) corrected for variations during release period as described in Section 7.5.2

7.6 Site Boundary Dose Rate - Radioiodine and Particulates

ODCM 3.11.2.1.b limits the dose rate to $\leq$ 1500 mrem/yr to any organ for I-131, I-133, tritium and particulates with half-lives greater than 8 days. To demonstrate compliance with this limit, an evaluation is performed at a frequency no greater than that corresponding to the sampling and analysis time period (nominally once per 7 days). The following equation may be used for the dose rate evaluation:

$$D_o = X/Q * R_{I-131} * \sum Q_i \qquad (7\text{-}9)$$

Where:

D_o = average organ dose rate over the sampling time period (mrem/yr)

X/Q = atmospheric dispersion to the controlling SITE BOUNDARY location for the inhalation pathway (sec/m^3) from Table 7-3 or plant procedures

R_{I-131} = I-131 dose parameter (mrem/yr per uCi/m^3) for the child inhalation pathway from Table 7-4

$\sum Q_i$ = total average release rate over the appropriate sampling period and analysis frequency for I-131, I-133, tritium and other radionuclides in particulate form with half lives greater than 8 days (uCi/sec)

$$Q_i = C_i * VF * 1.67E + 01$$

Where:

VF = Average ventilation flow for release point (liters/min)

C_i = Concentration of radionuclide i (uCi/cc)--usually determined by gamma spectral analysis of effluent sample

1.67E + 01 = 1E + 03 (cc/liter) * (1 min/ 60 sec)

Alternatively, the site boundary dose rate may be evaluated using the highest individual isotopic dose factors for all age groups to calculate inhalation and ground plane exposure at the highest dispersion factor location at or beyond the site boundary, as well as vegetation and milk exposure at the garden and milk locations with the highest deposition factors.

7.7 Noble Gas Effluent Dose Calculations - 10 CFR 50

7.7.1 UNRESTRICTED AREA Dose - Noble Gases

ODCM 3.11.2.2 requires a periodic assessment of releases of noble gases to evaluate compliance with the quarterly dose limits of 5 mrad, gamma-air and 10 mrad, beta-air and the calendar year limits 10 mrad, gamma-air and 20 mrad, beta-air. The following equations may be used to calculate the gamma-air and beta-air doses:

$$D_{\gamma} = 3.17E-08 * X/Q * \sum (M_i * Q_i) \tag{7-10}$$

and

$$D_{\beta} = 3.17E-08 * X/Q * \sum (N_i * Q_i) \tag{7-11}$$

Where:

D_{γ} = air dose due to gamma emissions for noble gas radionuclides (mrad)

D_{β} = air dose due to beta emissions for noble gas radionuclides (mrad)

X/Q = atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m^3)

Q_i = cumulative release of noble gas radionuclide i over the period of interest (uCi)

M_i = air dose factor due to gamma emissions from noble gas radionuclide i (mrad/yr per uCi/m^3, from Table 7.0-2)

N_i = air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per uCi/m^3, Table 7.0-2)

3.17 E - 08 = 1/3.15 E + 07 (year/sec)

7.7.2 Simplified Dose Calculation for Noble Gases

In lieu of the individual noble gas radionuclide dose assessment presented above, the following simplified dose calculational equations may be used for verifying compliance with the dose limits of ODCM 3.11.2.2. (Refer to Appendix B for the derivation and justification of this simplified method.)

$$D_\gamma = 2.0 * 3.17 E - 08 * X/Q * M_{eff} * \sum Q_i \quad (7\text{-}12)$$

and

$$D_\beta = 2.0 * 3.17 E - 08 * X/Q * N_{eff} * \sum Q_i \quad (7\text{-}13)$$

Where:

M_{eff} = 2.7 E + 03, effective gamma-air dose factor (mrad/yr per uCi/m^3)

N_{eff} = 2.3 E + 03, effective beta-air dose factor (mrad/yr per uCi/m^3)

2.0 = conservatism factor to account for potential variability in the radionuclide distribution

7.8 Radioiodine and Particulate Dose Calculations - 10 CFR 50

7.8.1 UNRESTRICTED AREA Dose - Radioiodine and Particulates

In accordance with requirements of ODCM 3.11.2.3, a periodic assessment is required to evaluate compliance with the quarterly dose limit of 7.5 mrem and the calendar year limit of 15 mrem to any organ. The following equation may be used to evaluate the maximum organ dose due to releases of I-131, tritium and particulates with half-lives greater than 8 days:

$$D_{aop} = 3.17 E - 08 * W * SF_p * \sum (R_i * Q_i) \quad (7\text{-}14)$$

Where:

D_{aop} = dose or dose commitment via controlling Pathway p and Age Group a (as identified in Table 7.0-3) to Organ o, including the total body (mrem)

W = atmospheric dispersion parameter to the controlling location(s) as identified in Table 7.0-3 or plant procedures:

W = X/Q, atmospheric dispersion for inhalation pathway and H-3 and C-14 dose contribution via other pathways (sec/m^3)

W = D/Q, atmospheric deposition for vegetation, milk and ground plane exposure pathways (m^{-2})

Where:

R_i = dose factor for radionuclide i, ($mrem/yr$ per uCi/m^3) or (m^2 - mrem/yr per uCi/sec) from Table 7.0-4 for each Age Group (a) and the applicable Pathway (p) as identified in Table 7.0-3 or plant procedures. Values for R_i were derived in accordance with the methods described in NUREG-0133. As noted in NUREG-0133 section 5.3.1.3, in the case that the milk animal is a goat, parameter values from Reg Guide 1.109 should be used. For I-131, for example, use of the goat feed/forage consumption rate given in Table E-3 and the stable element transfer factor given in Table E-2 of Reg Guide 1.109 results in grass-goat-milk dose factors which are equivalent to the grass-cow-milk dose factors in Table 7.0-4 multiplied by 1.2.

Q_i = cumulative release over the period of interest for radionuclide i -- I-131, I-133, tritium or radioactive material in particulate form with half-life greater than 8 days (uCi)

SF_p = annual seasonal correction factor to account for the fraction of the year that the applicable exposure pathway does not exist:

1) For milk and vegetation exposure pathways:

= A six month fresh vegetation and grazing season (May through October) limits exposure through this pathway to half the year

= 0.5 (derived from Reg Guide 1.109, Rev 1)

2) For inhalation and ground plane exposure pathways:

= 1.0 (derived from Reg Guide 1.109, Rev 1)

3.17 E - 08 = 1/3.15 E + 07 (year/sec)

The age group with the highest potential dose via the controlling pathway should be used for evaluating the maximum exposed individual. This determination is based on a comparison of the age group pathway dose conversion factors (Table 7-4). The infant age group is controlling for the milk pathway and the child age group is controlling for the vegetable pathway. Only the controlling age group and pathway identified in Table 7.0-3 need be evaluated for compliance with ODCM 3.11.2.3

7.8.2 Simplified Dose Calculation for Radioiodines and Particulates

In lieu of the individual radionuclide (I-131 and particulates) dose assessment presented above, the following simplified dose calculation may be used for verifying compliance with the dose limits of ODCM 3.11.2.3.

$$D_{max} = 3.17\ E - 08 * W * SF_p * R_{I-131} * \sum Q_i \qquad (7-15)$$

Where:

D_{max} = maximum organ dose (mrem)

R_{I-131} = I-131 dose parameter for the thyroid for the identified controlling pathway

= 4.76 E + 10, child thyroid dose parameter for the vegetable pathway (m^2 - mrem/yr per uCi/sec)

The ground plane exposure and inhalation pathways need not be considered when the above simplified calculational method is used because of the overall negligible contribution of these pathways to the total thyroid dose. It is recognized that for some particulate radionuclides (e.g., Co-60 and Cs-137), the ground exposure pathway may represent a higher dose contribution than either the vegetation or milk pathway. However, use of the I-131 thyroid dose parameter for all radionuclides will maximize the organ dose calculation, especially considering that no other radionuclide has a higher dose parameter for any organ via any pathway than I-131 for the thyroid via the vegetable or milk pathway.

The location of exposure pathways (critical receptors) and the corresponding maximum organ dose calculation should be based on the pathways identified by the annual land-use census (ODCM 3.12.2). Otherwise, the dose should be evaluated based on the predetermined controlling pathways identified in Table 7.0-3.

7.9 Gaseous Effluent Dose Projection

As with liquid effluents, the Fermi 2 ODCM controls on gaseous effluents require "processing" of gaseous effluents if the projected dose exceeds specified limits. These controls implement the requirements of 10 CFR 50.36a on maintaining and using the appropriate radwaste processing equipment to keep releases ALARA.

ODCM 3.11.2.5 requires that the VENTILATION EXHAUST TREATMENT SYSTEM be used to reduce radioactive material levels prior to discharge when the projected dose exceeds 0.3 mrem to any organ in any 31 day period (i.e., one-quarter of the design objective rate). Figure 7.0-1 presents the gaseous effluent release points and the VENTILATION EXHAUST TREATMENT SYSTEMS applicable for reducing effluents prior to release.

Dose projection is performed at least once per 31 days using the following equation:

$$D_{maxp} = D_{max} * (31 / d) \tag{7-16}$$

Where:

D_{maxp} = maximum organ dose projection for the next 31 day period (mrem)

NOTE: The reference calendar quarter is normally the current calendar quarter. If the dose projection is done in the first month of the quarter and is to be based on dose calculated for the previous quarter, the reference calendar quarter is the previous quarter.

D_{max} = the cumulative maximum organ dose from the beginning of the reference calendar quarter (normally the current quarter) to the end of the most recently evaluated release period as determined by Equation (7-14) or (7-15) (mrem)

d = number of days from the beginning of the reference calendar quarter to the end of the most recently evaluated release period.

31 = number of days in projection

END OF SECTION 7.0

TABLE 7.0-1

Values for Evaluating Gaseous
Release Rates and Alarm Setpoints

Release Point	Flow Rate* (liter/min)	Allocation Factor (AF)	Allocated Dose Rate Limit (mrem/year)
Reactor Building Exhaust Plenum D11-P280	2.67E6	0.50	T Body = 250 Skin = 1500 Organ = 750
Standby Gas Treatment System Div I D11-P275	1.07E5	0.10	T Body = 50 Skin = 300 Organ = 150
Standby Gas Treatment System Div II D11-P276	1.12E5	0.10	T Body = 50 Skin = 300 Organ = 150
Turbine Building Ventilation D11-P279	8.67E6	0.20	T Body = 100 Skin = 600 Organ = 300
Service Building Ventilation D11-P282	9.06E5	0.01	T Body = 5 Skin = 30 Organ = 15
Radwaste Building Ventilation D11-P281	1.13E6	0.02	T Body = 10 Skin = 60 Organ = 30
Onsite Storage Building Ventilation D11-P281	3.06E5	0.02	T Body = 10 Skin = 60 Organ = 30
Reactor Building Ventilation** Gulf Atomic Monitors D11-N408, N410	2.57E6	0.50	T Body = 125 Skin = 750

* Ventilation flow rate values are subject to change due to plant modifications and changing plant conditions, therefore updated values in plant procedures may be used.

** D11-N408 and N410 will start the SGTS, close the Drywell Purge/Vent Valves, isolate Rx Building Ventilation System, isolate Control Center, and initiate emergency recirculation mode.

TABLE 7.0-2

Dose Factors for Noble Gases*

Nuclide	Total Body Gamma Dose Factor Ki (mrem/yr per uCi/m^3)	Skin Beta Dose Factor Li (mrem/yr per uCi/m^3)	Gamma Air Dose Factor Mi (mrad/yr per uCi/m^3)	Beta Air Dose Factor Ni (mrad/yr per uCi/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

NOTE:

* Dose factors taken from NRC Regulatory Guide 1.109

TABLE 7.0-3

Controlling Locations, Pathways, and Atmospheric Dispersion for Dose Calculations*

ODCM Control	Location	Pathway(s)	Controlling Age Group	Atmospheric Dispersion Factor X/Q (sec/m^3)	Atmospheric Dispersion Factor D/Q (1/m^2)
3.11.2.1a	site boundary (0.57 mi, NW)	noble gases direct exposure	N/A	RB: 2.40E-6 TB: 1.14E-5 RW: 5.32E-6	N/A
3.11.2.1b	site boundary (0.57 mi, NW)	inhalation	child	RB: 2.40E-6 TB: 1.14E-5 RW: 5.32E-6	N/A
3.11.2.2	site boundary (0.57 mi, NW)	gamma-air beta-air	N/A	RB: 2.40E-6 TB: 1.14E-5 RW: 5.32E-6	N/A
3.11.2.3	residence (2.06 mi, WNW)	milk, inhalation, and ground plane	infant	RB: 2.82E-7 TB: 6.78E-7 RW: 4.04E-7	2.40E-9 3.86E-9 2.60E-9

NOTE:

* The identified controlling locations and pathways are derived from land use census data and dispersion factor data tables. The dispersion factor values listed are conservative values; they represent the highest annual average values seen between 1984 and 1991. When performing dose and dose rate evaluations for plant surveillances, the dispersion factor values and location and pathway information found in plant procedures should be used. This data in plant procedures should be the same as the above data unless recent information has shown the above data to be non-conservative or inaccurate. When performing annual dose evaluation for the Semiannual Effluent Release Report, the annual average dispersion factors for the year being evaluated should be used.

Table 7.0-4

Gaseous Effluent Pathway Dose Commitment Factors
R_{io}, Inhalation Pathway Dose Factors - ADULT

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3
C-14	1.82E+4	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3
Na-24	1.02E+4	1.02E+4	1.02E+4	1.02E+4	1.02E+4	1.02E+4	1.02E+4
P-32	1.32E+6	7.71E+4	-	-	-	8.64E+4	5.01E+4
Cr-51	-	-	5.95E+1	2.28E+1	1.44E+4	3.32E+3	1.00E+2
Mn-54	-	3.96E+4	-	9.84E+3	1.40E+6	7.74E+4	6.30E+3
Mn-56	-	1.24E+0	-	1.30E+0	9.44E+3	2.02E+4	1.83E-1
Fe-55	2.46E+4	1.70E+4	-	-	7.21E+4	6.03E+3	3.94E+3
Fe-59	1.18E+4	2.78E+4	-	-	1.02E+6	1.88E+5	1.06E+4
Co-57	-	6.92E+2	-	-	3.70E+5	3.14E+4	6.71E+2
Co-58	-	1.58E+3	-	-	9.28E+5	1.06E+5	2.07E+3
Co-60	-	1.15E+4	-	-	5.97E+6	2.85E+5	1.48E+4
Ni-63	4.32E+5	3.14E+4	-	-	1.78E+5	1.34E+4	1.45E+4
Ni-65	1.54E+0	2.10E-1	-	-	5.60E+3	1.23E+4	9.12E-2
Cu-64	-	1.46E+0	-	4.62E+0	6.78E+3	4.90E+4	6.15E-1
Zn-65	3.24E+4	1.03E+5	-	6.90E+4	8.64E+5	5.34E+4	4.66E+4
Zn-69	3.38E-2	6.51E-2	-	4.22E-2	9.20E+2	1.63E+1	4.52E-3
Br-82	-	-	-	-	-	1.04E+4	1.35E+4
Br-83	-	-	-	-	-	2.32E+2	2.41E+2
Br-84	-	-	-	-	-	1.64E-3	3.13E+2
Br-85	-	-	-	-	-	-	1.28E+1
Rb-86	-	1.35E+5	-	-	-	1.66E+4	5.90E+4
Rb-88	-	3.87E+2	-	-	-	3.34E-9	1.93E+2
Rb-89	-	2.56E+2	-	-	-	-	1.70E+2
Sr-89	3.04E+5	-	-	-	1.40E+6	3.50E+5	8.72E+3
Sr-90	9.92E+7	-	-	-	9.60E+6	7.22E+5	6.10E+6
Sr-91	6.19E+1	-	-	-	3.65E+4	1.91E+5	2.50E+0
Sr-92	6.74E+0	-	-	-	1.65E+4	4.30E+4	2.91E-1
Y-90	2.09E+3	-	-	-	1.70E+5	5.06E+5	5.61E+1
Y-91m	2.61E-1	-	-	-	1.92E+3	1.33E+0	1.02E-2
Y-91	4.62E+5	-	-	-	1.70E+6	3.85E+5	1.24E+4
Y-92	1.03E+1	-	-	-	1.57E+4	7.35E+4	3.02E-1
Y-93	9.44E+1	-	-	-	4.85E+4	4.22E+5	2.61E+0
Zr-95	1.07E+5	3.44E+4	-	5.42E+4	1.77E+6	1.50E+5	2.33E+4
Zr-97	9.68E+1	1.96E+1	-	2.97E+1	7.87E+4	5.23E+5	9.04E+0
Nb-95	1.41E+4	7.82E+3	-	7.74E+3	5.05E+5	1.04E+5	4.21E+3
Nb-97	2.22E-1	5.62E-2	-	6.54E-2	2.40E+3	2.42E+2	2.05E-2
Mo-99	-	1.21E+2	-	2.91E+2	9.12E+4	2.48E+5	2.30E+1
Tc-99m	1.03E-3	2.91E-3	-	4.42E-2	7.64E+2	4.16E+3	3.70E-2
Tc-101	4.18E-5	6.02E-5	-	1.08E-3	3.99E+2	-	5.90E-4
Ru-103	1.53E+3	-	-	5.83E+3	5.05E+5	1.10E+5	6.58E+2
Ru-105	7.90E-1	-	-	1.02E+0	1.10E+4	4.82E+4	3.11E-1
Ru-106	6.91E+4	-	-	1.34E+5	9.36E+6	9.12E+5	8.72E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.08E+4	1.00E+4	-	1.97E+4	4.63E+6	3.02E+5	5.94E+3
Sb-124	3.12E+4	5.89E+2	7.55E+1	-	2.48E+6	4.06E+5	1.24E+4
Sb-125	5.34E+4	5.95E+2	5.40E+1	-	1.74E+6	1.01E+5	1.26E+4
Te-125m	3.42E+3	1.58E+3	1.05E+3	1.24E+4	3.14E+5	7.06E+4	4.67E+2
Te-127m	1.26E+4	5.77E+3	3.29E+3	4.58E+4	9.60E+5	1.50E+5	1.57E+3
Te-127	1.40E+0	6.42E-1	1.06E+0	5.10E+0	6.51E+3	5.74E+4	3.10E-1
Te-129m	9.76E+3	4.67E+3	3.44E+3	3.66E+4	1.16E+6	3.83E+5	1.58E-3
Te-129	4.98E-2	2.39E-2	3.90E-2	1.87E-1	1.94E+3	1.57E+2	1.24E-2
Te-131m	6.99E+1	4.36E+1	5.50E+1	3.09E+2	1.40E+5	5.56E+5	2.90E+1
Te-131	1.11E-2	5.95E-3	9.36E-3	4.37E-2	1.39E+3	1.84E+1	3.59E-3
Te-132	2.60E+2	2.15E+2	1.90E+2	1.46E+3	2.88E+5	5.10E+5	1.62E+2
I-130	4.58E+3	1.34E+4	1.14E+6	2.09E+4	-	7.69E+3	5.28E+3
I-131	2.52E+4	3.58E+4	1.19E+7	6.13E+4	-	6.28E+3	2.05E+4
I-132	1.16E+3	3.26E+3	1.14E+5	5.18E+3	-	4.06E+2	1.16E+3
I-133	8.64E+3	1.48E+4	2.15E+6	2.58E+4	-	8.88E+3	4.52E+3
I-134	6.44E+2	1.73E+3	2.98E+4	2.75E+3	-	1.01E+0	6.15E+2
I-135	2.68E+3	6.98E+3	4.48E+5	1.11E+4	-	5.25E+3	2.57E+3
Cs-134	3.73E+5	8.48E+5	-	2.87E+5	9.76E+4	1.04E+4	7.28E+5
Cs-136	3.90E+4	1.46E+5	-	8.56E+4	1.20E+4	1.17E+4	1.10E+5
Cs-137	4.78E+5	6.21E+5	-	2.22E+5	7.52E+4	8.40E+3	4.28E+5
Cs-138	3.31E+2	6.21E+2	-	4.80E+2	4.86E+1	1.86E-3	3.24E+2
Ba-139	9.36E-1	6.66E-4	-	6.22E-4	3.76E+3	8.96E+2	2.74E-2
Ba-140	3.90E+4	4.90E+1	-	1.67E+1	1.27E+6	2.18E+5	2.57E+3
Ba-141	1.00E-1	7.53E-5	-	7.00E-5	1.94E+3	1.16E-7	3.36E-3
Ba-142	2.63E-2	2.70E-5	-	2.29E-5	1.19E+3	-	1.66E-3
La-140	3.44E+2	1.74E+2	-	-	1.36E+5	4.58E+5	4.58E+1
La-142	6.83E-1	3.10E-1	-	-	6.33E+3	2.11E+3	7.72E-2
Ce-141	1.99E+4	1.35E+4	-	6.26E+3	3.62E+5	1.20E+5	1.53E+3
Ce-143	1.86E+2	1.38E+2	-	6.08E+1	7.98E+4	2.26E+5	1.53E+1
Ce-144	3.43E+6	1.43E+6	-	8.48E+5	7.78E+6	8.16E+5	1.84E+5
Pr-143	9.36E+3	3.75E+3	-	2.16E+3	2.81E+5	2.00E+5	4.64E+2
Pr-144	3.01E-2	1.25E-2	-	7.05E-3	1.02E+3	2.15E-8	1.53E-3
Nd-147	5.27E+3	6.10E+3	-	3.56E+3	2.21E+5	1.73E+5	3.65E+2
W-187	8.48E+0	7.08E+0	-	-	2.90E+4	1.55E+5	2.48E+0
Np-239	2.30E+2	2.26E+1	-	7.00E+1	3.76E+4	1.19E+5	1.24E+1

Table 7.0-4 (continued)

Rie, Inhalation Pathway Dose Factors - TEENAGER

(mrem/yr per µCi/m³)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3
C-14	2.60E+4	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3
Na-24	1.38E+4	1.38E+4	1.38E+4	1.38E+4	1.38E+4	1.38E+4	1.38E+4
P-32	1.89E+6	1.10E+5	-	-	-	9.28E+4	7.16E+4
Cr-51	-	-	7.50E+1	3.07E+1	2.10E+4	3.00E+3	1.35E+2
Mn-54	-	5.11E+4	-	1.27E+4	1.98E+6	6.68E+4	8.40E+3
Mn-56	-	1.70E+0	-	1.79E+0	1.52E+4	5.74E+4	2.52E-1
Fe-55	3.34E+4	2.38E+4	-	-	1.24E+5	6.39E+3	5.54E+3
Fe-59	1.59E+4	3.70E+4	-	-	1.53E+6	1.78E+5	1.43E+4
Co-57	-	6.92E+2	-	-	5.86E+5	3.14E+4	9.20E+2
Co-58	-	2.07E+3	-	-	1.34E+6	9.52E+4	2.78E+3
Co-60	-	1.51E+4	-	-	8.72E+6	2.59E+5	1.98E+4
Ni-63	5.80E+5	4.34E+4	-	-	3.07E+5	1.42E+4	1.98E+4
Ni-65	2.18E+0	2.93E-1	-	-	9.36E+3	3.67E+4	1.27E-1
Cu-64	-	2.03E+0	-	6.41E+0	1.11E+4	6.14E+4	8.48E-1
Zn-65	3.86E+4	1.34E+5	-	8.64E+4	1.24E+6	4.66E+4	6.24E+4
Zn-69	4.83E-2	9.20E-2	-	6.02E-2	1.58E+3	2.85E+2	6.46E-3
Br-82	-	-	-	-	-	-	1.82E+4
Br-83	-	-	-	-	-	-	3.44E+2
Br-84	-	-	-	-	-	-	4.33E+2
Br-85	-	-	-	-	-	-	1.83E+1
Rb-86	-	1.90E+5	-	-	-	1.77E+4	8.40E+4
Rb-88	-	5.46E+2	-	-	-	2.92E-5	2.72E+2
Rb-89	-	3.52E+2	-	-	-	3.38E-7	2.33E+2
Sr-89	4.34E+5	-	-	-	2.42E+6	3.71E+5	1.25E+4
Sr-90	1.08E+8	-	-	-	1.65E+7	7.65E+5	6.68E+6
Sr-91	8.80E+1	-	-	-	6.07E+4	2.59E+5	3.51E+0
Sr-92	9.52E+0	-	-	-	2.74E+4	1.19E+5	4.06E-1
Y-90	2.98E+3	-	-	-	2.93E+5	5.59E+5	8.00E+1
Y-91m	3.70E-1	-	-	-	3.20E+3	3.02E+1	1.42E-2
Y-91	6.61E+5	-	-	-	2.94E+6	4.09E+5	1.77E+4
Y-92	1.47E+1	-	-	-	2.68E+4	1.65E+5	4.29E-1
Y-93	1.35E+2	-	-	-	8.32E+4	5.79E+5	3.72E+0
Zr-95	1.46E+5	4.58E+4	-	6.74E+4	2.69E+6	1.49E+5	3.15E+4
Zr-97	1.38E+2	2.72E+1	-	4.12E+1	1.30E+5	6.30E+5	1.26E+1
Nb-95	1.86E+4	1.03E+4	-	1.00E+4	7.51E+5	9.68E+4	5.66E+3
Nb-97	3.14E-1	7.78E-2	-	9.12E-2	3.93E+3	2.17E+3	2.84E-2
Mo-99	-	1.69E+2	-	4.11E+2	1.54E+5	2.69E+5	3.22E+1
Tc-99m	1.38E-3	3.86E-3	-	5.76E-2	1.15E+3	6.13E+3	4.99E-2
Tc-101	5.92E-5	8.40E-5	-	1.52E-3	6.67E+2	8.72E-7	8.24E-4
Ru-103	2.10E+3	-	-	7.43E+3	7.83E+5	1.09E+5	8.96E+2
Ru-105	1.12E+0	-	-	1.41E+0	1.82E+4	9.04E+4	4.34E-1
Ru-106	9.84E+4	-	-	1.90E+5	1.61E+7	9.60E+5	1.24E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.38E+4	1.31E+4	-	2.50E+4	6.75E+6	2.73E+5	7.99E+3
Sb-124	4.30E+4	7.94E+2	9.76E+1	-	3.85E+6	3.98E+5	1.68E+4
Sb-125	7.38E+4	8.08E+2	7.04E+1	-	2.74E+6	9.92E+4	1.72E+4
Te-125m	4.88E+3	2.24E+3	1.40E+3	-	5.36E+5	7.50E+4	6.67E+2
Te-127m	1.80E+4	8.16E+3	4.38E+3	6.54E+4	1.66E+6	1.59E+5	2.18E+3
Te-127	2.01E+0	9.12E-1	1.42E+0	7.28E+0	1.12E+4	8.08E+4	4.42E-1
Te-129m	1.39E+4	6.58E+3	4.58E+3	5.19E+4	1.98E+6	4.05E+5	2.25E+3
Te-129	7.10E-2	3.38E-2	5.18E-2	2.66E-1	3.30E+3	1.62E+3	1.76E-2
Te-131m	9.84E+1	6.01E+1	7.25E+1	4.39E+2	2.38E+5	6.21E+5	4.02E+1
Te-131	1.58E-2	8.32E-3	1.24E-2	6.18E-2	2.34E+3	1.51E+1	5.04E-3
Te-132	3.60E+2	2.90E+2	2.46E+2	1.95E+3	4.49E+5	4.63E+5	2.19E+2
I-130	6.24E+3	1.79E+4	1.49E+6	2.75E+4	-	9.12E+3	7.17E+3
I-131	3.54E+4	4.91E+4	1.46E+7	8.40E+4	-	6.49E+3	2.64E+4
I-132	1.59E+3	4.38E+3	1.51E+5	6.92E+3	-	1.27E+3	1.58E+3
I-133	1.22E+4	2.05E+4	2.92E+6	3.59E+4	-	1.03E+4	6.22E+3
I-134	8.88E+2	2.32E+3	3.95E+4	3.66E+3	-	2.04E+1	8.40E+2
I-135	3.70E+3	9.44E+3	6.21E+5	1.49E+4	-	6.95E+3	3.49E+3
Cs-134	5.02E+5	1.13E+6	-	3.75E+5	1.46E+5	9.76E+3	5.49E+5
Cs-136	5.15E+4	1.94E+5	-	1.10E+5	1.78E+4	1.09E+4	[illegible]
Cs-137	6.70E+5	8.48E+5	-	3.04E+5	1.21E+5	8.48E+3	[illegible]
Cs-138	4.66E+2	8.56E+2	-	6.62E+2	7.87E+1	2.70E-1	4.46E+2
Ba-139	1.34E+0	9.44E-4	-	8.88E-4	6.46E+3	6.45E+3	3.90E-2
Ba-140	5.47E+4	6.70E+1	-	2.28E+1	2.03E+6	2.29E+5	3.52E+3
Ba-141	1.42E-1	1.06E-4	-	9.84E-5	3.29E+3	7.46E-4	4.74E-3
Ba-142	3.70E-2	3.70E-5	-	3.14E-5	1.91E+3	-	2.27E-3
La-140	4.79E+2	2.36E+2	-	-	2.14E+5	4.87E+5	6.26E+1
La-142	9.60E-1	4.25E-1	-	-	1.02E+4	1.20E+4	1.06E-1
Ce-141	2.84E+4	1.90E+4	-	8.88E+3	6.14E+5	1.26E+5	2.17E+3
Ce-143	2.66E+2	1.94E+2	-	8.64E+1	1.30E+5	2.55E+5	2.16E+1
Ce-144	4.89E+6	2.02E+6	-	1.21E+6	1.34E+7	8.64E+5	2.62E+5
Pr-143	1.34E+4	5.31E+3	-	3.09E+3	4.83E+5	2.14E+5	6.62E+2
Pr-144	4.30E-2	1.76E-2	-	1.01E-2	1.75E+3	2.35E-4	2.18E-3
Nd-147	7.86E+3	8.56E+3	-	5.02E+3	3.72E+5	1.82E+5	5.13E+2
W-187	1.20E+1	9.76E+0	-	-	4.74E+4	1.77E+5	3.43E+0
Np-239	3.38E+2	3.19E+1	-	1.00E+2	6.49E+4	1.32E+5	1.77E+1

Table 7.0-4 (continued)

R_{io}, Inhalation Pathway Dose Factors - CHILD

(mrem/yr per µCi/m³)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3
C-14	3.59E+4	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3
Na-24	1.61E+4	1.61E+4	1.61E+4	1.61E+4	1.61E+4	1.61E+4	1.61E+4
P-32	2.60E+6	1.14E+5	-	-	-	4.22E+4	9.88E+4
Cr-51	-	-	8.55E+1	2.43E+1	1.70E+4	1.08E+3	1.54E+2
Mn-54	-	4.29E+4	-	1.00E+4	1.58E+6	2.29E+4	9.51E+3
Mn-56	-	1.66E+0	-	1.67E+0	1.31E+4	1.23E+5	3.12E-1
Fe-55	4.74E+4	2.52E+4	-	-	1.11E+5	2.87E+3	7.77E+3
Fe-59	2.07E+4	3.34E+4	-	-	1.27E+6	7.07E+4	1.67E+4
Co-57	-	9.03E+2	-	-	5.07E+5	1.32E+4	1.07E+3
Co-58	-	1.77E+3	-	-	1.11E+6	3.44E+4	3.16E+3
Co-60	-	1.31E+4	-	-	7.07E+6	9.62E+4	2.26E+4
Ni-63	8.21E+5	4.63E+4	-	-	2.75E+5	6.33E+3	2.80E+4
Ni-65	2.99E+0	2.96E-1	-	-	8.18E+3	8.40E+4	1.64E-1
Cu-64	-	1.99E+0	-	6.03E+0	9.58E+3	3.67E+4	1.07E+0
Zn-65	4.26E+4	1.13E+5	-	7.14E+4	9.95E+5	1.63E+4	7.03E+4
Zn-69	6.70E-2	9.66E-2	-	5.85E-2	1.42E+3	1.02E+4	8.92E-3
Br-82	-	-	-	-	-	-	2.09E+4
Br-83	-	-	-	-	-	-	4.74E+2
Br-84	-	-	-	-	-	-	5.48E+2
Br-85	-	-	-	-	-	-	2.53E+1
Rb-86	-	1.98E+5	-	-	-	7.99E+3	1.14E+5
Rb-88	-	5.62E+2	-	-	-	1.72E+1	3.66E+2
Rb-89	-	3.45E+2	-	-	-	1.89E+0	2.90E+2
Sr-89	5.99E+5	-	-	-	2.16E+6	1.67E+5	1.72E+4
Sr-90	1.01E+8	-	-	-	1.48E+7	3.43E+5	6.44E+6
Sr-91	1.21E+2	-	-	-	5.33E+4	1.74E+5	4.59E+0
Sr-92	1.31E+1	-	-	-	2.40E+4	2.42E+5	5.25E-1
Y-90	4.11E+3	-	-	-	2.62E+5	2.68E+5	1.11E+2
Y-91m	5.07E-1	-	-	-	2.81E+3	1.72E+3	1.84E-2
Y-91	9.14E+5	-	-	-	2.63E+6	1.84E+5	2.44E+4
Y-92	2.04E+1	-	-	-	2.39E+4	2.39E+5	5.81E-1
Y-93	1.86E+2	-	-	-	7.44E+4	3.89E+5	5.11E+0
Zr-95	1.90E+5	4.18E+4	-	5.96E+4	2.23E+6	6.11E+4	3.70E+4
Zr-97	1.88E+2	2.72E+1	-	3.89E+1	1.13E+5	3.51E+5	1.60E+1
Nb-95	2.35E+4	9.18E+3	-	8.62E+3	6.14E+5	3.70E+4	6.55E+3
Nb-97	4.29E-1	7.70E-2	-	8.55E-2	3.42E+3	2.78E+4	3.60E-2
Mo-99	-	1.72E+2	-	3.92E+2	1.35E+5	1.27E+5	4.26E+1
Tc-99m	1.78E-3	3.48E-3	-	5.07E-2	9.51E+2	4.81E+3	5.77E-2
Tc-101	8.10E-5	8.51E-5	-	1.45E-3	5.85E+2	1.63E+1	1.08E-3
Ru-103	2.79E+3	-	-	7.03E+3	6.62E+5	4.48E+4	1.07E+3
Ru-105	1.53E+0	-	-	1.34E+0	1.59E+4	9.95E+4	5.55E-1
Ru-106	1.36E+5	-	-	1.84E+5	1.43E+7	4.29E+5	1.69E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.69E+4	1.14E+4	-	2.12E+4	5.48E+6	1.00E+5	9.14E+3
Sb-124	5.74E+4	7.40E+2	1.26E+2	-	3.24E+6	1.64E+5	2.00E+4
Sb-125	9.84E+4	7.59E+2	9.10E+1	-	2.32E+6	4.03E+4	2.07E+4
Te-125m	6.73E+3	2.33E+3	1.92E+3	-	4.77E+5	3.38E+4	9.14E+2
Te-127m	2.49E+4	8.55E+3	6.07E+3	6.36E+4	1.48E+6	7.14E+4	3.02E+3
Te-127	2.77E+0	9.51E-1	1.96E+0	7.07E+0	1.00E+4	5.62E+4	6.11E-1
Te-129m	1.92E+4	6.85E+3	6.33E+3	5.03E+4	1.76E+6	1.82E+5	3.04E+3
Te-129	9.77E-2	3.50E-2	7.14E-2	2.57E-1	2.93E+3	2.55E+4	2.38E-2
Te-131m	1.34E+2	5.92E+1	9.77E+1	4.00E+2	2.06E+5	3.08E+5	5.07E+1
Te-131	2.17E-2	8.44E-3	1.70E-2	5.88E-2	2.05E+3	1.33E+3	6.59E-3
Te-132	4.81E+2	2.72E+2	3.17E+2	1.77E+3	3.77E+5	1.38E+5	2.63E+2
I-130	8.18E+3	1.64E+4	1.85E+6	2.45E+4	-	5.11E+3	8.44E+3
I-131	4.81E+4	4.81E+4	1.62E+7	7.88E+4	-	2.84E+3	2.73E+4
I-132	2.12E+3	4.07E+3	1.94E+5	6.25E+3	-	3.20E+3	1.88E+3
I-133	1.66E+4	2.03E+4	3.85E+6	3.38E+4	-	5.48E+3	7.70E+3
I-134	1.17E+3	2.16E+3	5.07E+4	3.30E+3	-	9.55E+2	9.95E+2
I-135	4.92E+3	8.73E+3	7.92E+5	1.34E+4	-	4.44E+3	4.14E+3
Cs-134	6.51E+5	1.01E+6	-	3.30E+5	1.21E+5	3.85E+3	2.25E+5
Cs-136	6.51E+4	1.71E+5	-	9.55E+4	1.45E+4	4.18E+3	1.16E+5
Cs-137	9.07E+5	8.25E+5	-	2.82E+5	1.04E+5	3.62E+3	1.28E+5
Cs-138	6.33E+2	8.40E+2	-	6.22E+2	6.81E+1	2.70E+2	5.55E+2
Ba-139	1.84E+0	9.84E-4	-	8.62E-4	5.77E+3	5.77E+4	5.37E-2
Ba-140	7.40E+4	6.48E+1	-	2.11E+1	1.74E+6	1.02E+5	4.33E+3
Ba-141	1.96E-1	1.09E-4	-	9.47E-5	2.92E+3	2.75E+2	6.36E-3
Ba-142	5.00E-2	3.60E-5	-	2.91E-5	1.64E+3	2.74E+0	2.79E-3
La-140	6.44E+2	2.25E+2	-	-	1.83E+5	2.26E+5	7.55E+1
La-142	1.30E+0	4.11E-1	-	-	8.70E+3	7.59E+4	1.29E-1
Ce-141	3.92E+4	1.95E+4	-	8.55E+3	5.44E+5	5.66E+4	2.90E+3
Ce-143	3.66E+2	1.99E+2	-	8.36E+1	1.15E+5	1.27E+5	2.87E+1
Ce-144	6.77E+6	2.12E+6	-	1.17E+6	1.20E+7	3.89E+5	3.61E+5
Pr-143	1.85E+4	5.55E+3	-	3.00E+3	4.33E+5	9.73E+4	9.14E+2
Pr-144	5.96E-2	1.85E-2	-	9.77E-3	1.57E+3	1.97E+2	3.00E-3
Nd-147	1.08E+4	8.73E+3	-	4.81E+3	3.28E+5	8.21E+4	6.81E+2
W-187	1.63E+1	9.66E+0	-	-	4.11E+4	9.10E+4	4.33E+0
Np-239	4.66E+2	3.34E+1	-	9.73E+1	5.81E+4	6.40E+4	2.35E+1

Table 7.0-4 (continued)

R_i, Inhalation Pathway Dose Factors - INFANT

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2
C-14	2.65E+4	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3
Na-24	1.06E+4	1.06E+4	1.06E+4	1.06E+4	1.06E+4	1.06E+4	1.06E+4
P-32	2.03E+6	1.12E+5	-	-	-	1.61E+4	7.74E+4
Cr-51	-	-	5.75E+1	1.32E+1	1.28E+4	3.57E+2	8.95E+1
Mn-54	-	2.53E+4	-	4.98E+3	1.00E+6	7.06E+3	4.98E+3
Mn-56	-	1.54E+0	-	1.10E+0	1.25E+4	7.17E+4	2.21E-1
Fe-55	1.97E+4	1.17E+4	-	-	8.69E+4	1.09E+3	3.33E+3
Fe-59	1.36E+4	2.35E+4	-	-	1.02E+6	2.48E+4	9.48E+3
Co-57	-	6.51E+2	-	-	3.79E+5	4.86E+3	6.41E+2
Co-58	-	1.22E+3	-	-	7.77E+5	1.11E+4	1.82E+3
Co-60	-	8.02E+3	-	-	4.51E+6	3.19E+4	1.18E+4
Ni-63	3.39E+5	2.04E+4	-	-	2.09E+5	2.42E+3	1.16E+4
Ni-65	2.39E+0	2.84E-1	-	-	8.12E+3	5.01E+4	1.23E-1
Cu-64	-	1.88E+0	-	3.98E+0	9.30E+3	1.50E+4	7.74E-1
Zn-65	1.93E+4	6.26E+4	-	3.25E+4	6.47E+5	5.14E+4	3.11E+4
Zn-69	5.39E-2	9.67E-2	-	4.02E-2	1.47E+3	1.32E+4	7.18E-3
Br-82	-	-	-	-	-	-	1.33E+4
Br-83	-	-	-	-	-	-	3.81E+2
Br-84	-	-	-	-	-	-	4.00E+2
Br-85	-	-	-	-	-	-	2.04E+1
Rb-86	-	1.90E+5	-	-	-	3.04E+3	8.82E+4
Rb-88	-	5.57E+2	-	-	-	3.39E+2	2.87E+2
Rb-89	-	3.21E+2	-	-	-	6.82E+1	2.06E+2
Sr-89	3.98E+5	-	-	-	2.03E+6	6.40E+4	1.14E+4
Sr-90	4.09E+7	-	-	-	1.12E+7	1.31E+5	2.5[illegible]E+6
Sr-91	9.56E+1	-	-	-	5.26E+4	7.34E+4	3.46E+0
Sr-92	1.05E+1	-	-	-	2.38E+4	1.40E+5	3.91E-1
Y-90	3.29E+3	-	-	-	2.69E+5	1.04E+5	8.82E+1
Y-91m	4.07E-1	-	-	-	2.79E+3	2.35E+3	1.39E-2
Y-91	5.88E+5	-	-	-	2.45E+6	7.03E+4	1.57E+4
Y-92	1.64E+1	-	-	-	2.45E+4	1.27E+5	4.61E-1
Y-93	1.50E+2	-	-	-	7.64E+4	1.67E+5	4.07E+0
Zr-95	1.15E+5	2.79E+4	-	3.11E+4	1.75E+6	2.17E+4	2.03E+4
Zr-97	1.50E+2	2.56E+1	-	2.59E+1	1.10E+5	1.40E+5	1.17E+1
Nb-95	1.57E+4	6.43E+3	-	4.72E+3	4.79E+5	1.27E+4	3.78E+3
Nb-97	3.42E-1	7.29E-2	-	5.70E-2	3.32E+3	2.69E+4	2.63E-2
Mo-99	-	1.65E+2	-	2.65E+2	1.35E+5	4.87E+4	3.23E+1
Tc-99m	1.40E-3	2.88E-3	-	3.11E-2	8.11E+2	2.03E+3	3.72E-2
Tc-101	6.51E-5	8.23E-5	-	9.79E-4	5.84E+2	8.44E+2	8.12E-4
Ru-103	2.02E+3	-	-	4.24E+3	5.52E+5	1.61E+4	6.79E+2
Ru-105	1.22E+0	-	-	8.99E-1	1.57E+4	4.84E+4	4.10E-1
Ru-106	8.68E+4	-	-	1.07E+5	1.16E+7	1.64E+5	1.09E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	9.98E+3	7.22E+3	-	1.09E+4	3.67E+6	3.30E+4	5.00E+3
Sb-124	3.79E+4	5.56E+2	1.01E+2	-	2.65E+6	5.91E+4	1.20E+4
Sb-125	5.17E+4	4.77E+2	6.23E+1	-	1.64E+6	1.47E+4	1.09E+4
Te-125m	4.76E+3	1.99E+3	1.62E+3	-	4.47E+5	1.29E+4	6.58E+2
Te-127m	1.67E+4	6.90E+3	4.87E+3	3.75E+4	1.31E+6	2.73E+4	2.07E+3
Te-127	2.23E+0	9.53E-1	1.85E+0	4.86E+0	1.03E+4	2.44E+4	4.89E-1
Te-129m	1.41E+4	6.09E+3	5.47E+3	3.18E+4	1.68E+6	6.90E+4	2.23E+3
Te-129	7.88E-2	3.47E-2	6.75E-2	1.75E-1	3.00E+3	2.63E+4	1.88E-2
Te-131m	1.07E+2	5.50E+1	8.93E+1	2.65E+2	1.99E+5	1.19E+5	3.63E+1
Te-131	1.74E-2	8.22E-3	1.58E-2	3.99E-2	2.06E+3	8.22E+3	5.00E-3
Te-132	3.72E+2	2.37E+2	2.79E+2	1.03E+3	3.40E+5	4.41E+4	1.76E+2
I-130	6.36E+3	1.39E+4	1.60E+6	1.53E+4	-	1.99E+3	5.57E+3
I-131	3.79E+4	4.44E+4	1.48E+7	5.18E+4	-	1.06E+3	1.96E+4
I-132	1.69E+3	3.54E+3	1.69E+5	3.95E+3	-	1.90E+3	1.26E+3
I-133	1.32E+4	1.92E+4	3.56E+6	2.24E+4	-	2.16E+3	5.60E+3
I-134	9.21E+2	1.88E+3	4.45E+4	2.09E+3	-	1.29E+3	6.65E+2
I-135	3.86E+3	7.60E+3	6.96E+5	8.47E+3	-	1.83E+3	2.77E+3
Cs-134	3.96E+5	7.03E+5	-	1.90E+5	7.97E+4	1.33E+3	7.45E+4
Cs-136	4.83E+4	1.35E+5	-	5.64E+4	1.18E+4	1.43E+3	5.29E+4
Cs-137	5.49E+5	6.12E+5	-	1.72E+5	7.13E+4	1.33E+3	4.55E+4
Cs-138	5.05E+2	7.81E+2	-	4.10E+2	6.54E+1	8.76E+2	3.98E+2
Ba-139	1.48E+0	9.84E-4	-	5.92E-4	5.95E+3	5.10E+4	4.30E-2
Ba-140	5.60E+4	5.60E+1	-	1.34E+1	1.60E+6	3.84E+4	2.90E+3
Ba-141	1.57E-1	1.08E-4	-	6.50E-5	2.97E+3	4.75E+3	4.97E-3
Ba-142	3.98E-2	3.30E-5	-	1.90E-5	1.55E+3	6.93E+2	1.96E-3
La-140	5.05E+2	2.00E+2	-	-	1.68E+5	8.48E+4	5.15E+1
La-142	1.03E+0	3.77E-1	-	-	8.22E+3	5.95E+4	9.04E-2
Ce-141	2.77E+4	1.67E+4	-	5.25E+3	5.17E+5	2.16E+4	1.99E+3
Ce-143	2.93E+2	1.93E+2	-	5.64E+1	1.16E+5	4.97E+4	2.21E+1
Ce-144	3.19E+6	1.21E+6	-	5.38E+5	9.84E+6	1.48E+5	1.76E+5
Pr-143	1.40E+4	5.24E+3	-	1.97E+3	4.33E+5	3.72E+4	6.99E+2
Pr-144	4.79E-2	1.85E-2	-	6.72E-3	1.61E+3	4.28E+3	2.41E-3
Nd-147	7.94E+3	8.13E+3	-	3.15E+3	3.22E+5	3.12E+4	5.00E+2
W-187	1.30E+1	9.02E+0	-	-	3.96E+4	3.56E+4	3.12E+0
Np-239	3.71E+2	3.32E+1	-	6.62E+1	5.95E+4	[illegible].49E+4	1.88E+1

Table 7.0-4 (continued)

R_{io}, Grass-Cow-Milk Pathway Dose Factors - ADULT

(mrem/yr per μCi/m³) for H-3 and C-14
(m² x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2
C-14	3.63E+5	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4
Na-24	2.54E+6	2.54E+6	2.54E+6	2.54E+6	2.54E+6	2.54E+6	2.54E+6
P-32	1.71E+10	1.06E+9	-	-	-	1.92E+9	6.60E+8
Cr-51	-	-	1.71E+4	6.30E+3	3.80E+4	7.20E+6	2.86E+4
Mn-54	-	8.40E+6	-	2.50E+6	-	2.57E+7	1.60E+6
Mn-56	-	4.23E-3	-	5.38E-3	-	1.35E-1	7.51E-4
Fe-55	2.51E+7	1.73E+7	-	-	9.67E+6	9.95E+6	4.04E+6
Fe-59	2.98E+7	7.00E+7	-	-	1.95E+7	2.33E+8	2.68E+7
Co-57	-	1.28E+6	-	-	-	3.25E+7	2.13E+6
Co-58	-	4.72E+6	-	-	-	9.57E+7	1.06E+7
Co-60	-	1.64E+7	-	-	-	3.08E+8	3.62E+7
Ni-63	6.73E+9	4.66E+8	-	-	-	9.73E+7	2.26E+8
Ni-65	3.70E-1	4.81E-2	-	-	-	1.22E+0	2.19E-2
Cu-64	-	2.41E+4	-	6.08E+4	-	2.05E+6	1.13E+4
Zn-65	1.37E+9	4.36E+9	-	2.92E+9	-	2.75E+9	1.97E+9
Zn-69	-	-	-	-	-	-	-
Br-82	-	-	-	-	-	3.72E+7	3.25E+7
Br-83	-	-	-	-	-	1.49E-1	1.03E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.59E+9	-	-	-	5.11E+8	1.21E+9
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	1.45E+9	-	-	-	-	2.33E+8	4.16E+7
Sr-90	4.68E+10	-	-	-	-	1.35E+9	1.15E+10
Sr-91	3.13E+4	-	-	-	-	1.49E+5	1.27E+3
Sr-92	4.89E-1	-	-	-	-	9.68E+0	2.11E-2
Y-90	7.07E+1	-	-	-	-	7.50E+5	1.90E+0
Y-91m	-	-	-	-	-	-	-
Y-91	8.60E+3	-	-	-	-	4.73E+6	2.30E+2
Y-92	5.42E-5	-	-	-	-	9.49E-1	1.58E-6
Y-93	2.33E-1	-	-	-	-	7.39E+3	6.43E-3
Zr-95	9.46E+2	3.03E+2	-	4.76E+2	-	9.62E+5	2.05E+2
Zr-97	4.26E-1	8.59E-2	-	1.30E-1	-	2.66E+4	3.93E-2
Nb-95	8.25E+4	4.59E+4	-	4.54E+4	-	2.79E+8	2.47E+4
Nb-97	-	-	-	-	-	5.47E-9	-
Mo-99	-	2.52E+7	-	5.72E+7	-	5.85E+7	4.80E+6
Tc-99m	3.25E+0	9.19E+0	-	1.40E+2	4.50E+0	5.44E+3	1.17E+2
Tc-101	-	-	-	-	-	-	-
Ru-103	1.02E+3	-	-	3.89E+3	-	1.19E+5	4.39E+2
Ru-105	8.57E-4	-	-	1.11E-2	-	5.24E-1	3.38E-4
Ru-106	2.04E+4	-	-	3.94E+4	-	1.32E+6	2.58E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	5.83E+7	5.39E+7	-	1.06E+8	-	2.20E+10	3.20E+7
Sb-124	2.57E+7	4.86E+5	6.24E+4	-	2.00E+7	7.31E+8	1.02E+7
Sb-125	2.04E+7	2.28E+5	2.08E+4	-	1.58E+7	2.25E+8	4.86E+6
Te-125m	1.63E+7	5.90E+6	4.90E+6	6.63E+7	-	6.50E+7	2.18E+6
Te-127m	4.58E+7	1.64E+7	1.17E+7	1.86E+8	-	1.54E+8	5.58E+6
Te-127	6.72E+2	2.41E+2	4.98E+2	2.74E+3	-	5.30E+4	1.45E+2
Te-129m	6.04E+7	2.25E+7	2.08E+7	2.52E+8	-	3.04E+8	9.57E+6
Te-129	-	-	-	-	-	-	-
Te-131m	3.61E+5	1.77E+5	2.80E+5	1.79E+6	-	1.75E+7	1.47E+5
Te-131	-	-	-	-	-	-	-
Te-132	2.39E+6	1.55E+6	1.71E+6	1.49E+7	-	7.32E+7	1.45E+6
I-130	4.26E+5	1.26E+6	1.07E+8	1.96E+6	-	1.08E+6	4.96E+5
I-131	2.96E+8	4.24E+8	1.39E+11	7.27E+8	-	1.12E+8	2.43E+8
I-132	1.64E-1	4.37E-1	1.53E+1	6.97E-1	-	8.22E-2	1.53E-1
I-133	3.97E+6	6.90E+6	1.01E+9	1.20E+7	-	6.20E+6	2.10E+6
I-134	-	-	-	-	-	-	-
I-135	1.39E+4	3.63E+4	2.40E+6	5.83E+4	-	4.10E+4	1.34E+4
Cs-134	5.65E+9	1.34E+10	-	4.35E+9	1.44E+9	2.35E+8	1.10E+10
Cs-136	2.61E+8	1.03E+9	-	5.74E+8	7.87E+7	1.17E+8	7.42E+8
Cs-137	7.38E+9	1.01E+10	-	3.43E+9	1.14E+9	1.95E+8	6.61E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	4.70E-8	-	-	-	-	8.34E-8	1.38E-9
Ba-140	2.69E+7	3.38E+4	-	1.15E+4	1.93E+4	5.54E+7	1.76E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	4.49E+0	2.26E+0	-	-	-	1.66E+5	5.97E-1
La-142	-	-	-	-	-	3.03E-8	-
Ce-141	4.84E+3	3.27E+3	-	1.52E+3	-	1.25E+7	3.71E+2
Ce-143	4.19E+1	3.09E+4	-	1.36E+1	-	1.16E+6	3.42E+0
Ce-144	3.58E+5	1.50E+5	-	8.87E+4	-	1.21E+8	1.92E+4
Pr-143	1.59E+2	6.37E+1	-	3.68E+1	-	6.96E+5	7.88E+0
Pr-144	-	-	-	-	-	-	-
Nd-147	9.42E+1	1.09E+2	-	6.37E+1	-	5.23E+5	6.52E+0
W-187	6.56E+3	5.48E+3	-	-	-	1.80E+6	1.92E+3
Np-239	3.66E+0	3.60E-1	-	1.12E+0	-	7.39E+4	1.98E-1

Table 7.0-4 (continued)

R_{io}, Grass-Cow-Milk Pathway Dose Factors - TEENAGER

(mrem/yr per μCi/m³) for H-3 and C-14
(m² x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2
C-14	6.70E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5
Na-24	4.44E+6	4.44E+6	4.44E+6	4.44E+6	4.44E+6	4.44E+6	4.44E+6
P-32	3.15E+10	1.95E+9	-	-	-	2.65E+9	1.22E+9
Cr-51	-	-	2.78E+4	1.10E+4	7.13E+4	8.40E+6	5.00E+4
Mn-54	-	1.40E+7	-	4.17E+6	-	2.87E+7	2.78E+6
Mn-56	-	7.51E-3	-	9.50E-3	-	4.94E-1	1.33E-3
Fe-55	4.45E+7	3.16E+7	-	-	2.00E+7	1.37E+7	7.36E+6
Fe-59	5.20E+7	1.21E+8	-	-	3.82E+7	2.87E+8	4.68E+7
Co-57	-	2.25E+6	-	-	-	4.19E+7	3.76E+6
Co-58	-	7.95E+6	-	-	-	1.10E+8	1.83E+7
Co-60	-	2.78E+7	-	-	-	3.62E+8	6.26E+7
Ni-63	1.18E+10	8.35E+8	-	-	-	1.33E+8	4.01E+8
Ni-65	6.78E-1	8.66E-2	-	-	-	4.70E+0	3.94E-2
Cu-64	-	4.29E+4	-	1.09E+5	-	3.33E+6	2.02E+4
Zn-65	2.11E+9	7.31E+9	-	4.68E+9	-	3.10E+9	3.41E+9
Zn-69	-	-	-	-	-	-	-
Br-82	-	-	-	-	-	-	5.64E+7
Br-83	-	-	-	-	-	-	1.91E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	4.73E+9	-	-	-	7.00E+8	2.22E+9
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	2.67E+9	-	-	-	-	3.18E+8	7.66E+7
Sr-90	6.61E+10	-	-	-	-	1.86E+9	1.63E+10
Sr-91	5.75E+4	-	-	-	-	2.61E+5	2.29E+3
Sr-92	8.95E-1	-	-	-	-	2.28E+1	3.81E-2
Y-90	1.30E+2	-	-	-	-	1.07E+6	3.50E+0
Y-91m	-	-	-	-	-	-	-
Y-91	1.58E+4	-	-	-	-	6.48E+6	4.24E+2
Y-92	1.00E-4	-	-	-	-	2.75E+0	2.90E-6
Y-93	4.30E-1	-	-	-	-	1.31E+4	1.18E-2
Zr-95	1.65E+3	5.22E+2	-	7.67E+2	-	1.20E+6	3.59E+2
Zr-97	7.75E-1	1.53E-1	-	2.32E-1	-	4.15E+4	7.06E-2
Nb-95	1.41E+5	7.80E+4	-	7.57E+4	-	3.34E+8	4.30E+4
Nb-97	-	-	-	-	-	6.34E-8	-
Mo-99	-	4.56E+7	-	1.04E+8	-	8.16E+7	8.69E+6
Tc-99m	5.64E+0	1.57E+1	-	2.34E+2	8.73E+0	1.03E+4	2.04E+2
Tc-101	-	-	-	-	-	-	-
Ru-103	1.81E+3	-	-	6.40E+3	-	1.52E+5	7.75E+2
Ru-105	1.57E-3	-	-	1.97E-2	-	1.26E+0	6.08E-4
Ru-106	3.75E+4	-	-	7.23E+4	-	1.80E+6	4.73E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	9.63E+7	9.11E+7	-	1.74E+8	-	2.56E+10	5.54E+7
Sb-124	4.59E+7	8.46E+5	1.04E+5	-	4.01E+7	9.25E+8	1.79E+7
Sb-125	3.65E+7	3.99E+5	3.49E+4	-	3.21E+7	2.84E+8	8.54E+6
Te-125m	3.00E+7	1.08E+7	8.39E+6	-	-	8.86E+7	4.02E+6
Te-127m	8.44E+7	2.99E+7	2.01E+7	3.42E+8	-	2.10E+8	1.00E+7
Te-127	1.24E+3	4.41E+2	8.59E+2	5.04E+3	-	9.61E+4	2.68E+2
Te-129m	1.11E+8	4.10E+7	3.57E+7	4.62E+8	-	4.15E+8	1.75E+7
Te-129	-	-	-	1.67E-9	-	2.18E-9	-
Te-131m	6.57E+5	3.15E+5	4.74E+5	3.29E+6	-	2.53E+7	2.63E+5
Te-131	-	-	-	-	-	-	-
Te-132	4.28E+6	2.71E+6	2.86E+6	2.60E+7	-	8.58E+7	2.55E+6
I-130	7.49E+5	2.17E+6	1.77E+8	3.34E+6	-	1.67E+6	8.66E+5
I-131	5.38E+8	7.53E+8	2.20E+11	1.30E+9	-	1.49E+8	4.04E+8
I-132	2.90E-1	7.59E-1	2.56E+1	1.20E+0	-	3.31E-1	2.72E-1
I-133	7.24E+6	1.23E+7	1.72E+9	2.15E+7	-	9.30E+6	3.75E+6
I-134	-	-	-	-	-	-	-
I-135	2.47E+4	6.35E+4	4.08E+6	1.00E+5	-	7.03E+4	2.35E+4
Cs-134	9.81E+9	2.31E+10	-	7.34E+9	2.80E+9	2.87E+8	1.07E+10
Cs-136	4.45E+8	1.75E+9	-	9.53E+8	1.50E+8	1.41E+8	1.18E+9
Cs-137	1.34E+10	1.78E+10	-	6.06E+9	2.35E+9	2.53E+8	6.20E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	8.69E-8	-	-	-	-	7.75E-7	2.53E-9
Ba-140	4.85E+7	5.95E+4	-	2.02E+4	4.00E+4	7.49E+7	3.13E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	8.06E+0	3.96E+0	-	-	-	2.27E+5	1.05E+0
La-142	-	-	-	-	-	2.23E-7	-
Ce-141	8.87E+3	5.92E+3	-	2.79E+3	-	1.69E+7	6.81E+2
Ce-143	7.69E+1	5.60E+4	-	2.51E+1	-	1.68E+6	6.25E+0
Ce-144	6.58E+5	2.72E+5	-	1.63E+5	-	1.66E+8	3.54E+4
Pr-143	2.92E+2	1.17E+2	-	6.77E+1	-	9.61E+5	1.45E+1
Pr-144	-	-	-	-	-	-	-
Nd-147	1.81E+2	1.97E+2	-	1.16E+2	-	7.11E+5	1.18E+1
W-187	1.20E+4	9.78E+3	-	-	-	2.65E+6	3.43E+3
Np-239	6.99E+0	6.59E-1	-	2.07E+0	-	1.06E+5	3.66E-1

Table 7.0-4 (continued)

R_{io}, Grass-Cow-Milk Pathway Dose Factors - CHILD

(mrem/yr per μCi/m³) for H-3 and C-14
(m² x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3
C-14	1.65E+6	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5
Na-24	9.23E+6	9.23E+6	9.23E+6	9.23E+6	9.23E+6	9.23E+6	9.23E+6
P-32	7.77E+10	3.64E+9	-	-	-	2.15E+9	3.00E+9
Cr-51	-	-	5.66E+4	1.55E+4	1.03E+5	5.41E+6	1.02E+5
Mn-54	-	2.09E+7	-	5.87E+6	-	1.76E+7	5.58E+6
Mn-56	-	1.31E-2	-	1.58E-2	-	1.90E+0	2.95E-3
Fe-55	1.12E+8	5.93E+7	-	-	3.35E+7	1.10E+7	1.84E+7
Fe-59	1.20E+8	1.95E+8	-	-	5.65E+7	2.03E+8	9.71E+7
Co-57	-	3.84E+6	-	-	-	3.14E+7	7.77E+6
Co-58	-	1.21E+7	-	-	-	7.08E+7	3.72E+7
Co-60	-	4.32E+7	-	-	-	2.39E+8	1.27E+8
Ni-63	2.96E+10	1.59E+9	-	-	-	1.07E+8	1.01E+9
Ni-65	1.66E+0	1.56E-1	-	-	-	1.91E+1	9.11E-2
Cu-64	-	7.55E+4	-	1.82E+5	-	3.54E+6	4.56E+4
Zn-65	4.13E+9	1.10E+10	-	6.94E+9	-	1.93E+9	6.85E+9
Zn-69	-	-	-	-	-	2.14E-9	-
Br-82	-	-	-	-	-	-	1.15E+8
Br-83	-	-	-	-	-	-	4.69E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	8.77E+9	-	-	-	5.64E+8	5.39E+9
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	6.62E+9	-	-	-	-	2.56E+8	1.89E+8
Sr-90	1.12E+11	-	-	-	-	1.51E+9	2.83E+10
Sr-91	1.41E+5	-	-	-	-	3.12E+5	5.33E+3
Sr-92	2.19E+0	-	-	-	-	4.14E+1	8.76E-2
Y-90	3.22E+2	-	-	-	-	9.15E+5	8.61E+0
Y-91m	-	-	-	-	-	-	-
Y-91	3.91E+4	-	-	-	-	5.21E+6	1.04E+3
Y-92	2.46E-4	-	-	-	-	7.10E+0	7.03E-6
Y-93	1.06E+0	-	-	-	-	1.57E+4	2.90E-2
Zr-95	3.84E+3	8.45E+2	-	1.21E+3	-	8.81E+5	7.52E+2
Zr-97	1.89E+0	2.72E-1	-	3.91E-1	-	4.13E+4	1.61E-1
Nb-95	3.18E+5	1.24E+5	-	1.16E+5	-	2.29E+8	8.84E+4
Nb-97	-	-	-	-	-	1.45E-6	-
Mo-99	-	8.29E+7	-	1.77E+8	-	6.86E+7	2.05E+7
Tc-99m	1.29E+1	2.54E+1	-	3.68E+2	1.29E+1	1.44E+4	4.20E+2
Tc-101	-	-	-	-	-	-	-
Ru-103	4.29E+3	-	-	1.08E+4	-	1.11E+5	1.65E+3
Ru-105	3.82E-3	-	-	3.36E-2	-	2.49E+0	1.39E-3
Ru-106	9.24E+4	-	-	1.25E+5	-	1.44E+6	1.15E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	2.09E+8	1.41E+8	-	2.63E+8	-	1.68E+10	1.13E+8
Sb-124	1.09E+8	1.41E+8	2.40E+5	-	6.03E+7	6.79E+8	3.81E+7
Sb-125	8.70E+7	1.61E+6	8.06E+4	-	4.85E+7	2.08E+8	1.82E+7
Te-125m	7.38E+7	2.00E+7	2.07E+7	-	-	7.12E+7	9.84E+6
Te-127m	2.08E+8	5.60E+7	4.97E+7	5.93E+8	-	1.68E+8	2.47E+7
Te-127	3.06E+3	8.25E+2	2.12E+3	8.71E+3	-	1.20E+5	6.56E+2
Te-129m	2.72E+8	7.61E+7	8.78E+7	8.00E+8	-	3.32E+8	4.23E+7
Te-129	-	-	-	2.87E-9	-	6.12E-8	-
Te-131m	1.60E+6	5.53E+5	1.14E+6	5.35E+6	-	2.24E+7	5.89E+5
Te-131	-	-	-	-	-	-	-
Te-132	1.02E+7	4.52E+6	6.58E+6	4.20E+7	-	4.55E+7	5.46E+6
I-130	1.75E+6	3.54E+6	3.90E+8	5.29E+6	-	1.66E+6	1.82E+6
I-131	1.30E+9	1.31E+9	4.34E+11	2.15E+9	-	1.17E+8	7.46E+8
I-132	6.86E-1	1.26E+0	5.85E+1	1.93E+0	-	1.48E+0	5.80E-1
I-133	1.76E+7	2.18E+7	4.04E+9	3.63E+7	-	8.77E+6	8.23E+6
I-134	-	-	-	-	-	-	-
I-135	5.84E+4	1.05E+5	9.30E+6	1.61E+5	-	8.00E+4	4.97E+4
Cs-134	2.26E+10	3.71E+10	-	1.15E+10	4.13E+9	2.00E+8	7.83E+9
Cs-136	1.00E+9	2.76E+9	-	1.47E+9	2.19E+8	9.70E+7	1.79E+9
Cs-137	3.22E+10	3.09E+10	-	1.01E+10	3.62E+9	1.93E+8	4.55E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	2.14E-7	-	-	-	-	1.23E-5	6.19E-9
Ba-140	1.17E+8	1.03E+5	-	3.34E+4	6.12E+4	5.94E+7	6.84E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	1.93E+1	6.74E+0	-	-	-	1.88E+5	2.27E+0
La-142	-	-	-	-	-	2.51E-6	-
Ce-141	2.19E+4	1.09E+4	-	4.78E+3	-	1.36E+7	1.62E+3
Ce-143	1.89E+2	1.02E+5	-	4.29E+1	-	1.50E+6	1.48E+1
Ce-144	1.62E+6	5.09E+	-	2.82E+5	-	1.33E+8	8.66E+4
Pr-143	7.23E+2	2.17E+	-	1.17E+2	-	7.80E+5	3.59E+1
Pr-144	-	-	-	-	-	-	-
Nd-147	4.45E+2	3.60E+2	-	1.98E+2	-	5.71E+5	2.79E+1
W-187	2.91E+4	1.72E+4	-	-	-	2.42E+6	7.73E+3
Np-239	1.72E+1	1.23E+0	-	3.57E+0	-	9.14E+4	8.68E-1

Table 7.0-4 (continued)

Rio, Grass-Cow-Milk Pathway Dose Factors - INFANT

(mrem/yr per µCi/m^3) for H-3 and C-14
(m^2 x mrem/yr per µCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3
C-14	3.23E+6	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5
Na-24	1.61E+7	1.61E+7	1.61E+7	1.61E+7	1.61E+7	1.61E+7	1.61E+7
P-32	1.60E+11	9.42E+9	-	-	-	2.17E+9	6.21E+9
Cr-51	-	-	1.05E+5	2.30E+4	2.05E+5	4.71E+6	1.61E+5
Mn-54	-	3.89E+7	-	8.63E+6	-	1.43E+7	8.83E+6
Mn-56	-	3.21E-2	-	2.76E-2	-	2.91E+0	5.53E-3
Fe-55	1.35E+8	8.72E+7	-	-	4.27E+7	1.11E+7	2.33E+7
Fe-59	2.25E+8	3.93E+8	-	-	1.16E+8	1.88E+8	1.55E+8
Co-57	-	8.95E+6	-	-	-	3.05E+7	1.46E+7
Co-58	-	2.43E+7	-	-	-	6.05E+7	6.06E+7
Co-60	-	8.81E+7	-	-	-	2.10E+8	2.08E+8
Ni-63	3.49E+10	2.16E+9	-	-	-	1.07E+8	1.21E+9
Ni-65	3.51E+0	3.97E-1	-	-	-	3.02E+1	1.81E-1
Cu-64	-	1.88E+5	-	3.17E+5	-	3.85E+6	8.69E+4
Zn-65	5.55E+9	1.90E+10	-	9.23E+9	-	1.61E+10	8.78E+9
Zn-69	-	-	-	-	-	7.36E-9	-
Br-82	-	-	-	-	-	-	1.94E+8
Br-83	-	-	-	-	-	-	9.95E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.22E+10	-	-	-	5.69E+8	1.10E+10
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	1.26E+10	-	-	-	-	2.59E+8	3.61E+8
Sr-90	1.22E+11	-	-	-	-	1.52E+9	3.10E+10
Sr-91	2.94E+5	-	-	-	-	3.48E+5	1.06E+4
Sr-92	4.65E+0	-	-	-	-	5.01E+1	1.73E-1
Y-90	6.80E+2	-	-	-	-	9.39E+5	1.82E+1
Y-91m	-	-	-	-	-	-	-
Y-91	7.33E+4	-	-	-	-	5.26E+6	1.95E+3
Y-92	5.22E-4	-	-	-	-	9.97E+0	1.47E-5
Y-93	2.25E+0	-	-	-	-	1.78E+4	6.13E-2
Zr-95	6.83E+3	1.66E+3	-	1.79E+3	-	8.28E+5	1.18E+3
Zr-97	3.99E+0	6.85E-1	-	6.91E-1	-	4.37E+6	3.13E-1
Nb-95	5.93E+5	2.44E+5	-	1.75E+5	-	2.06E+8	1.41E+5
Nb-97	-	-	-	-	-	3.70E-6	-
Mo-99	-	2.12E+8	-	3.17E+8	-	6.98E+7	4.13E+7
Tc-99m	2.69E+1	5.55E+1	-	5.97E+2	2.90E+1	1.61E+4	7.15E+2
Tc-101	-	-	-	-	-	-	-
Ru-103	8.69E+3	-	-	1.81E+4	-	1.06E+5	2.91E+3
Ru-105	8.06E-3	-	-	5.92E-2	-	3.21E+0	2.71E-3
Ru-106	1.90E+5	-	-	2.25E+5	-	1.44E+6	2.38E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	3.86E+8	2.82E+8	-	4.03E+8	-	1.46E+10	1.86E+8
Sb-124	2.09E+8	3.08E+6	5.56E+5	-	1.31E+8	6.46E+8	6.49E+7
Sb-125	1.49E+8	1.45E+6	1.87E+5	-	9.38E+7	1.99E+8	3.07E+7
Te-125m	1.51E+8	5.04E+7	5.07E+7	-	-	7.18E+7	2.04E+7
Te-127m	4.21E+8	1.40E+8	1.22E+8	1.04E+9	-	1.70E+8	5.10E+7
Te-127	6.50E+3	2.18E+3	5.29E+3	1.59E+4	-	1.36E+5	1.40E+3
Te-129m	5.59E+8	1.92E+8	2.15E+8	1.40E+9	-	3.34E+8	8.62E+7
Te-129	2.08E-9	-	1.75E-9	5.18E-9	-	1.66E-7	-
Te-131m	3.38E+6	1.36E+6	2.76E+6	9.35E+6	-	2.29E+7	1.12E+6
Te-131	-	-	-	-	-	-	-
Te-132	2.10E+7	1.04E+7	1.54E+7	6.51E+7	-	3.85E+7	9.72E+6
I-130	3.60E+6	7.92E+6	8.88E+8	8.70E+6	-	1.70E+6	3.18E+6
I-131	2.72E+9	3.21E+9	1.05E+12	3.75E+9	-	1.15E+8	1.41E+9
I-132	1.42E+0	2.89E+0	1.35E+2	3.22E+0	-	2.34E+0	1.03E+0
I-133	3.72E+7	5.41E+7	9.84E+9	6.36E+7	-	9.16E+6	1.58E+7
I-134	-	-	1.01E-9	-	-	-	-
I-135	1.21E+5	2.41E+5	2.16E+7	2.69E+5	-	8.74E+4	8.80E+4
Cs-134	3.65E+10	6.80E+10	-	1.75E+10	7.18E+9	1.85E+8	6.87E+9
Cs-136	1.96E+9	5.77E+9	-	2.30E-9	4.70E+8	8.76E+7	2.15E+9
Cs-137	5.15E+10	6.02E+10	-	1.62E+10	6.55E+9	1.88E+8	4.27E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	4.55E-7	-	-	-	-	2.88E-5	1.32E-8
Ba-140	2.41E+8	2.41E+5	-	5.73E+4	1.48E+5	5.92E+7	1.24E+7
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	4.03E+1	1.59E+1	-	-	-	1.87E+5	4.09E+0
La-142	-	-	-	-	-	5.21E-6	-
Ce-141	4.33E+4	2.64E+4	-	8.15E+3	-	1.37E+7	3.11E+3
Ce-143	4.00E+2	2.65E+5	-	7.72E+1	-	1.55E+6	3.02E+1
Ce-144	2.33E+6	9.52E+5	-	3.85E+5	-	1.33E+8	1.30E+5
Pr-143	1.49E+3	5.59E+2	-	2.08E+2	-	7.89E+5	7.41E+1
Pr-144	-	-	-	-	-	-	-
Nd-147	8.82E+2	9.06E+2	-	3.49E+2	-	5.74E+5	5.55E+1
W-187	6.12E+4	4.26E+4	-	-	-	2.50E+6	1.47E+4
Np-239	3.64E+1	3.25E+0	-	6.49E+0	-	9.40E+4	1.84E+0

Table 7.0-4 (continued)

Kiw, Grass-Cow-Meat Pathway Dose Factors - ADULT

(mrem/yr per μCi/m³) for H-3 and C-14
(m² x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	3.25E+2	3.25E+2	3.25E+2	3.25E+2	3.25E+2	3.25E+2
C-14	3.33E+5	6.66E+4	6.66E+4	6.66E+4	6.66E+4	6.66E+4	6.66E+4
Na-24	1.84E-3	1.84E-3	1.84E-3	1.84E-3	1.84E-3	1.84E-3	1.84E-3
P-32	4.65E+9	2.89E+8	-	-	-	5.23E+8	1.80E+0
Cr-51	-	-	4.22E+3	1.56E+3	9.38E+3	1.78E+6	7.07E+3
Mn-54	-	9.15E+6	-	2.72E+6	-	2.80E+7	1.75E+6
Mn-56	-	-	-	-	-	-	-
Fe-55	2.93E+8	2.02E+8	-	-	1.13E+8	1.16E+8	4.72E+7
Fe-59	2.67E+8	6.27E+8	-	-	1.75E+8	2.09E+9	2.40E+8
Co-57	-	5.64E+6	-	-	-	1.43E+8	9.37E+6
Co-58	-	1.83E+7	-	-	-	3.70E+8	4.10E+7
Co-60	-	7.52E+7	-	-	-	1.41E+9	1.66E+8
Ni-63	1.89E+10	1.31E+9	-	-	-	2.73E+8	6.33E+8
Ni-65	-	-	-	-	-	-	-
Cu-64	-	2.95E-7	-	7.45E-7	-	2.52E-5	1.39E-7
Zn-65	3.56E+8	1.13E+9	-	7.57E+8	-	7.13E+8	5.12E+8
Zn-69	-	-	-	-	-	-	-
Br-82	-	-	-	-	-	1.44E+3	1.26E+3
Br-83	-	-	-	-	-	-	-
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	4.87E+8	-	-	-	9.60E+7	2.27E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	3.01E+8	-	-	-	-	4.84E+7	8.65E+6
Sr-90	1.24E+10	-	-	-	-	3.59E+8	3.05E+9
Sr-91	-	-	-	-	-	1.38E-9	-
Sr-92	-	-	-	-	-	-	-
Y-90	1.07E+2	-	-	-	-	1.13E+6	2.86E+0
Y-91m	-	-	-	-	-	-	-
Y-91	1.13E+6	-	-	-	-	6.24E+8	3.03E+4
Y-92	-	-	-	-	-	-	-
Y-93	-	-	-	-	-	2.08E-7	-
Zr-95	1.88E+6	6.04E+5	-	9.48E+5	-	1.91E+9	4.09E+5
Zr-97	1.83E-5	3.69E-6	-	5.58E-6	-	1.14E+0	1.69E-6
Nb-95	2.29E+6	1.28E+6	-	1.26E+6	-	7.75E+9	6.86E+5
Nb-97	-	-	-	-	-	-	-
Mo-99	-	1.09E+5	-	2.46E+5	-	2.52E+5	2.07E+4
Tc-99m	-	-	-	-	-	-	-
Tc-101	-	-	-	-	-	-	-
Ru-103	1.06E+8	-	-	4.03E+8	-	1.23E+10	4.55E+7
Ru-105	-	-	-	-	-	-	-
Ru-106	2.80E+9	-	-	5.40E+9	-	1.81E+11	3.54E+8
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	6.69E+6	6.19E+6	-	1.22E+7	-	2.52E+9	3.67E+6
Sb-124	1.98E+7	3.74E+5	4.80E+4	-	1.54E+7	5.62E+8	7.85E+6
Sb-125	1.91E+7	2.13E+5	1.94E+4	-	1.47E+7	2.10E+8	4.54E+6
Te-125m	3.59E+8	1.30E+8	1.08E+8	1.46E+9	-	1.43E+9	4.81E+7
Te-127m	1.12E+9	3.99E+8	2.85E+8	4.53E+9	-	3.74E+9	1.36E+8
Te-127	-	-	-	1.09E-9	-	2.10E-8	-
Te-129m	1.14E+9	4.27E+8	3.93E+8	4.77E+9	-	5.76E+9	1.81E+8
Te-129	-	-	-	-	-	-	-
Te-131m	4.51E+2	2.21E+2	3.50E+2	2.24E+3	-	2.19E+4	1.84E+2
Te-131	-	-	-	-	-	-	-
Te-132	1.40E+6	9.07E+5	1.00E+6	8.73E+6	-	4.29E+7	8.51E+5
I-130	2.35E-6	6.94E-6	5.88E-4	1.08E-5	-	5.98E-6	2.74E-6
I-131	1.08E+7	1.54E+7	5.05E+9	2.64E+7	-	4.07E+6	8.83E+6
I-132	-	-	-	-	-	-	-
I-133	4.30E-1	7.47E-1	1.10E+2	1.30E+0	-	6.72E-1	2.28E-1
I-134	-	-	-	-	-	-	-
I-135	-	-	-	-	-	-	-
Cs-134	6.57E+8	1.56E+9	-	5.06E+8	1.68E+8	2.74E+7	1.28E+9
Cs-136	1.18E+7	4.67E+7	-	2.60E+7	3.56E+6	5.30E+6	3.36E+7
Cs-137	8.72E+8	1.19E+9	-	4.05E+8	1.35E+8	2.31E+7	7.81E+8
Cs-138	-	-	-	-	-	-	-
Ba-139	-	-	-	-	-	-	-
Ba-140	2.88E+7	3.61E+4	-	1.23E+4	2.07E+4	5.92E+7	1.89E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	3.60E-2	1.81E-2	-	-	-	1.33E+3	4.79E-3
La-142	-	-	-	-	-	-	-
Ce-141	1.40E+4	9.48E+3	-	4.40E+3	-	3.62E+7	1.08E+3
Ce-143	2.09E-2	1.55E+1	-	6.80E-3	-	5.78E+2	1.71E-3
Ce-144	1.46E+6	6.09E+5	-	3.61E+5	-	4.93E+8	7.83E+4
Pr-143	2.13E+4	8.54E+3	-	4.93E+3	-	9.33E+7	1.06E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	7.08E+3	8.18E+3	-	4.78E+3	-	3.93E+7	4.90E+2
W-187	2.16E-2	1.81E-2	-	-	-	5.92E+0	6.32E-3
Np-239	2.56E-1	2.51E-2	-	7.84E-2	-	5.15E+3	1.39E-2

Table 7.0-4 (continued)

R_{io}, Grass-Cow-Meat Pathway Dose Factors - TEENAGER

(mrem/yr per µCi/m³) for H-3 and C-14
(m² x mrem/yr per µCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.94E+2	1.94E+2	1.94E+2	1.94E+2	1.94E+2	1.94E+2
C-14	2.81E+5	5.62E+4	5.62E+4	5.62E+4	5.62E+4	5.62E+4	5.62E+4
Na-24	1.47E-3	1.47E-3	1.47E-3	1.47E-3	1.47E-3	1.47E-3	1.47E-3
P-32	3.93E+9	2.44E+8	-	-	-	3.30E+8	1.52E+8
Cr-51	-	-	3.14E+3	1.24E+3	8.07E+3	9.50E+5	5.65E+3
Mn-54	-	6.98E+6	-	2.08E+6	-	1.43E+7	1.38E+6
Mn-56	-	-	-	-	-	-	-
Fe-55	2.38E+8	1.69E+8	-	-	1.07E+8	7.30E+7	3.93E+7
Fe-59	2.13E+8	4.98E+8	-	-	1.57E+8	1.18E+9	1.92E+8
Co-57	-	4.53E+6	-	-	-	8.45E+7	7.59E+6
Co-58	-	1.41E+7	-	-	-	1.94E+8	3.25E+7
Co-60	-	5.83E+7	-	-	-	7.60E+8	1.31E+8
Ni-63	1.52E+10	1.07E+9	-	-	-	1.71E+8	5.15E+8
Ni-65	-	-	-	-	-	-	-
Cu-64	-	2.41E-7	-	6.10E-7	-	1.87E-5	1.13E-7
Zn-65	2.50E+8	8.69E+8	-	5.56E+8	-	3.68E+8	4.05E+8
Zn-69	-	-	-	-	-	-	-
Br-82	-	-	-	-	-	-	9.98E+2
Br-83	-	-	-	-	-	-	-
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	4.06E+8	-	-	-	6.01E+7	1.91E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	2.54E+8	-	-	-	-	3.03E+7	7.29E+6
Sr-90	8.05E+9	-	-	-	-	2.26E+8	1.99E+9
Sr-91	-	-	-	-	-	1.10E-9	-
Sr-92	-	-	-	-	-	-	-
Y-90	8.98E+1	-	-	-	-	7.40E+5	2.42E+0
Y-91m	-	-	-	-	-	-	-
Y-91	9.56E+5	-	-	-	-	3.92E+8	2.56E+4
Y-92	-	-	-	-	-	-	-
Y-93	-	-	-	-	-	1.69E-7	-
Zr-95	1.51E+6	4.76E+5	-	6.99E+5	-	1.10E+9	3.27E+5
Zr-97	1.53E-5	3.02E-6	-	4.58E-6	-	8.18E-1	1.39E-6
Nb-95	1.79E+6	9.94E+5	-	9.64E+5	-	4.25E+9	5.47E+5
Nb-97	-	-	-	-	-	-	-
Mo-99	-	8.98E+4	-	2.06E+5	-	1.61E+5	1.71E+4
Tc-99m	-	-	-	-	-	-	-
Tc-101	-	-	-	-	-	-	-
Ru-103	8.60E+7	-	-	3.03E+8	-	7.18E+9	3.68E+7
Ru-105	-	-	-	-	-	-	-
Ru-106	2.36E+9	-	-	4.55E+9	-	1.13E+11	2.97E+8
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	5.06E+6	4.79E+6	-	9.14E+6	-	1.35E+9	2.91E+6
Sb-124	1.62E+7	2.98E+5	3.67E+4	-	1.41E+7	3.26E+8	6.31E+6
Sb-125	1.56E+7	1.71E+5	1.49E+4	-	1.37E+7	1.22E+8	3.66E+6
Te-125m	3.03E+8	1.09E+8	8.47E+7	-	-	8.94E+8	4.05E+7
Te-127m	9.41E+8	3.34E+8	2.24E+8	3.82E+9	-	2.35E+9	1.12E+8
Te-127	-	-	-	-	-	1.75E-8	-
Te-129m	9.58E+8	3.56E+8	3.09E+8	4.01E+9	-	3.60E+9	1.52E+8
Te-129	-	-	-	-	-	-	-
Te-131m	3.76E+2	1.80E+2	2.71E+2	1.88E+3	-	1.45E+4	1.50E+2
Te-131	-	-	-	-	-	-	-
Te-132	1.15E+6	7.26E+5	7.66E+5	6.97E+6	-	2.30E+7	6.84E+5
I-130	1.89E-6	5.48E-6	4.47E-4	8.44E-6	-	4.21E-6	2.19E-6
I-131	8.95E+6	1.25E+7	3.66E+9	2.16E+7	-	2.48E+6	6.73E+6
I-132	-	-	-	-	-	-	-
I-133	3.59E-1	6.10E-1	8.51E+1	1.07E+0	-	4.61E-1	1.86E-1
I-134	-	-	-	-	-	-	-
I-135	-	-	-	-	-	-	-
Cs-134	5.23E+8	1.23E+9	-	3.91E+8	1.49E+8	1.53E+7	5.71E+8
Cs-136	9.22E+6	3.63E+7	-	1.97E+7	3.11E+6	2.92E+6	2.44E+7
Cs-137	7.24E+8	9.63E+8	-	3.28E+8	1.27E+8	1.37E+7	3.36E+8
Cs-138	-	-	-	-	-	-	-
Ba-139	-	-	-	-	-	-	-
Ba-140	2.38E+7	2.91E+4	-	9.88E+3	1.96E+4	3.67E+7	1.53E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	2.96E-2	1.45E-2	-	-	-	8.35E+2	3.87E-3
La-142	-	-	-	-	-	-	-
Ce-141	1.18E+4	7.86E+3	-	3.70E+3	-	2.25E+7	9.03E+2
Ce-143	1.76E-2	1.28E+1	-	5.74E-3	-	3.85E+2	1.43E-3
Ce-144	1.23E+6	5.08E+5	-	3.04E+5	-	3.09E+8	6.60E+4
Pr-143	1.79E+4	7.15E+3	-	4.16E+3	-	5.[illegible]E+7	8.92E+2
Pr-144	-	-	-	-	-	-	-
Nd-147	6.24E+3	6.79E+3	-	3.98E+3	-	2.45E+7	4.06E+2
W-187	1.81E-2	1.48E-2	-	-	-	3.99E+0	5.17E-3
Np-239	2.23E-1	2.11E-2	-	6.61E-2	-	3.39E+3	1.17E-2

Table 7.0-4 (continued)

R[io], Grass-Cow-Meat Pathway Dose Factors - CHILD

(mrem/yr per µCi/m³) for H-3 and C-14
(m² x mrem/yr per µCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.34E+2	2.34E+2	2.34E+2	2.34E+2	2.34E+2	2.34E+2
C-14	5.29E+5	1.06E+5	1.06E+5	1.06E+5	1.06E+5	1.06E+5	1.06E+5
Na-24	2.34E-3	2.34E-3	2.34E-3	2.34E-3	2.34E-3	2.34E-3	2.34E-3
P-32	7.41E+9	3.47E+8	-	-	-	2.05E+8	2.86E+8
Cr-51	-	-	4.89E+3	1.34E+3	8.93E+3	4.67E+5	8.81E+3
Mn-54	-	7.99E+6	-	2.24E+6	-	6.70E+6	2.13E+6
Mn-56	-	-	-	-	-	-	-
Fe-55	4.57E+8	2.42E+8	-	-	1.37E+8	4.49E+7	7.51E+7
Fe-59	3.78E+8	6.12E+8	-	-	1.77E+8	6.37E+8	3.05E+8
Co-57	-	5.92E+6	-	-	-	4.85E+7	1.20E+7
Co-58	-	1.65E+7	-	-	-	9.60E+7	5.04E+7
Co-60	-	6.93E+7	-	-	-	3.84E+8	2.04E+8
Ni-63	2.91E+10	1.56E+9	-	-	-	1.05E+8	9.91E+8
Ni-65	-	-	-	-	-	-	-
Cu-64	-	3.24E-7	-	7.82E-7	-	1.52E-5	1.96E-7
Zn-65	3.75E+8	1.00E+9	-	6.30E+8	-	1.76E+8	6.22E+8
Zn-69	-	-	-	-	-	-	-
Br-82	-	-	-	-	-	-	1.56E+3
Br-83	-	-	-	-	-	-	-
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	5.76E+8	-	-	-	3.71E+7	3.54E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	4.82E+8	-	-	-	-	1.86E+7	1.38E+7
Sr-90	1.04E+10	-	-	-	-	1.40E+8	2.64E+9
Sr-91	-	-	-	-	-	1.01E-9	-
Sr-92	-	-	-	-	-	-	-
Y-90	1.70E+2	-	-	-	-	4.84E+5	4.55E+0
Y-91m	-	-	-	-	-	-	-
Y-91	1.81E+6	-	-	-	-	2.41E+8	4.83E+4
Y-92	-	-	-	-	-	-	-
Y-93	-	-	-	-	-	1.55E-7	-
Zr-95	2.68E+6	5.89E+5	-	8.43E+5	-	6.14E+8	5.24E+5
Zr-97	2.84E-5	4.10E-6	-	5.89E-6	-	6.21E-1	2.42E-6
Nb-95	3.09E+6	1.20E+6	-	1.13E+6	-	2.23E+9	8.61E+5
Nb-97	-	-	-	-	-	-	-
Mo-99	-	1.25E+5	-	2.67E+5	-	1.03E+5	3.09E+4
Tc-99m	-	-	-	-	-	-	-
Tc-101	-	-	-	-	-	-	-
Ru-103	1.56E+8	-	-	3.92E+8	-	4.02E+9	5.98E+7
Ru-105	-	-	-	-	-	-	-
Ru-106	4.44E+9	-	-	5.99E+9	-	6.90E+10	5.54E+8
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	8.40E+6	5.67E+6	-	1.06E+7	-	6.75E+8	4.53E+6
Sb-124	2.93E+7	3.80E+5	6.46E+4	-	1.62E+7	1.83E+8	1.03E+7
Sb-125	2.85E+7	2.19E+5	2.64E+4	-	1.59E+7	6.80E+7	5.96E+6
Te-125m	5.69E+8	1.54E+8	1.60E+8	-	-	5.49E+8	7.59E+7
Te-127m	1.77E+9	4.78E+8	4.24E+8	5.06E+9	-	1.44E+9	2.11E+8
Te-127	-	-	-	1.21E-9	-	1.66E-8	-
Te-129m	1.81E+9	5.04E+8	5.82E+8	5.30E+9	-	2.20E+9	2.80E+8
Te-129	-	-	-	-	-	-	-
Te-131m	7.00E+2	2.42E+2	4.98E+2	2.34E+3	-	9.82E+3	2.58E+2
Te-131	-	-	-	-	-	-	-
Te-132	2.09E+6	9.27E+5	1.35E+6	8.60E+6	-	9.33E+6	1.12E+6
I-130	3.39E-6	6.85E-6	7.54E-4	1.02E-5	-	3.20E-6	3.53E-6
I-131	1.66E+7	1.67E+7	5.52E+9	2.74E+7	-	1.49E+6	9.49E+6
I-132	-	-	-	-	-	-	-
I-133	6.68E-1	8.26E-1	1.53E+2	1.38E+0	-	3.33E-1	3.12E-1
I-134	-	-	-	-	-	-	-
I-135	-	-	-	-	-	-	-
Cs-134	9.22E+8	1.51E+9	-	4.69E+8	1.68E+8	8.15E+6	3.19E+8
Cs-136	1.59E+7	4.37E+7	-	2.33E+7	3.47E+6	1.54E+6	2.83E+7
Cs-137	1.33E+9	1.28E+9	-	4.16E+8	1.50E+8	7.99E+6	1.88E+8
Cs-138	-	-	-	-	-	-	-
Ba-139	-	-	-	-	-	-	-
Ba-140	4.39E+7	3.85E+4	-	1.25E+4	2.29E+4	2.22E+7	2.56E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	5.41E-2	1.89E-2	-	-	-	5.27E+2	6.38E-3
La-142	-	-	-	-	-	-	-
Ce-141	2.22E+4	1.11E+4	-	4.84E+3	-	1.38E+7	1.64E+3
Ce-143	3.30E-2	1.79E+1	-	7.51E-3	-	2.62E+2	2.59E-3
Ce-144	2.32E+6	7.26E+5	-	4.02E+5	-	1.89E+8	1.24E+5
Pr-143	3.39E+4	1.02E+4	-	5.51E+3	-	3.66E+7	1.68E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	1.17E+4	9.48E+3	-	5.20E+3	-	1.50E+7	7.34E+2
W-187	3.36E-2	1.99E-2	-	-	-	2.79E+0	8.92E-3
Np-239	4.20E-1	3.02E-2	-	8.73E-2	-	2.23E+3	2.12E-2

Table 7.0-4 (continued)

R_{io}, Vegetation Pathway Dose Factors - ADULT

(mrem/yr per μCi/m³) for H-3 and C-14
(m² x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3
C-14	8.97E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5
Na-24	2.76E+5	2.76E+5	2.76E+5	2.76E+5	2.76E+5	2.76E+5	2.76E+5
P-32	1.40E+9	8.73E+7	-	-	-	1.58E+8	5.42E+7
Cr-51	-	-	2.79E+4	1.03E+4	6.19E+4	1.17E+7	4.66E+4
Mn-54	-	3.11E+8	-	9.27E+7	-	9.54E+8	5.94E+7
Mn-56	-	1.61E+1	-	2.04E+1	-	5.13E+2	2.85E+0
Fe-55	2.09E+8	1.45E+8	-	-	8.06E+7	8.29E+7	3.37E+7
Fe-59	1.27E+8	2.99E+8	-	-	8.35E+7	9.96E+8	1.14E+8
Co-57	-	1.17E+7	-	-	-	2.97E+8	1.95E+7
Co-58	-	3.09E+7	-	-	-	6.26E+8	6.92E+7
Co-60	-	1.67E+8	-	-	-	3.14E+9	3.69E+8
Ni-63	1.04E+10	7.21E+8	-	-	-	1.50E+8	3.49E+8
Ni-65	6.15E+1	7.99E+0	-	-	-	2.03E+2	3.65E+0
Cu-64	-	9.27E+3	-	2.34E+4	-	7.90E+5	4.35E+3
Zn-65	3.17E+8	1.01E+9	-	6.75E+8	-	6.36E+8	4.56E+8
Zn-69	8.75E-6	1.67E-5	-	1.09E-5	-	2.51E-6	1.16E-6
Br-82	-	-	-	-	-	1.73E+6	1.51E+6
Br-83	-	-	-	-	-	4.63E+0	3.21E+0
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.19E+8	-	-	-	4.32E+7	1.02E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	9.96E+9	-	-	-	-	1.60E+9	2.86E+8
Sr-90	6.05E+11	-	-	-	-	1.75E+10	1.48E+11
Sr-91	3.20E+5	-	-	-	-	1.52E+6	1.29E+4
Sr-92	4.27E+2	-	-	-	-	8.46E+3	1.85E+1
Y-90	1.33E+4	-	-	-	-	1.41E+8	3.56E+2
Y-91m	5.83E-9	-	-	-	-	1.71E-8	-
Y-91	5.13E+6	-	-	-	-	2.82E+9	1.37E+5
Y-92	9.01E-1	-	-	-	-	1.58E+4	2.63E-2
Y-93	1.74E+2	-	-	-	-	5.52E+6	4.80E+0
Zr-95	1.19E+6	3.81E+5	-	5.97E+5	-	1.21E+9	2.58E+5
Zr-97	3.33E+2	6.73E+1	-	1.02E+2	-	2.06E+7	3.08E+1
Nb-95	1.42E+5	7.91E+4	-	7.81E+4	-	4.80E+8	4.25E+4
Nb-97	2.90E-6	7.34E-7	-	8.56E-7	-	2.71E-3	2.68E-7
Mo-99	-	6.25E+6	-	1.41E+7	-	1.45E+7	1.19E+6
Tc-99m	3.06E+0	8.66E+0	-	1.32E+2	4.24E+0	5.12E+3	1.10E+2
Tc-101	-	-	-	-	-	-	-
Ru-103	4.80E+6	-	-	1.83E+7	-	5.61E+8	2.07E+6
Ru-105	5.39E+1	-	-	6.96E+2	-	3.30E+4	2.13E+1
Ru-106	1.93E+8	-	-	3.72E+8	-	1.25E+10	2.44E+7
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.06E+7	9.76E+6	-	1.92E+7	-	3.98E+9	5.80E+6
Sb-124	1.04E+8	1.96E+6	2.52E+5	-	8.08E+7	2.95E+9	4.11E+7
Sb-125	1.36E+8	1.52E+6	1.39E+5	-	1.05E+8	1.50E+9	3.25E+7
Te-125m	9.66E+7	3.50E+7	2.90E+7	3.93E+8	-	3.86E+8	1.29E+7
Te-127m	3.49E+8	1.25E+8	8.92E+7	1.42E+9	-	1.17E+9	4.26E+7
Te-127	5.76E+3	2.07E+3	4.27E+3	2.35E+4	-	4.54E+5	1.25E+3
Te-129m	2.55E+8	9.50E+7	8.75E+7	1.06E+9	-	1.28E+9	4.03E+7
Te-129	6.65E-4	2.50E-4	5.10E-4	2.79E-3	-	5.02E-4	1.62E-4
Te-131m	9.12E+5	4.46E+5	7.06E+5	4.52E+6	-	4.43E+7	3.72E+5
Te-131	-	-	-	-	-	-	-
Te-132	4.29E+6	2.77E+6	3.06E+6	2.67E+7	-	1.31E+8	2.60E+6
I-130	3.96E+5	1.17E+6	9.90E+7	1.82E+6	-	1.01E+6	4.61E+5
I-131	8.09E+7	1.16E+8	3.79E+10	1.98E+8	-	3.05E+7	6.63E+7
I-132	5.74E+1	1.54E+2	5.38E+3	2.45E+2	-	2.89E+1	5.38E+1
I-133	2.12E+6	3.69E+6	5.42E+8	6.44E+6	-	3.31E+6	1.12E+6
I-134	1.06E-4	2.88E-4	5.00E-3	4.59E-4	-	2.51E-7	1.03E-4
I-135	4.08E+4	1.07E+5	7.04E+6	1.71E+5	-	1.21E+5	3.94E+4
Cs-134	4.66E+9	1.11E+10	-	3.59E+9	1.19E+9	1.94E+8	9.07E+9
Cs-136	4.20E+7	1.66E+8	-	9.24E+7	1.27E+7	1.89E+7	1.19E+8
Cs-137	6.36E+9	8.70E+9	-	2.95E+9	9.81E+8	1.68E+8	5.70E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	2.95E-2	2.10E-5	-	1.96E-5	1.19E-5	5.23E-2	8.64E-4
Ba-140	1.29E+8	1.62E+5	-	5.49E+4	9.25E+4	2.65E+8	8.43E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	1.97E+3	9.92E+2	-	-	-	7.28E+7	2.62E+2
La-142	1.40E-4	6.35E-5	-	-	-	4.64E-1	1.58E-5
Ce-141	1.96E+5	1.33E+5	-	6.17E+4	-	5.08E+8	1.51E+4
Ce-143	1.00E+3	7.42E+5	-	3.26E+2	-	2.77E+7	8.21E+1
Ce-144	3.29E+7	1.38E+7	-	8.16E+6	-	1.11E+10	1.77E+6
Pr-143	6.34E+4	2.54E+4	-	1.47E+4	-	2.78E+8	3.14E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	3.34E+4	3.86E+4	-	2.25E+4	-	1.85E+8	2.31E+3
W-187	3.82E+4	3.19E+4	-	-	-	1.05E+7	1.12E+4
Np-239	1.42E+3	1.40E+2	-	4.37E+2	-	2.87E+7	7.72E+1

Table 7.0-4 (continued)

R_{io}, Vegetation Pathway Dose Factors - TEENAGER

(mrem/yr per µCi/m³) for H-3 and C-14
(m² x mrem/yr per µCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3
C-14	1.45E+6	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5
Na-24	2.45E+5	2.45E+5	2.45E+5	2.45E+5	2.45E+5	2.45E+5	2.45E+5
P-32	1.61E+9	9.96E+7	-	-	-	1.35E+8	6.23E+7
Cr-51	-	-	3.44E+4	1.36E+4	8.85E+4	1.04E+7	6.20E+4
Mn-54	-	4.52E+8	-	1.35E+8	-	9.27E+8	8.97E+7
Mn-56	-	1.45E+1	-	1.83E+1	-	9.54E+2	2.58E+0
Fe-55	3.25E+8	2.31E+8	-	-	1.46E+8	9.98E+7	5.38E+7
Fe-59	1.81E+8	4.22E+8	-	-	1.33E+8	9.98E+8	1.63E+8
Co-57	-	1.79E+7	-	-	-	3.34E+8	3.00E+7
Co-58	-	4.38E+7	-	-	-	6.04E+8	1.01E+8
Co-60	-	2.49E+8	-	-	-	3.24E+9	5.60E+8
Ni-63	1.61E+10	1.13E+9	-	-	-	1.81E+8	5.45E+8
Ni-65	5.73E+1	7.32E+0	-	-	-	3.97E+2	3.33E+0
Cu-64	-	8.40E+3	-	2.12E+4	-	6.51E+5	3.95E+3
Zn-65	4.24E+8	1.47E+9	-	9.41E+8	-	6.23E+8	6.86E+8
Zn-69	8.19E-6	1.56E-5	-	1.02E-5	-	2.88E-5	1.09E-6
Br-82	-	-	-	-	-	-	1.33E+6
Br-83	-	-	-	-	-	-	3.01E+0
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.73E+8	-	-	-	4.05E+7	1.28E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	1.51E+10	-	-	-	-	1.80E+9	4.33E+8
Sr-90	7.51E+11	-	-	-	-	2.11E+10	1.85E+11
Sr-91	2.99E+5	-	-	-	-	1.36E+6	1.19E+4
Sr-92	3.97E+2	-	-	-	-	1.01E+4	1.69E+1
Y-90	1.24E+4	-	-	-	-	1.02E+8	3.34E+2
Y-91m	5.43E-9	-	-	-	-	2.56E-7	-
Y-91	7.87E+6	-	-	-	-	3.23E+9	2.11E+5
Y-92	6.47E-1	-	-	-	-	2.32E+4	2.45E-2
Y-93	1.63E+2	-	-	-	-	4.98E+6	4.47E+0
Zr-95	1.74E+6	5.49E+5	-	8.07E+5	-	1.27E+9	3.78E+5
Zr-97	3.09E+2	6.11E+1	-	9.26E+1	-	1.65E+7	2.81E+1
Nb-95	1.92E+5	1.06E+5	-	1.03E+5	-	4.55E+8	5.86E+4
Nb-97	2.69E-6	6.67E-7	-	7.80E-7	-	1.59E-2	2.44E-7
Mo-99	-	5.74E+6	-	1.31E+7	-	1.03E+7	1.09E+6
Tc-99m	2.70E+0	7.54E+0	-	1.12E+2	4.19E+0	4.95E+3	9.77E+1
Tc-101	-	-	-	-	-	-	-
Ru-103	6.87E+6	-	-	2.42E+7	-	5.74E+8	2.94E+6
Ru-105	5.00E+1	-	-	6.31E+2	-	4.04E+4	1.94E+1
Ru-106	3.09E+8	-	-	5.97E+8	-	1.48E+10	3.90E+7
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.52E+7	1.44E+7	-	2.74E+7	-	4.04E+9	8.74E+6
Sb-124	1.55E+8	2.85E+6	3.51E+5	-	1.35E+8	3.11E+9	6.03E+7
Sb-125	2.14E+8	2.34E+6	2.04E+5	-	1.88E+8	1.66E+9	5.00E+7
Te-125m	1.48E+8	5.34E+7	4.14E+7	-	-	4.37E+8	1.98E+7
Te-127m	5.51E+8	1.96E+8	1.31E+8	2.24E+9	-	1.37E+9	6.56E+7
Te-127	5.43E+3	1.92E+3	3.74E+3	2.20E+4	-	4.19E+5	1.17E+3
Te-129m	3.67E+8	1.36E+8	1.18E+8	1.54E+9	-	1.38E+9	5.81E+7
Te-129	6.22E-4	2.32E-4	4.45E-4	2.61E-3	-	3.40E-3	1.51E-4
Te-131m	8.44E+5	4.05E+5	6.09E+5	4.22E+6	-	3.25E+7	3.38E+5
Te-131	-	-	-	-	-	-	-
Te-132	3.90E+6	2.47E+6	2.60E+6	2.37E+7	-	7.82E+7	2.32E+6
I-130	3.54E+5	1.02E+6	8.35E+7	1.58E+6	-	7.87E+5	4.09E+5
I-131	7.70E+7	1.08E+8	3.14E+10	1.85E+8	-	2.13E+7	5.79E+7
I-132	5.18E+1	1.36E+2	4.57E+3	2.14E+2	-	5.91E+1	4.87E+1
I-133	1.97E+6	3.34E+6	4.66E+8	5.86E+6	-	2.53E+6	1.02E+6
I-134	9.59E-5	2.54E-4	4.24E-3	4.01E-4	-	3.35E-6	9.13E-5
I-135	3.68E+4	9.48E+4	6.10E+6	1.50E+5	-	1.05E+5	3.52E+4
Cs-134	7.09E+9	1.67E+10	-	5.30E+9	2.02E+9	2.08E+8	7.74E+9
Cs-136	4.29E+7	1.69E+8	-	9.19E+7	1.45E+7	1.36E+7	1.13E+8
Cs-137	1.01E+10	1.35E+10	-	4.59E+9	1.78E+9	1.92E+8	4.69E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	2.77E-2	1.95E-5	-	1.84E-5	1.34E-5	2.47E-1	8.08E-4
Ba-140	1.38E+8	1.69E+5	-	5.75E+4	1.14E+5	2.13E+8	8.91E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	1.80E+3	8.84E+2	-	-	-	5.08E+7	2.35E+2
La-142	1.28E-4	5.69E-5	-	-	-	1.73E+0	1.42E-5
Ce-141	2.82E+5	1.88E+5	-	8.86E+4	-	5.38E+8	2.16E+4
Ce-143	9.37E+2	6.82E+5	-	3.06E+2	-	2.05E+7	7.62E+1
Ce-144	5.27E+7	2.18E+7	-	1.30E+7	-	1.33E+10	2.83E+6
Pr-143	7.12E+4	2.84E+4	-	1.65E+4	-	2.34E+8	3.55E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	3.63E+4	3.94E+4	-	2.32E+4	-	1.42E+8	2.36E+3
W-187	3.55E+4	2.90E+4	-	-	-	7.84E+6	1.02E+4
Np-239	1.38E+3	1.30E+2	-	4.09E+2	-	2.10E+7	7.24E+1

Table 7.0-4 (continued)

Ris, Vegetation Pathway Dose Factors - CHILD

(mrem/yr per µCi/m³) for H-3 and C-14
(m² x mrem/yr per µCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3
C-14	3.50E+6	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5
Na-24	3.83E+5	3.83E+5	3.83E+5	3.83E+5	3.83E+5	3.83E+5	3.83E+5
P-32	3.37E+9	1.58E+8	-	-	-	9.30E+7	1.30E+8
Cr-51	-	-	6.54E+4	1.79E+4	1.19E+5	6.25E+6	1.18E+5
Mn-54	-	6.61E+8	-	1.85E+8	-	5.55E+8	1.76E+8
Mn-56	-	1.90E+1	-	2.29E+1	-	2.75E+3	4.28E+0
Fe-55	8.00E+8	4.24E+8	-	-	2.40E+8	7.86E+7	1.31E+8
Fe-59	4.01E+8	6.49E+8	-	-	1.88E+8	6.76E+8	3.23E+8
Co-57	-	2.99E+7	-	-	-	2.45E+8	6.04E+7
Co-58	-	6.47E+7	-	-	-	3.77E+8	1.98E+8
Co-60	-	3.78E+8	-	-	-	2.10E+9	1.12E+9
Ni-63	3.95E+10	2.11E+9	-	-	-	1.42E+8	1.34E+9
Ni-65	1.05E+2	9.89E+0	-	-	-	1.21E+3	5.77E+0
Cu-64	-	1.11E+4	-	2.68E+4	-	5.20E+5	6.69E+3
Zn-65	8.12E+8	2.16E+9	-	1.36E+9	-	3.80E+8	1.35E+9
Zn-69	1.51E-5	2.18E-5	-	1.32E-5	-	1.38E-3	2.02E-6
Br-82	-	-	-	-	-	-	2.04E+6
Br-83	-	-	-	-	-	-	5.55E+0
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	4.52E+8	-	-	-	2.91E+7	2.78E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	3.59E+10	-	-	-	-	1.39E+9	1.03E+9
Sr-90	1.24E+12	-	-	-	-	1.67E+10	3.15E+11
Sr-91	5.50E+5	-	-	-	-	1.21E+6	2.08E+4
Sr-92	7.28E+2	-	-	-	-	1.38E+4	2.92E+1
Y-90	2.30E+4	-	-	-	-	6.56E+7	6.17E+2
Y-91m	9.94E-9	-	-	-	-	1.95E-5	-
Y-91	1.87E+7	-	-	-	-	2.49E+9	5.01E+5
Y-92	1.56E+0	-	-	-	-	4.51E+4	4.46E-2
Y-93	3.01E+2	-	-	-	-	4.48E+6	8.25E+0
Zr-95	3.90E+6	8.58E+5	-	1.23E+6	-	8.95E+8	7.64E+5
Zr-97	5.64E+2	8.15E+1	-	1.17E+2	-	1.23E+7	4.81E+1
Nb-95	4.10E+5	1.59E+5	-	1.50E+5	-	2.95E+8	1.14E+5
Nb-97	4.90E-6	8.85E-7	-	9.82E-7	-	2.73E-1	4.13E-7
Mo-99	-	7.83E+6	-	1.67E+7	-	6.48E+6	1.94E+6
Tc-99m	4.65E+0	9.12E+0	-	1.33E+2	4.63E+0	5.19E+3	1.51E+2
Tc-101	-	-	-	-	-	-	-
Ru-103	1.55E+7	-	-	3.89E+7	-	3.99E+8	5.94E+6
Ru-105	9.17E+1	-	-	8.06E+2	-	5.98E+4	3.33E+1
Ru-106	7.45E+8	-	-	1.01E+9	-	1.16E+10	9.30E+7
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	3.22E+7	2.17E+7	-	4.05E+7	-	2.58E+9	1.74E+7
Sb-124	3.52E+8	4.57E+6	7.78E+5	-	1.96E+8	2.20E+9	1.23E+8
Sb-125	4.99E+8	3.85E+6	4.62E+5	-	2.78E+8	1.19E+9	1.05E+8
Te-125m	3.51E+8	9.50E+7	9.84E+7	-	-	3.38E+8	4.67E+7
Te-127m	1.32E+9	3.56E+8	3.16E+8	3.77E+9	-	1.07E+9	1.57E+8
Te-127	1.00E+4	2.70E+3	6.93E+3	2.85E+4	-	3.91E+5	2.15E+3
Te-129m	8.54E+8	2.39E+8	2.75E+8	2.51E+9	-	1.04E+9	1.33E+8
Te-129	1.15E-3	3.22E-4	8.22E-4	3.37E-3	-	7.17E-2	2.74E-4
Te-131m	1.54E+6	5.33E+5	1.10E+6	5.16E+6	-	2.16E+7	5.66E+5
Te-131	-	-	-	-	-	-	-
Te-132	6.98E+6	3.09E+6	4.50E+6	2.87E+7	-	3.11E+7	3.73E+6
I-130	6.21E+5	1.26E+6	1.38E+8	1.88E+6	-	5.87E+5	6.47E+5
I-131	1.43E+8	1.44E+8	4.76E+10	2.36E+8	-	1.28E+7	8.18E+7
I-132	9.20E+1	1.69E+2	7.84E+3	2.59E+2	-	1.99E+2	7.77E+1
I-133	3.59E+6	4.44E+6	8.25E+8	7.40E+6	-	1.79E+6	1.68E+6
I-134	1.70E-4	3.16E-4	7.28E-3	4.84E-4	-	2.10E-4	1.46E-4
I-135	6.54E+4	1.18E+5	1.04E+7	1.81E+5	-	8.98E+4	5.57E+4
Cs-134	1.60E+10	2.63E+10	-	8.14E+9	2.92E+9	1.42E+8	5.54E+9
Cs-136	8.06E+7	2.22E+8	-	1.18E+8	1.76E+7	7.79E+6	1.43E+8
Cs-137	2.39E+10	2.29E+10	-	7.46E+9	2.68E+9	1.43E+8	3.38E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	5.11E-2	2.73E-5	-	2.38E-5	1.61E-5	2.95E+0	1.48E-3
Ba-140	2.77E+8	2.43E+5	-	7.90E+4	1.45E+5	1.40E+8	1.62E+7
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	3.23E+3	1.13E+3	-	-	-	3.15E+7	3.81E+2
La-142	2.32E-4	7.40E-5	-	-	-	1.47E+1	2.32E-5
Ce-141	1.23E+5	6.14E+4	-	2.69E+4	-	7.66E+7	9.12E+3
Ce-143	1.73E+3	9.36E+5	-	3.93E+2	-	1.37E+7	1.36E+2
Ce-144	1.27E+8	3.98E+7	-	2.21E+7	-	1.04E+10	6.78E+6
Pr-143	1.48E+5	4.46E+4	-	2.41E+4	-	1.60E+8	7.37E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	7.16E+4	5.80E+4	-	3.18E+4	-	9.18E+7	4.49E+3
W-187	6.47E+4	3.83E+4	-	-	-	5.38E+6	1.72E+4
Np-239	2.55E+3	1.83E+2	-	5.30E+2	-	1.36E+7	1.29E+2

Table 7.0-4 (continued)

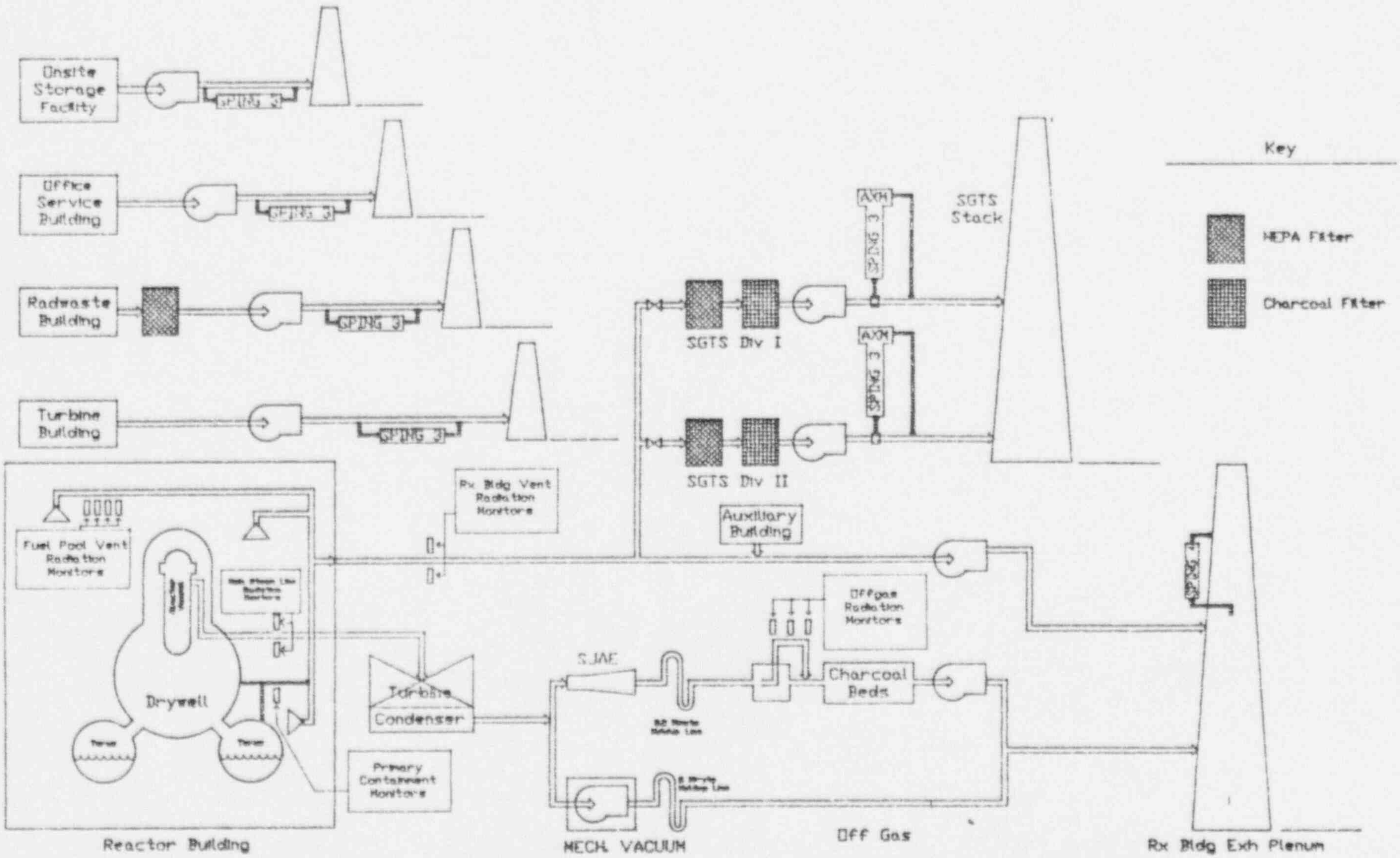
$R_{i\star}$, Ground Plane Pathway Dose Factors

(m^2 x mrem/yr per μCi/sec)

Nuclide	Any Organ
H-3	-
C-14	-
Na-24	1.21E+7
P-32	-
Cr-51	4.68E+6
Mn-54	1.34E+9
Mn-56	9.05E+5
Fe-55	-
Fe-59	2.75E+8
Co-58	3.82E+8
Co-60	2.16E+10
Ni-63	-
Ni-65	2.97E+5
Cu-64	6.09E+5
Zn-65	7.45E+8
Zn-69	-
Br-83	4.89E+3
Br-84	2.03E+5
Br-85	-
Rb-86	8.98E+6
Rb-88	3.29E+4
Rb-89	1.21E+5
Sr-89	2.16E+4
Sr-90	-
Sr-91	2.19E+6
Sr-92	7.77E+5
Y-90	4.48E+3
Y-91m	1.01E+5
Y-91	1.08E+6
Y-92	1.80E+5
Y-93	1.85E+5
Zr-95	2.48E+8
Zr-97	2.94E+6
Nb-95	1.36E+8
Mo-99	4.05E+6
Tc-99m	1.83E+5
Tc-101	2.04E+4
Ru-103	1.09E+8
Ru-105	6.36E+5
Ru-106	4.21E+8
Rh-103m	-
Rh-106	-
Ag-110m	3.47E+9
Te-125m	1.55E+6
Te-127m	9.17E+4
Te-127	3.00E+3
Te-129m	2.00E+7
Te-129	2.60E+4
Te-131m	8.03E+6
Te-131	2.93E+4
Te-132	4.22E+6
I-130	5.53E+6
I-131	1.72E+7
I-132	1.24E+6
I-133	2.47E+6
I-134	4.49E+5
I-135	2.56E+6
Cs-134	6.75E+9
Cs-136	1.49E+8
Cs-137	1.04E+10
Cs-138	3.59E+5
Ba-139	1.06E+5
Ba-140	2.05E+7
Ba-141	4.18E+4
Ba-142	4.49E+4
La-140	1.91E+7
La-142	7.36E+5
Ce-141	1.36E+7
Ce-143	2.32E+6
Ce-144	6.95E+7
Pr-143	-
Pr-144	1.83E+3
Nd-147	8.40E+6
W-187	2.36E+6
Np-239	1.71E+6

FIGURE 7.0-1

GASEOUS RADIOACTIVE EFFLUENT MONITORING AND VENTILATION SYSTEMS DIAGRAM



NOTE: The HEPA and charcoal filters identified on the Standby Gas Treatment System (SGTS) are part of the engineered safety feature and are not considered Ventilation Exhaust Treatment Systems (VETS). No effluent reduction was credited in the UFSAR 10CFR50 Appendix I evaluation for the HEPA filter installed in the Radwaste ventilation. Fermi 2 conforms with 10CFR50 Appendix I without VETS installed.

END

8.0 SPECIAL DOSE ANALYSES

8.1 Doses Due to Activities inside the SITE BOUNDARY

In accordance with ODCM 5.9.1.8, the Semiannual Radioactive Effluent Release Report submitted within 60 days after January 1 of each year shall include an assessment of radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY.

Two locations within the Fermi 2 SITE BOUNDARY are accessible to MEMBERS OF THE PUBLIC for activities unrelated to Detroit Edison operational and support activities. One is the over-water portion of the SITE BOUNDARY due east of the plant. Ice fishermen sometimes fish here during the winter. The other is the Fermi 2 Visitor's Center, outside the protected area (but inside the Owner Controlled Area), approximately 470 meters SSW of the Reactor Building. The Visitor's Center is open to the public and is routinely visited by MEMBERS OF THE PUBLIC, including school tour groups on a frequency of once per year.

Conservative assumptions of locations, exposure times and exposure pathways for assessing doses due to activities inside the SITE BOUNDARY are presented in Table 8.0-1. The calculational methods presented in ODCM Sections 7.6 and 7.7 may be used for determining the maximum potential dose to a MEMBER OF THE PUBLIC based on the above assumptions.

The potential dose from the fish pathway to a MEMBER OF THE PUBLIC engaged in ice fishing within the SITE BOUNDARY is accounted for by the modeling presented in ODCM Section 6.5. Therefore, no additional special dose analyses are required for this exposure pathway for reporting in the Semiannual Radioactive Effluent Release Report.

8.2 Doses to MEMBERS OF THE PUBLIC - 40 CFR 190

The Semiannual Radioactive Effluent Release Report shall also include an assessment of the radiation dose to the likely most exposed MEMBER OF THE PUBLIC for reactor releases and other nearby uranium fuel cycle sources (including dose contributions from effluents and direct radiation from onsite sources). For the likely most exposed MEMBER OF THE PUBLIC in the vicinity of the Fermi 2 site, the sources of exposure need consider only the radioactive effluents and direct exposure contribution from Fermi 2. No other fuel cycle facilities contribute significantly to the cumulative dose to a MEMBER OF THE PUBLIC in the immediate vicinity of the site. Davis-Besse is the closest fuel cycle facility located about 20 miles to the SSE. Due to environmental dispersion, any routine releases from Davis-Besse would contribute insignificantly to the potential doses in the vicinity of Fermi 2.

As appropriate for demonstrating/evaluating compliance with the limits of ODCM 3.11.4 (40 CFR 190), the results of the environmental monitoring program may be used to provide data on actual measured levels of radioactive material in the actual pathways of exposure.

8.2.1 Effluent Dose Calculations

For purposes of implementing the surveillance requirements of ODCM 3.11.4 and the reporting requirements of ODCM 5.9.1.8, dose calculations for Fermi 2 may be performed using the calculational methods contained within this ODCM; the conservative controlling pathways and locations of Table 7.0-3 or the actual pathways and locations as identified by the land use census (ODCM 3.12.2 and ODCM 9.0) may be used. Liquid pathway doses may be calculated using Equation (6-10). Doses due to releases of radioiodines, tritium and particulates are calculated based on Equation (7-14).

The following equations may be used for calculating the doses to MEMBERS OF THE PUBLIC from releases of noble gases:

$$D_{tb} = 3.17\ E - 08 * X/Q * \sum (K_i * Q_i) \quad (8\text{-}1)$$

and

$$D_s = 3.17\ E - 08 * X/Q * \sum ([L_i + 1.1\ M_i] * Q_i) \quad (8\text{-}2)$$

where:

D_{tb} = total body dose due to gamma emissions for noble gas radionuclides (mrem)

D_s = skin dose due to gamma and beta emissions for noble gas radionuclides (mrad)

X/Q = atmospheric dispersion to the offsite location (sec/m^3)

Q_i = cumulative release of noble gas radionuclide i over the period of interest (uCi)

= C_i x VF x 1.67E + 01

C_i = concentration of radionuclide i as determined by gamma spectral analysis of media (uCi/ml)

VF = average ventilation flow for release point (liters/min)

1.67E + 01 = (1E + 03 ml/liter) * (1 min/60 sec)

K_i = total body dose factor due to gamma emissions from noble gas radionuclide i (mrem/yr per uCi/m^3) (from Table 7.0-2)

L_i = skin dose factor due to beta emissions from noble gas radionuclide i (mrem/yr per uCi/m^3) (from Table 7.0-2)

M_i = gamma air dose factor for noble gas radionuclide i (mrad/yr per uCi/m^3) (from Table 7.0-2)

1.1 = mrem skin dose per mrad gamma air dose (mrem/mrad)

3.17 E - 08 = 1/3.15 E + 07 yr/sec

Average annual meterological dispersion parameters or meterological conditions concurrent with the release period under evaluation may be used (e.g., quarterly averages or year-specific annual averages).

8.2.2 Direct Exposure Dose Determination

From evaluations performed in the Fermi 2 Environmental Report, Section 5.3.4, the direct exposure to the highest offsite location from the Turbine Building N-16 skyshine dose has been calculated to be approximately 3 mrem/year. This value may be used as a baseline for actual direct exposure contributions during plant operations. Other potentially significant direct exposure contributions to offsite individual doses may be evaluated based on the results of the environmental measurements (e.g., TLD, ion chamber measurements) or by the use of a radiation transport and shielding calculational method. Only during atypical conditions will there exist any potential for significant onsite sources at Fermi 2 that would yield potentially significant offsite doses to a MEMBER OF THE PUBLIC. However, should a situation exist whereby the direct exposure contribution is potentially significant, onsite measurements, offsite measurements and calculational techniques will be used for determination of dose for assessing 40 CFR 190 compliance. The calculational techniques will be identified, reviewed, and approved at that time.

8.2.3 Dose Assessment Based on Radiological Environmental Monitoring Data

Normally, the assessment of potential doses to MEMBERS OF THE PUBLIC must be calculated based on the measured radioactive effluents at the plant. The resultant levels of radioactive material in the offsite environment are so minute as to be undetectable. The calculational methods as presented in this ODCM are used for modeling the transport in the environment and the resultant exposure to offsite individuals.

The results of the radiological environmental monitoring program can provide input into the overall assessment of impact of plant operations and radioactive effluents. With measured levels of plant related radioactive material in principal pathways of exposure, a quantitative assessment of potential exposures can be performed. With the monitoring program not identifying any measurable levels, the data provides a qualitative assessment - a confirmatory demonstration of the negligible impact.

Dose modeling can be simplified into three basic parameters that can be applied in using environmental monitoring data for dose assessment:

$$D = C * U * DF \qquad (8\text{-}3)$$

where:

D = dose or dose commitment

C = concentration in the exposure media, such as air concentration for the inhalation pathway, or fish, vegetation or milk concentration for the ingestion pathway

U = individual exposure to the pathway, such as hr/yr for direct exposure, kg/yr for ingestion pathway

DF = dose conversion factor to convert from an exposure or uptake to an individual dose or dose commitment

The applicability of each of these basic modeling parameters to the use of environmental monitoring data for dose assessment is addressed below:

Concentration - C

The main value of using environmental sampling data to assess potential doses to individuals is that the data represents actual measured levels of radioactive material in the exposure pathways. This eliminates one main uncertainty and the modeling has been removed - the release from the plant and the transport to the environmental exposure medium.

Environmental samples are collected on a routine frequency per the ODCM. To determine the annual average concentration in the environmental medium for use in assessing cumulative dose for the year, an average concentration should be determined based on the sampling frequency and measured levels:

$$\overline{C_i} = \sum (C_i * t)/365 \quad (8-4)$$

where:

$\overline{C_i}$ = average concentration in the sampling medium for the year

C_i = concentration of each radionuclide i measured in the individual sampling medium

t = period of time that the measured concentration is considered representative of the sampling medium (typically equal to the sampling frequency; e.g., 7 days for weekly samples, 30 days for monthly samples).

If the concentration in the sampling medium is below the detection capabilities (i.e., less than Lower Limits of Detection (LLD), a value of zero should be used for C_i (C_i = 0).

Exposure - U

Default Exposure Values (U) as recommended in Regulatory Guide 1.109 are presented in Table 8.0-2. These values should be used only when specific data applicable to the environmental pathway being evaluated is unavailable.

Also, the routine radiological environmental monitoring program is designed to sample/monitor the environmental media that would provide early indications of any measurable levels in the environment but not necessarily levels to which any individual is exposed. For example, sediment samples are collected in the area of the liquid discharge: typically, no individuals are directly exposed. To apply the measured levels of radioactivity in samples that are not directly applicable to exposure to real individuals, the approach recommended is to correlate the location and measured levels to actual locations of exposure.

Hydrological or atmospheric dilution factors can be used to provide reasonable correlations of concentrations (and doses) at other locations. The other alternative is to conservatively assume a hypothetical individual at the sampling location. Doses that are calculated in this manner should be presented as hypothetical and very conservatively determined - actual exposure would be much less. Samples collected from the Monroe water supply intake should be used for estimating the potential drinking water doses. Other water samples collected, such as near field dilution area, are not applicable to this pathway.

Dose Factors - DF

The dose factors are used to convert the intake of the radioactive material to an individual dose commitment. Values of the dose factors are presented in NRC Regulatory Guide 1.109. The use of the RG 1.109 values applicable to the exposure pathway and maximum exposed individual is referenced in Table 8.0-2.

Assessment of Direct Exposure Doses

Thermoluminescent Dosimeters (TLD) are routinely used to assess the direct exposure component of radiation doses in the environment. However, because routine releases of radioactive material (noble gases) are so low, the resultant direct exposure doses are also very low. A study* performed for the NRC concluded that it was generally impractical to distinguish any plant contribution to the natural background radiation levels (direct exposure) below around 10 mrem per year. Therefore, for routine releases from nuclear power plants the use of TLD is mainly confirmatory - ensuring actual exposures are within the expected natural background variation.

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* NUREG/CR-0711, Evaluation of Methods for the Determination of X- and Gamma-Ray Exposure Attributable to a Nuclear Facility Using Environmental TLD Measurements, Gail dePlanque, June 1979, USNRC.

For releases of noble gases, environmental modeling using plant measured releases and atmospheric transport models as presented in ODCM Sections 7.6 and 8.2.1 represents the best method of assessing potential environmental doses. However, any observed variations in TLD measurements outside the norm should be evaluated.

END OF SECTION 8.0

TABLE 8.0-1

Assumptions for Assessing Doses Due to Activities inside SITE BOUNDARY

	Ice Fishing	Visitor's Center
Distance/Direction:	470 meters / E	470 meters / SSW
Estimated Exposure Time:	240 hr/yr (20 hr/week over 3 month period)	4 hr/yr (4 hr/visit, 1 visit per year)
Exposure Pathways:	direct exposure (noble gases)	direct exposure (noble gases)
	inhalation (H-3, I-131, -133, particulates)	inhalation (H-3, I-131, -133 particulates)
Meteorological Dispersion:	annual average (as determined for year being evaluated)	annual average (as determined for year being evaluated)
	6.48E-6 sec/m^3*	2.54E-6 sec/m^3*

* Annual average values for 1991

TABLE 8.0-2

Recommended Exposure Rates in Lieu of Site Specific Data*

Exposure Pathway	Maximum Exposed Age Group	Exposure Rates	Table Reference for Dose Factor from RG 1.109
Liquid Releases			
Fish	Adult	21 kg/y	E-11
Drinking Water	Adult	730 l/y	E-11
Bottom Sediment	Teen	67 h/y	E-6
Atmospheric Releases			
Inhalation	Teen	8,000 m^3/y	E-8
Direct Exposure	All	6,100 h/y**	N/A
Leafy Vegetables	Child	26 kg/y	E-13
Fruits, Vegetables and Grain	Teen	630 kg/y	E-12
Milk	Infant	330 l/y	E-14

* Adapted from Regulatory Guide 1.109, Table E-5

** Net exposure of 6,100 h/y is based on the total 8760 hours per year adjusted by a 0.7 shielding factor as recommended in Regulatory Guide 1.109.

END

9.0 ASSESSMENT OF LAND USE CENSUS DATA

A Land Use Census (LUC) is conducted annually in the vicinity of the Fermi 2 site. This census fulfills two main purposes: 1) Meet requirements of ODCM 3.12.2 for identifying controlling location/pathway for dose assessment of ODCM 3.11.2.3; and 2) provide data on actual exposure pathways for assessing realistic doses to MEMBERS OF THE PUBLIC.

9.1 Land Use Census as Required by ODCM 3.12.2

As required by ODCM 3.12.2, a land use census shall be conducted during the growing season at least once per twelve months. The purpose of the census is to identify within a 5 mile distance the location in each of the 16 meterological sectors of all milk producing animals, all meat producing animals, all gardens larger than 500 ft^2 producing broadleaf vegetation, and the closest residence to the plant. The data from the LUC is used for updating the location/pathway for dose assessment and for updating the Radiological Environmental Monitoring Program.

If the census identifies a location/pathway(s) yielding a higher potential dose to a MEMBER OF THE PUBLIC than currently being assessed as required by ODCM 3.11.2.3 (and ODCM Section 7.7 and Table 7.0-3), this new location pathway(s) shall be used for dose assessment. Table 7.0-3 shall be updated to include the currently identified controlling location/pathway(s). Also, if the census identifies a location(s) that yields a calculated potential dose (via the same exposure pathway) 20% greater than a location currently included in the Radiological Environmental Monitoring Program, the new location(s) shall be added to the program within 30 days. The sampling location(s), excluding control locations, having the lowest calculated dose may be deleted from the program after October 31 following the current census. As required by ODCM 3.12.2 and 5.9.1.8, the new location/pathway(s) shall be identified in the next Semiannual Radiation Effluent Release Report. The following guideline shall be used for assessing the results from the land use census to ensure compliance with ODCM 3.12.2.

9.1.1 Data Compilation

1. Compile all locations and pathways of exposure as identified by the land use census.

2. From this compiled data, identify any changes from the previous year's census. Identify the current controlling location/pathway (critical receptor) used in ODCM Table 7.0-3. Also, identify any location currently included in the REMP (Table 10-1).

ARMS - INFORMATION SERVICES

Date approved: 7-30-92 Release authorized by: B. Kruger for T. Unterberg

Change numbers incorporated: LCR 91-104-ODM

DSN ODCM-9.0 Rev 4 Date August 7, 1992

DTC TMPLAN File 1715.02 Recipient

3. Determine the historical, annual average meterological dispersion parameters (X/Q, D/Q) for any location to be evaluated for dose significance. All locations should be evaluated against the same historical meterological data set.

9.1.2 Relative Dose Significance

For locations which may receive a higher dose than the current critical receptor, calculate the relative dose significance by applicable pathways of exposure.

1. Relative dose calculations should be based on the actual Fermi 2 gaseous effluent releases for the most recent six month period of reactor operation.

2. The pathway dose equations of the ODCM should be used.

9.1.3 Data Evaluation

1. Formulate a listing of locations of high dose significance in descending order of relative dose significance. Include the relative dose significance in the listing.

2. If any location/pathway(s) is identified with a higher relative dose than the current critical receptor in ODCM Table 7.0-3, this location/pathway(s) should replace the previously identified controlling location/pathway in Table 7.0-3. If the previously identified controlling pathway is no longer present, the current controlling location/pathway should be determined. In identifying the critical receptor for Table 7.0-3, all age groups and all pathways that may be present at each evaluated location are considered. The critical receptor is assumed to be a member of the age group with the highest calculated dose to the maximally exposed organ due to iodines, tritium and particulates. Other receptors may have higher doses to other organs than the critical receptor has.

3. The Land Use Census data should be used to revise the REMP and Section 10.0 of the ODCM in accordance with ODCM 3.12.2, Action Item b.

4. Any changes in either the controlling location/pathway(s) (critical receptor) for the ODCM dose calculations (Section 7.7 and Table 7.0-3) or the REMP (ODCM Section 10.0 and Table 10-1) shall be reported to NRC in accordance with ODCM 3.12.2, Action Items a. and b. and ODCM 5.9.1.8.

   NOTE: As permitted by footnote to ODCM 3.12.2, broadleaf vegetation sampling may be performed at the SITE BOUNDARY in two locations, in different sectors with highest predicted D/Qs, in lieu of the garden census. Also, for conservatism in dose assessment for compliance with ODCM 3.11.2.3 (see also ODCM Section 7.7 and Table 7.0-3), hypothetical exposure location/pathway(s) and conservative dispersion factors may be assumed (e.g., milk cow at 5 mile

location or garden at SITE BOUNDARY in highest D/Q sector). By this approach, the ODCM is not subject to frequent revision as pathways and locations change from year to year. A verification that the hypothetical pathway remains conservative and valid is still required. Also, for NRC reporting, the actual pathways and doses should be reported along with the hypothetical. The reporting of the actual pathway and doses provides a formal documentation of the more realistic dose impact.

9.2 Land Use Census to Support Realistic Dose Assessment

The LUC provides data needed to support the special dose analyses of the ODCM Section 8.0. Activities inside the SITE BOUNDARY should be periodically reviewed for dose assessment as required by ODCM 5.9.1.8 (see also ODCM Section 8.1). Assessment of realistic doses to MEMBERS OF THE PUBLIC is required by ODCM 3.11.4 for demonstrating compliance with the EPA Environmental Dose Standard, 40 CFR 190 (ODCM Section 8.2).

To support these dose assessments, the LUC shall include use of Lake Erie water on and near the site. The LUC shall include data on Lake Erie use obtained from local and state officials. Reasonable efforts shall be made to identify individual irrigation and potable water users, and industrial and commercial water users whose source is Lake Erie. This data is used to verify the pathways of exposure used in ODCM Section 6.5.

END OF SECTION 9.0

10.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The Radiological Environmental Monitoring Program (REMP) is conducted in accordance with the requirements of ODCM 3.12.1. The sampling and analysis program described herein was developed to provide representative measurements of radiation and radioactive materials resulting from station operation in the principal pathways of exposure of MEMBERS OF THE PUBLIC. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent control 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 the modeling of the environmental exposure pathways. Guidance for the development of this monitoring program is provided by the NRC Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979.

10.1 Sampling Locations

Sampling locations as required by ODCM 3.12.1 are described in Table 10.0-1 and shown on the maps in Figures 10.0-1, 10.0-2, 10.0-3, and 10.0-4. Fermi 1 sampling locations are described in Table 10.0-2 and shown on the map in Figure 10.0-5.

NOTE: For purposes of implementing ODCM 3.12.2, sampling locations will be modified as required to reflect the findings of the annual land use census as described in ODCM Section 9.1 and as required by other contingencies (e.g. unavailability of milk from a listed location). Such changes will be documented in plant records and reflected in the next ODCM revision, the next Semiannual Effluent Release Report, and the next Annual Radiological Environmental Operating Report. Also, if the circumstances of such changes involve a possible change in the maximally exposed individual evaluated for ODCM Control 3.11.2.3, the identity of this individual will be reevaluated.

10.2 Reporting Levels

ODCM 3.12.1, Action b, describes criteria for a Special Report to the NRC if levels of plant-related radioactive material, when averaged over a calendar quarter, exceed the prescribed levels of ODCM Table 3.12.1-2. The reporting levels are based on the design objective doses of 10 CFR 50, Appendix I (i.e., the annual limits of ODCM 3.11.1.2, 3.11.2.2 and 3.11.2.3). In other words, levels of radioactive material in the respective sampling medium equal to the prescribed reporting levels are representative of potential annual doses of 3 mrem, total body or 10 mrem, maximum organ from liquid pathways; or 5 mrem, total body, or 15 mrem, maximum organ for the gaseous effluent pathway. These potential doses are modeled on the maximum individual exposure or consumption rates of NRC Regulatory Guide 1.109.

The evaluation of potential doses should be based solely on radioactive material resulting from plant operation. As stated in ODCM 3.12.1, Action b, the report shall also be submitted if radionuclides other than those in ODCM Table 3.12.1-2 are detected (and are a result of plant effluents) and the potential dose exceeds the above annual design objectives. The method described in ODCM Section 8.2.3 may be used for assessing the potential dose and required reporting for radionuclides other than those in ODCM Table 3.12.1-2.

10.3 **Interlaboratory Comparison Program**

A major objective of this program is to assist laboratories involved in environmental radiation measurements to develop and maintain both an intralaboratory and an interlaboratory quality control program. This is accomplished through an extensive laboratory intercomparison study ("cross-check") program involving environmental media (milk, water, air, food, soil, and gases) and a variety of radionuclides with activities at or near environmental levels.

Simulated environmental samples, containing known amounts of one or more radionuclides, are prepared and routinely distributed to all laboratories upon request. These laboratories perform the required analyses and return their data to the Quality Assurance Branch of the Environmental Protection Agency (EPA). The EPA performs statistical analysis and comparison with known values and analytical values obtained from other participating laboratories. A report and control chart are returned to each participant. The program thus enables each laboratory to document the precision and accuracy of its radiation data, identify instrument and procedural problems, and compare its performance with that of other laboratories.

The environmental laboratory is required to participate in a Commission-approved Interlaboratory Comparison Program and to submit QA Program Progress Summary Reports to Detroit Edison on a bimonthly or quarterly basis. These reports contain summary descriptions and performance data summaries on reference standards, blank, blind, spiked, and duplicate analyses, as well as the USEPA and other Laboratory Intercommission Programs, as applicable. A summary of the Interlaboratory Comparison Program results obtained is required to be included in the Annual Radiological Environmental Operating Report pursuant to ODCM 5.9.1.7.

Participation in an approved Interlaboratory Comparison Program ensures that an independent check on the precision and accuracy of the measurements of radioactive material in environmental sample matrices is performed as part of the QA Program for environmental monitoring in order to demonstrate that the results are valid for the purpose of Section IV.B.2 of Appendix I to 10 CFR Part 50.

END OF SECTION 10.0

TABLE 10.0-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
FERMI 2 SAMPLE LOCATIONS AND ASSOCIATED MEDIA

KEY

1 -	T	TLD Locations (Pg. 10.0-4 to 10.0-6)
2 -	S	Sediments Locations (Pg. 10.0-7)
3 -	F	Fish Locations (Pg. 10.0-7)
4 -	M	Milk Locations (Pg. 10.0-8)
5 -	DW	Drinking Water Locations (Pg. 10.0-9)
6 -	SW	Surface Water Locations (Pg. 10.0-9)
7 -	GW	Ground Water Locations (Pg. 10.0-9)
8 -	API	Air Particulate/Iodine Locations (Pg. 10.0-10)
9 -	FP	Food Products Locations (Pg. 10.0-11)

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Direct Radiation

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
T1	NE/38°	1.3 mi	Estral Beach Pole on Lakeshore, 23 Poles S of Lakeview (Special Area)	Direct Radiation	Q
T2	NNE/22°	1.2 mi	East of termination of Brancheau St on post (Special Area)	Direct Radiation	Q
T3	N/9°	1.1 mi	Pole, NW Corner of Swan Boat Club Fence (Special Area)	Direct Radiation	Q
T4	NNW/337°	0.6 mi	Site Boundary and Toll Rd, on Site Fence by API #2	Direct Radiation	Q
T5	NW/313°	0.6 mi	Site Boundary and Toll Rd, on Site Fence by API #3	Direct Radiation	Q
T6	WNW/293°	0.6 mi	Pole, NE Corner of Bridge over Toll Rd	Direct Radiation	Q
T7	W/270°	14.2 mi	Pole, behind Doty Farm, 7512 N Custer Rd (Control)	Direct Radiation	Q
T8	NW/305°	1.9 mi	Pole on Post Rd near NE Corner of Dixie Hwy and Post Rd	Direct Radiation	Q
T9	NNW/334°	1.5 mi	Pole, NW Corner of rombley and Swan View Rd	Direct Radiation	Q
T10	N/6°	2.1 mi	Pole, S Side of Massarant - 2 Poles W of Chinavarre	Direct Radiation	Q
T11	NNE/23°	6.2 mi	Pole NE Corner of Milliman and Jefferson	Direct Radiation	Q
T12	NNE/29°	6.3 mi	Pointe Mouillee Game Area - Field Office, Pole near Tree, N Area of Parking Lot	Direct Rad[illegible]ion	Q
T13	N/356°	4.1 mi	Labo and Dixie Hwy - Pole on SW Corner with Light	Direct Radiation	Q
T14	NNW/337°	4.4 mi	Labo and Brandon - Pole on SE Corner near RR	Direct Radiation	Q
T15	NW/315°	3.9 mi	Pole, behind Newport Post Office	Direct Radiation	Q

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Direct Radiation

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
T16	WNW/283°	4.9 mi	Pole, SE of War and Post Rds	Direct Radiation	Q
T17	W/271°	4.9 mi	Pole, NE Corner of Nadeau and Laprad near Mobile Home Park	Direct Radiation	Q
T18	WSW/247°	4.8 mi	Pole, NE Corner of Mentel and Hurd	Direct Radiation	Q
T19	SW/236°	5.2 mi	1st Pole E of Fermi Siren on Waterworks Rd, NE corner of intersection - Sterling State Park Rd Entrance Drive/Waterworks (in Sterling State Park)	Direct Radiation	Q
T20	WSW/257°	2.7 mi	Pole, S Side of Williams Rd - 8 Poles W of Dixie Hwy (Special Area)	Direct Radiation	Q
T21	WSW/239°	2.7 mi	Pole, N Side of Pearl at Parkview - Woodland Beach (Special Area)	Direct Radiation	Q
T22	S/172°	1.2 mi	Pole, N Side of Pointe Aux Peaux 2 Poles W of Long - Site Boundary	Direct Radiation	Q
T23	SSW/195°	1.1 mi	Pole, S Side of Pointe Aux Peaux - 1 Pole W of Huron next to Vent Pipe - Site Boundary	Direct Radiation	Q
T24	SW/225°	1.2 mi	Fermi Gate along Pointe Aux Peaux Rd - on fence wire W of Gate - Site Boundary	Direct Radiation	Q
T25	WSW/251°	1.5 mi	Pole, Toll Rd - 13 Poles S of Fermi Dr	Direct Radiation	Q
T26	WSW/259°	1.1 mi	Pole, Toll Rd, 6 Poles S of Fermi Dr	Direct Radiation	Q
T27	SW/225°	6.8 mi	Pole, NE Corner of McMillan and East Front St (Special Area)	Direct Radiation	Q
T28	SW/229°	10.7 mi	Pole, SE Corner of Mortar Creek and LaPlaisance (Control)	Direct Radiation	Q
T29	WSW/237°	10.3 mi	Pole, E Side of S Dixie, 1 Pole S of Albain (Control)	Direct Radiation	Q
T30	WSW/247°	7.8 mi	Pole, St. Mary's Park Corner of Elm and Monroe St, S side of parking lot next to river (Special Area)	Direct Radiation	Q

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Direct Radiation

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
T31	WSW/255°	9.6 mi	1st Pole W of Entrance Drive Milton "Pat" Munson Recreational Reserve - N Custer Rd (Control)	Direct Radiation	Q
T32	WNW/295°	10.3 mi	Pole, Corner of Stony Creek and Finzel Rds	Direct Radiation	Q
T33	NW/317°	9.2 mi	Pole, W Side of Grafton Rd, 1 Pole N of Ash/Grafton Intersection	Direct Radiation	Q
T34	NNW/338°	9.7 mi	Pole, E Side of Port Creek, 1 Pole S of Will-Carleton Rd	Direct Radiation	Q
T35	N/359°	6.9 mi	Pole, S Side of S Huron River Dr across from Race St (Special Area)	Direct Radiation	Q
T36	N/358°	9.1 mi	Pole, NE Corner of Gibraltar and Cahill Rds	Direct Radiation	Q
T37	NNE/21°	9.8 mi	Pole, S Corner of Adams and Gibraltar (across from Humbug Marina)	Direct Radiation	Q
T38	WNW/294°	1.7 mi	Residence - 6594 N. Dixie Hwy.	Direct Radiation	Q
T39	S/176°	0.3 mi	SE Corner of Protected Area Fence (PAF)	Direct Radiation	Q
T40	S/170°	0.3 mi	Midway along OBA - PAF	Direct Radiation	Q
T41	SSE/161°	0.2 mi	Midway between OBA and Shield Wall - PAF	Direct Radiation	Q
T42	SSE/149°	0.2 mi	Midway along Shield Wall - PAF	Direct Radiation	Q
T43	SE/131°	0.1 mi	Midway between Shield Wall and Aux Boilers - PAF	Direct Radiation	Q
T44	ESE/109°	0.1 mi	Opposite OSSF Door - PAF	Direct Radiation	Q
T45	E/86°	0.1 mi	NE Corner - PAF		
T46	ENE/67°	0.2 mi	NE Side Barge Slip - on Fence	Direct Radiation	Q

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Direct Radiation

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
T47	S/185	0.1 mi	South of Turbine Bldg. rollup door on PAF	Direct Radiation	Q
T48	SW/235	0.2 mi	30 ft. from corner of AAP on PAF		
T49	WSW/251	1.1 mi	Corner of site boundary fence north of NOC along Critical Path Rd.	Direct Radiation	Q
T50	W/270	0.9 mi	Site boundary fence near main gate by the south Bullit St. sign	Direct Radiation	Q
T51	N/3	0.4 mi	Site boundary fence north of North Cooling Tower	Direct Radiation	Q
T52	NNE/20	0.4 mi	Site boundary fence at the corner of Arson and Tower	Direct Radiation	Q
T53	NE/55	0.2 mi	Site boundary fence east of South Cooling Tower	Direct Radiation	Q
T54	S/189	0.3 mi	Pole, next to Fermi 2 Visitors Center	Direct Radiation	Q
T55	WSW/251	3.3 mi	Pole, north side of Nadeau Rd. across from Sodt Elementary School Marquee	Direct Radiation	Q
T56	WSW/255	4.9 mi	Pole, entrance to Jefferson Middle School on Stoney Creek Rd.	Direct Radiation	Q
T57	W/260	2.7 mi	Pole, north side of Willians Rd. across from Jefferson High School entrance	Direct Radiation	Q
T58	WSW/249	4.9 mi	Pole, west of Hurd Elementary School Marquee	Direct Radiation	Q
T59	NW/325	2.6 mi	Pole, north of St. Charles Church entrance on Dixie Hwy.	Direct Radiation	Q
T60	NNW/341	2.5 mi	1st pole north of North Elementary School entrance on Dixie Hwy.	Direct Radiation	Q
T61	W/268	10.1 mi	Pole, SW Corner of Stewart and Raisinville Rds.	Direct Radiation	Q
T62	SW/232	9.7 mi	Pole, NW Corner of Albain and Hull Rds.	Direct Radiation	Q
T63	WSW/245	9.6 mi	Pole, Corner of Dunbar and Telegraph Rds.	Direct Radiation	Q

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Fish and Sediment

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
SEDIMENTS					
S-1	SSE/165°	0.9 mi	Pointe Aux Peaux. Shoreline to 500 ft offshore sighting directly to Land Base Water Tower	Sediment	SA
S-2	E/81°	0.2 mi	Fermi 2 Discharge, approx 200 ft offshore	Sediment	SA
S-3	NE/39°	1.1 mi	Estral Beach, approx 200 ft offshore, off North shoreline where Swan Creek and Lake Erie meet	Sediment	SA
S-4	WSW/241°	3.0 mi	Indian Trails Community Beach	Sediment	SA
S-5	NNE/20°	11.7 mi	DECo's Trenton Channel Power Plant intake area (Control)	Sediment	SA
FISH					
F-1	NNE/31°	9.5 mi	Celeron Island (Control)	Fish	SA
F-2	E/86°	0.4 mi	Fermi 2 Discharge (approx 1200 ft offshore)	Fish	SA
F-3	WSW/238°	4.8 mi	Brest Bay Marina Area (Control)	Fish	SA

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Milk/Grass

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
M-2	NW/319°	5.4 mi	Reaume Farm - 2705 E Labo	Milk	M-SM
M-3	NW/317°	4.2 mi	Voas Farm - 3239 Newport Rd	Milk	M-SM
M-7	WNW/301°	2.1 mi	Webb Farm - 4262 Post Rd	*Grass	M-SM
M-8	WNW/289°	9.9 mi	Calder Dairy - 9334 Finzel Rd	Milk/Grass	M-SM

* Grass taken in lieu of milk samples--residence is calculated critical receptor, but does not participate in REMP program.

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Water

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
DRINKING WATER					
DW-1	S/174°	1.1 mi	Monroe Water Station N Side of Pointe Aux Peaux 1/2 Block W of Long Rd	Drinking Water	M
DW-2	N/8°	18.5 mi	Detroit Water Station 14700 Moran Rd, Allen Park (Control)	Drinking Water	M
SURFACE WATER					
SW-1	SSE/160°	0.3 mi	Fermi 1 Raw Lake Water Intake Structure	Surface Water	M
SW-2	NNE/20°	11.7 mi	DECo's Trenton Channel Power Plant Intake Structure (Screenhouse #1) (Control)	Surface Water	M
SITE WELLS					
GW-1	S/175°	0.4 mi	Approx 100 ft W of Lake Erie, EF-1 Parking lot near gas fired peakers	Groundwater	Q
GW-2	SSW/208°	1.0 mi	4 ft S of Pointe Aux Peaux (PAP) Rd Fence 427 ft W of where PAP crosses over Stoney Point's Western Dike	Groundwater	Q
GW-3	SW/226°	1.0 mi	143 ft W of PAP Rd Gate, 62 ft N of PAP Rd Fence	Groundwater	Q
GW-4	WNW/299°	0.6 mi	42 ft S of Langton Rd, 8 ft E of Toll Rd Fence	Groundwater	Q

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Air Particulate Air Iodine

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
API-1	NE/39°	1.4 mi	Estral Beach Pole on Lakeshore, 18 Poles S of Lakeview (Nearest Community with highest X/Q)	Radioiodine Particulates	W W
API-2	NNW/337°	0.6 mi	Site Boundry and Toll Road, on Site Fence by T-4	Radioiodine Particulates	W W
API-3	NW/313°	0.6 mi	Site Boundry and Toll Road, on Site Fence by T-5	Radioiodine Particulates	W W
API-4	W/270°	14.2 mi	Pole, behind Doty Farm - 7512 N Custer Road (Control)	Radioiodine Particulates	W W
API-5	S/191°	1.2 mi	One pole south of Pointe Aux Peaux Rd on Erie St	Radioiodine Particulates	W W

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Food Products

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (Approx)	Description	Media	Frequency
FP-1	NNE/21°	3.9 mi	9501 Turnpike Highway	Food Products	M (when available)
FP-3	NNE/12°	1.1 mi	6441 Brancheau	Food Products	M (when available)
FP-5	NNE/19°	4.5 mi	7806 Labo	Food Products	M (when available)
FP-6	WNW/290°	14.5 mi	8200 Geirman (Control)	Food Products	M (when available)

TABLE 10.0-1

Radiological Environmental Monitoring Program, Fermi 2 Sample Locations and Associated Media

Land Use Census Closest Residences

Meteorological Sector	Distance from Reactor (Approx)	Description
NE	1.1 mi	6760 Lakeshore
NNE	1.1 mi	6460 Brancheau
N	1.1 mi	6200 Blanchett
NNW	1.1 mi	5701 Post
NW	1.0 mi	6577 Leroux
WNW	0.7 mi	6200 Langton
W	1.1 mi	6001 Toll
WSW	1.4 mi	4981 Pointe Aux Peaux
SW	1.3 mi	5194 Pointe Aux Peaux
SSW	1.1 mi	5820 Pointe Aux Peaux
S	1.0 mi	4834 Long
ESE-SSE		Lake Erie

TABLE 10.0-2

Radiological Environmental Monitoring Program, Fermi 1 Sample Locations and Associated Media

Water

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (approx.)	Description	Media	Frequency
Surface Water					
South Lagoon	S/190^{0}	0.5 mi	Shoreline behind fuel oil storage tank	SW	SA
Swan Creek	NW/56^{0}	1.9 mi	Area below bridge N. of Dixie Hwy and Swan Creek Rd. (Public Access area)	SW	SA
Reactor Channel	NE/0^{0}	0.4 mi	Area where overflow canal meets Swan Creek	SW	SA
Lake Water #3	SSE/159^{0}	0.4 mi	Fermi 1 inlet E. of pumphouse	SW	SA
Raw City Water					
City of Monroe	S/169^{0}	1.2 mi	Monroe Water Station, N. side of Point Aux Peaux, 1/2 block W. of Long Rd.	RW	SA
Fermi 1	SSE/159^{0}	0.4 mi	Fermi Unit 1 Raw Lake water intake structure	RW	SA
City of Detroit	NNE/28^{0}	29.5 mi	Detroit City Water Treatment Plant N. of Belle Isle on Jefferson Ave.	RW	SA

Note: Distances were taken from Fermi 2 Reactor Center Line.

TABLE 10.0-2

Radiological Environmental Monitoring Program, Fermi 1 Sample Locations and Associated Media

Sediments

Station Number	Meteorological Sector/Azimuth Direction	Distance from Reactor (approx)	Description	Media	Frequency
South Lagoon	S/190°	0.5 mi	Shoreline behind fuel oil storage tank	Sediment	SA
Reactor Channel	N/0°	0.4 mi	Area where overflow canal meets Swan Creek	Sediment	SA
Swan Creek	N/W/56°	1.9 mi	Area below bridge N. of Dixie Hwy. and Swan Creek Rd. (public access area)	Sediment	SA

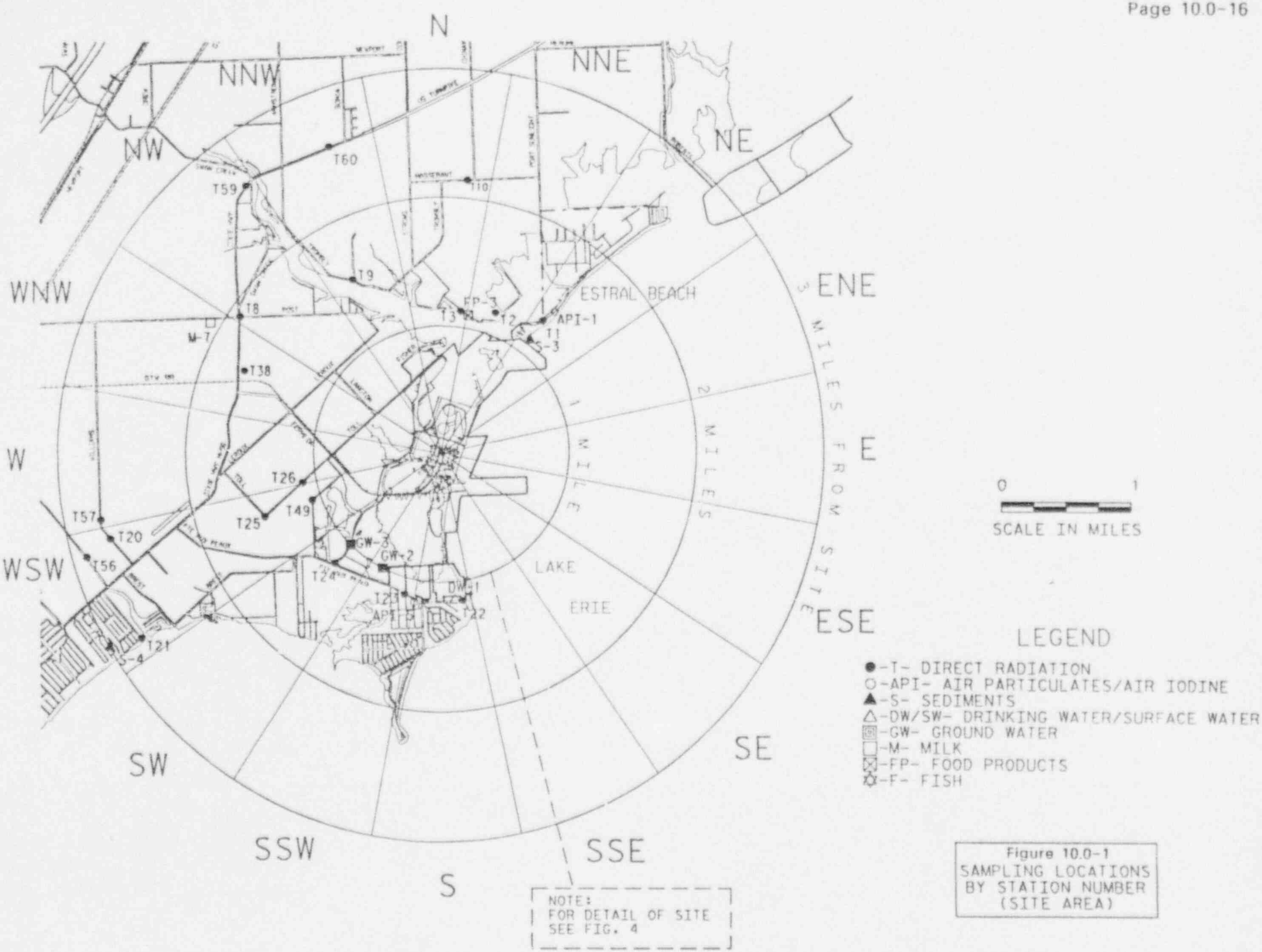
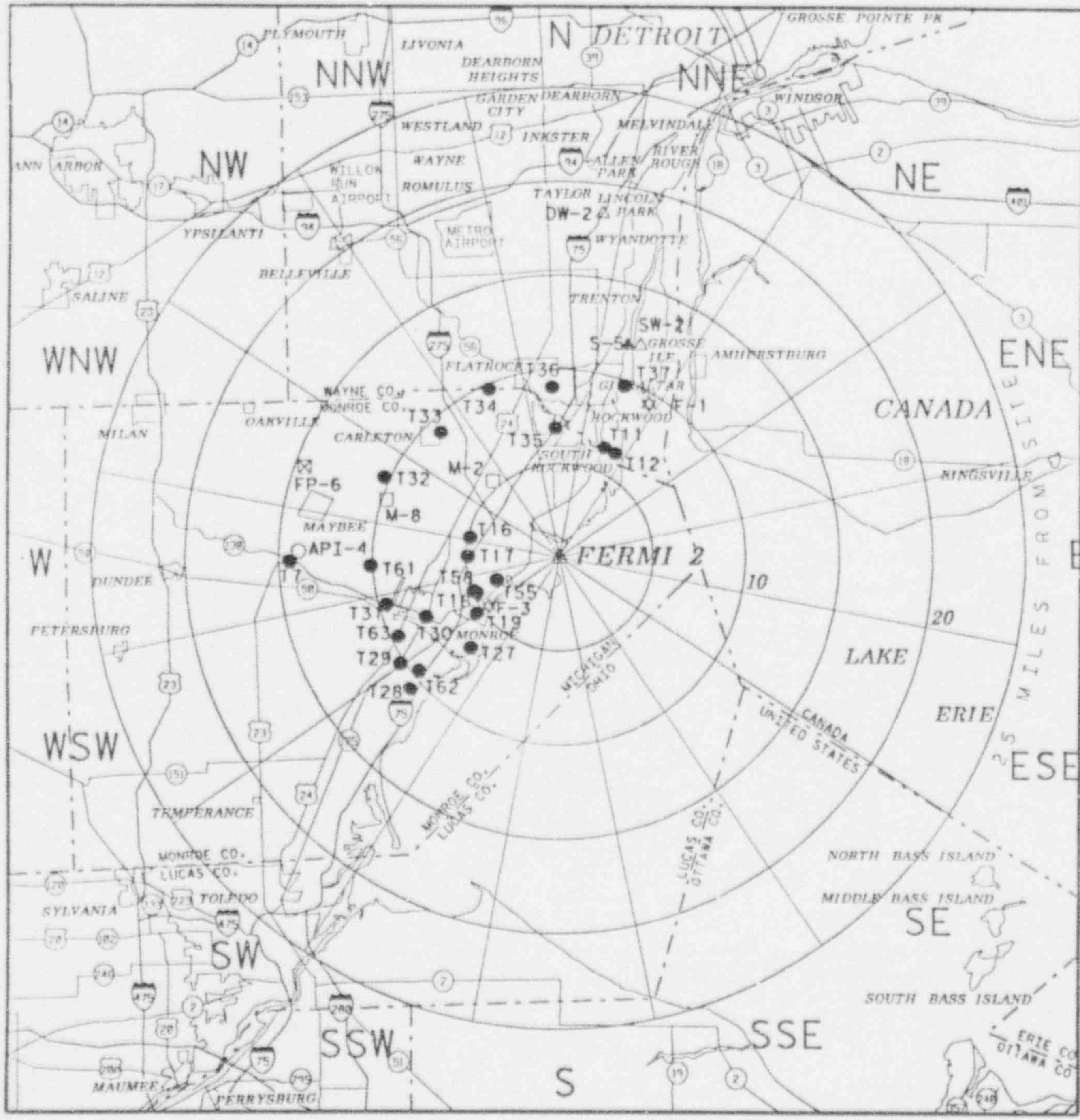


Figure 10.0-1
SAMPLING LOCATIONS
BY STATION NUMBER
(SITE AREA)



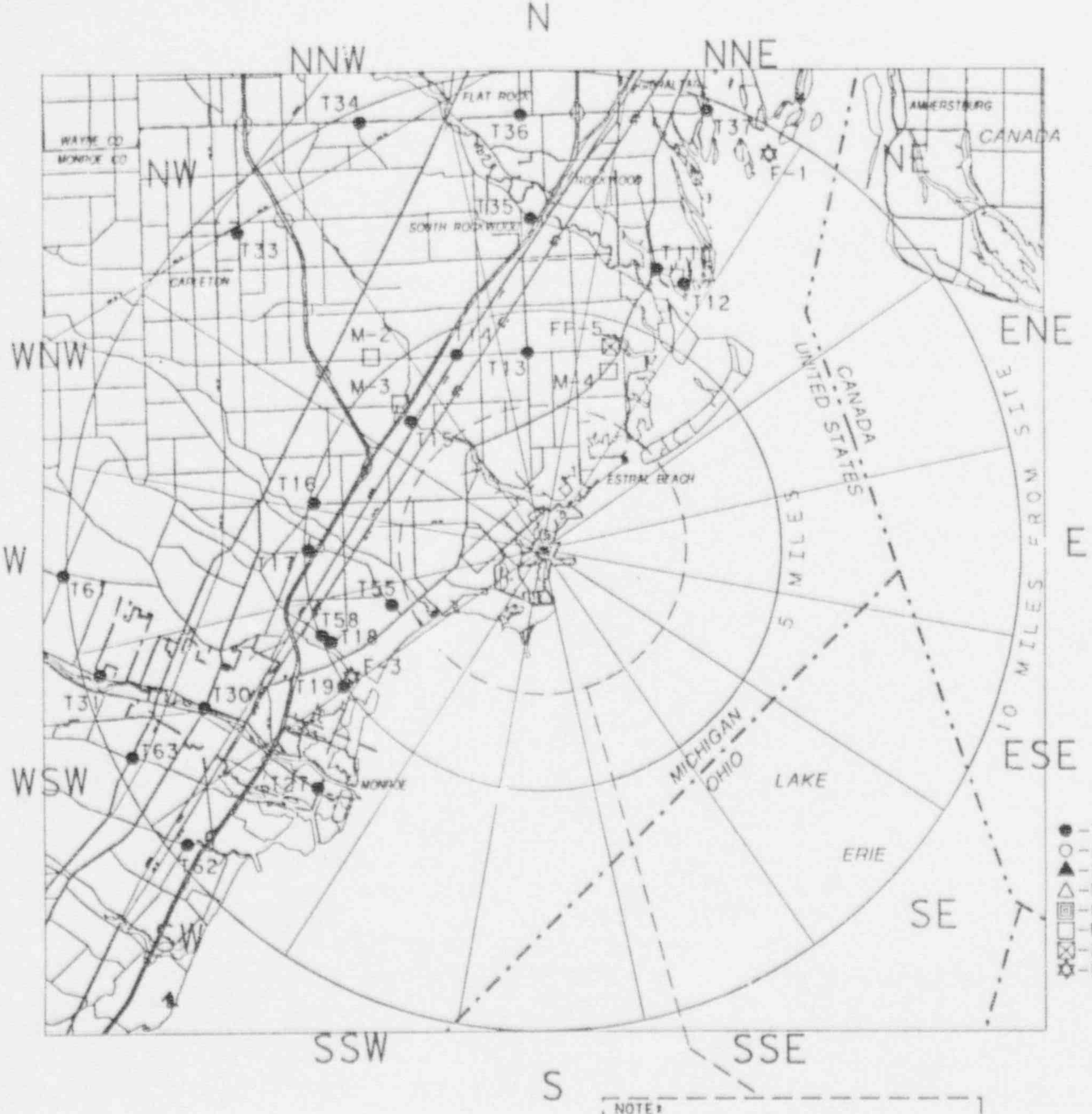
5 0 5 10

SCALE IN MILES

LEGEND

- ● -T- DIRECT RADIATION
- ○ -API- AIR PARTICULATES OR AIR IODINE
- ▲ -S- SEDIMENTS
- △ -DW/SW- DRINKING WATER/SURFACE WATER
- -GW- GROUND WATER
- □ -M- MILK
- ⊠ -FP- FOOD PRODUCTS
- ✡ -F- FISH

Figure 10.0-2
SAMPLING LOCATIONS
BY STATION NUMBER
(GREATER THAN 10 MILES)



1 0 1 2 3

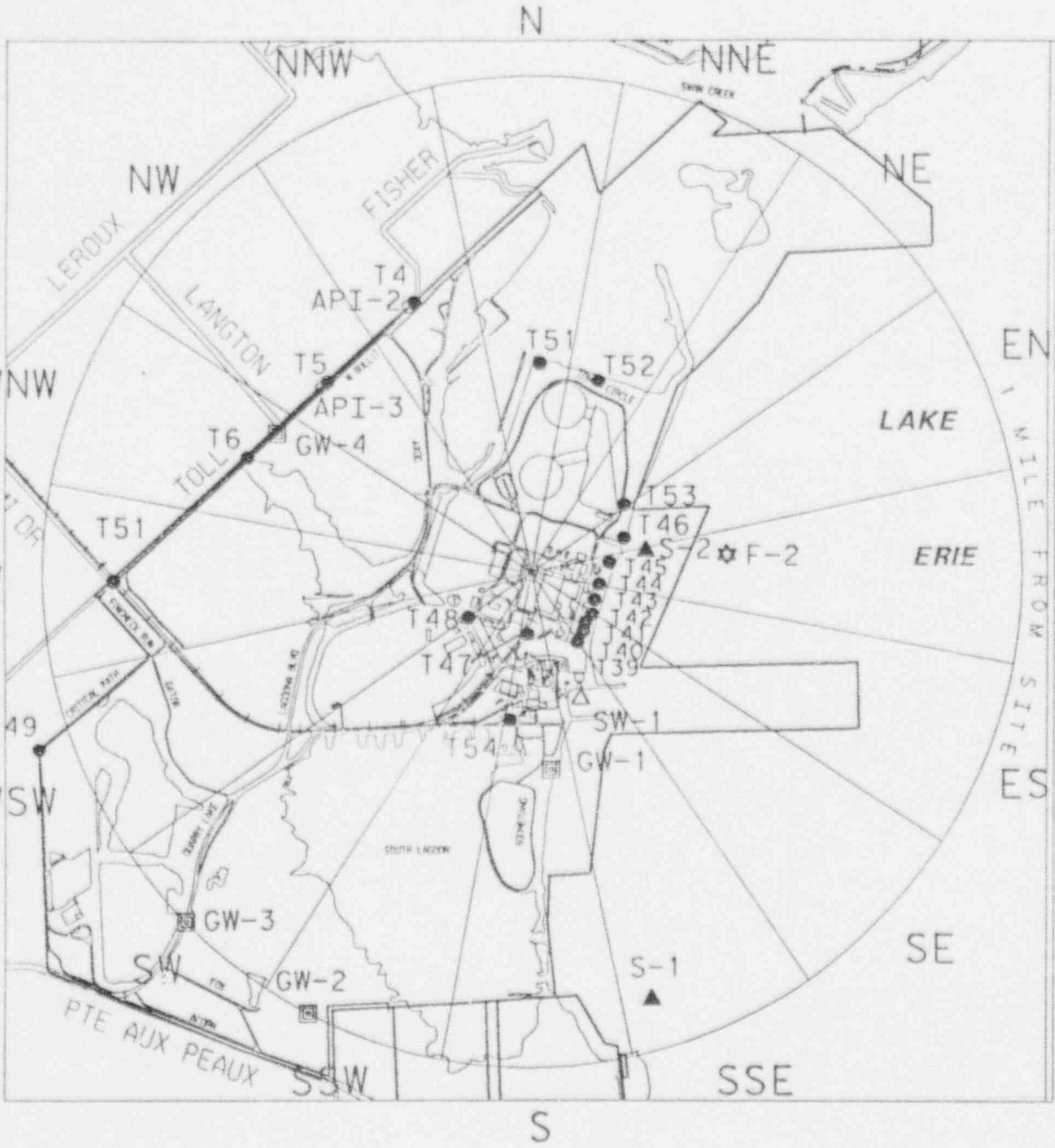
SCALE IN MILES

LEGEND

- ● -T- DIRECT RADIATION
- ○ -API- AIR PARTICULATES/AIR IODINE
- ▲ -S- SEDIMENTS
- △ -DW/SW- DRINKING WATER/SURFACE WATER
- ▣ -GW- GROUND WATER
- □ -M- MILK
- ⊠ -FP- FOOD PRODUCTS
- ✡ -F- FISH

NOTE:
FOR SITE AREA, SEE FIG.1.
FOR GREATER THAN 5 MILES, SEE FIG.2.
FOR LESS THAN 10 MILES, SEE FIG.3.

Figure 10.0-3
SAMPLING LOCATIONS
BY STATION NUMBER
(LESS THAN 10 MILES)

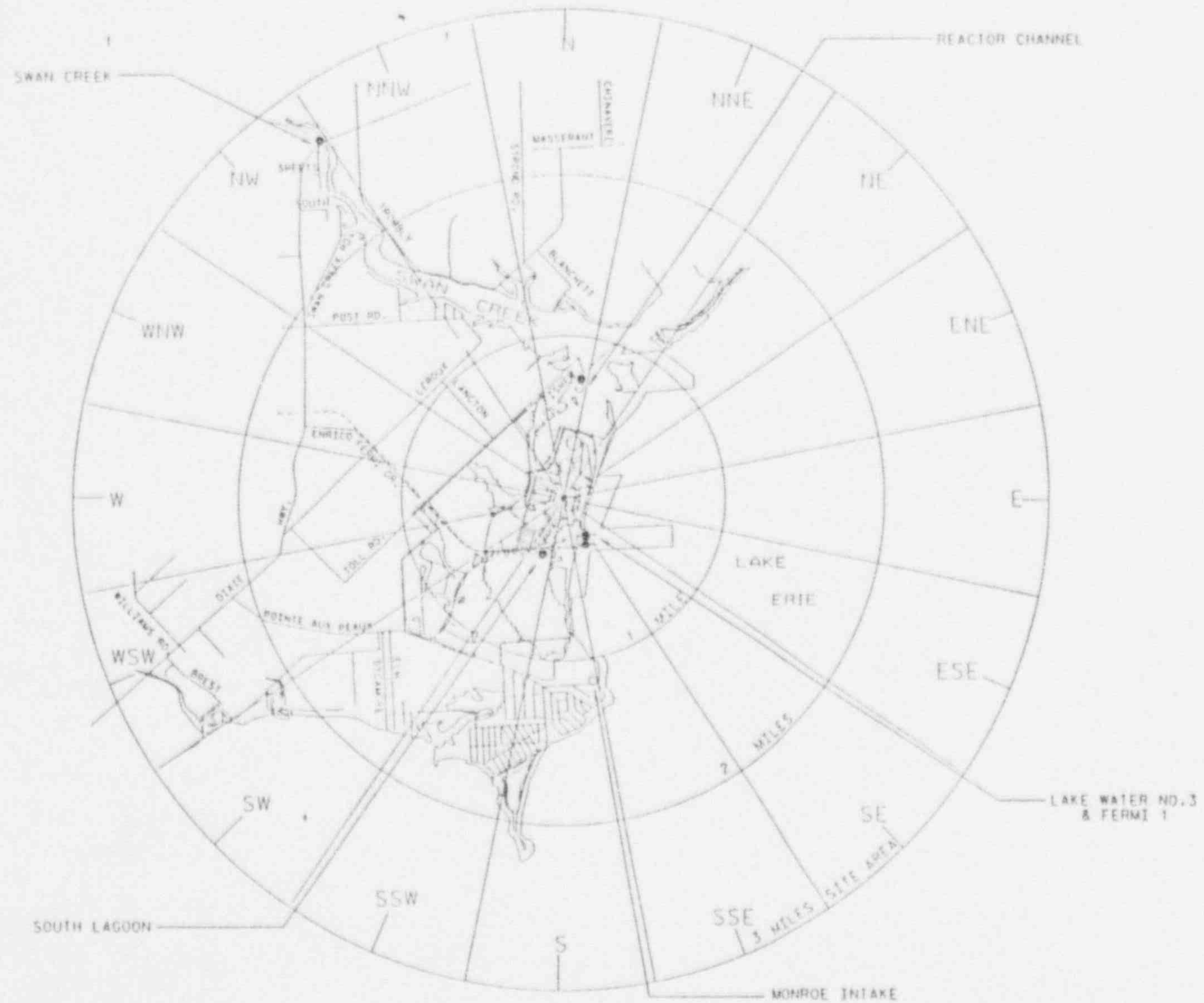


0 0.5
SCALE IN MILES

LEGEND

- ●-T- DIRECT RADIATION
- ○-API- AIR PARTICULATES/AIR IODINE
- ▲-S- SEDIMENTS
- △-DW/SW- DRINKING WATER/SURFACE WATER
- ▣-GW- GROUND WATER
- □-M- MILK
- ⊠-FP- FOOD PRODUCTS
- ✡-F- FISH

Figure 10.0-4
SAMPLING LOCATIONS
BY STATION NUMBER
SITE AREA-LAKE ERIE



SCALE OF MILE
0 1

LEGEND

● SURFACE WATER AND CITY WATER
○ SEDIMENT

Figure 10.0-5
Fermi 1
SAMPLING LOCATIONS

051I[3],14]TLD006.DGN JULY 87 BY CHUNG

APPENDIX A: TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS LIQUID EFFLUENT RELEASES

Overview

To simplify the dose calculation process, it is conservative to identify a controlling, dose-significant radionuclide and to use its dose conversion factor in the dose calculations. Using the total release (i.e., the cumulative activity of all radionuclides) and this single dose conversion factor as inputs to a one-step dose assessment yields a dose calculation method which is both simple and conservative.

Fermi 2 does not have a large data base of previous releases of radioactive liquid effluents upon which to base the determination of the controlling, dose-significant isotope. The Fermi 2 UFSAR, Table 11.2-9 presents the estimated annual releases from liquid effluents as calculated using the NRC GALE computer code, (NUREG-0016, Revision 1). Site specific dose conversion factors (A_{io}) from ODCM Table 6.0-1 were multiplied by the UFSAR estimated annual release quantity to determine a relative dose significance. Table A-1 presents the results of this relative dose evaluation.

Because Cs-134 is the controlling nuclide for the total body dose and has the highest dose conversion factor among the nuclides evaluated for that dose, the use of its dose conversion factor in the simplified dose assessment method for evaluating the total body dose is demonstrably conservative.

Selection of the appropriate dose conversion factor for the maximum organ dose is not so straightforward. Inspection of Table A-1 shows that the thyroid dose is the controlling organ dose, and it follows that the iodines are the controlling radionuclides. However, this identification is based upon the FSAR estimate of annual releases. To be adequately conservative when using this simplified method, it is appropriate to select the largest dose conversion factor from among all the radionuclides evaluated to assure that offsite doses are not mistakenly underestimated.

For the UFSAR Table 11.2-9 isotopes evaluated, there are a few radionuclides with a higher dose conversion factor than I-133 for the thyroid dose. Further inspection of Table A-1 shows that P-32 is the major contributor to the dose to the bone, which is the second highest organ dose. P-32 has a high dose conversion factor (1.39 E + 06 mrem/hr per uCi/ml) and would provide additional conservatism if used as the simplifying dose conversion factor. However, analysis for P-32 is not required. P-32 decays by beta emission without any accompanying characteristic gammas.

Use of the P-32 dose conversion factor is therefore inappropriate. The next largest dose conversion factor of the evaluated radionuclides is Cs-134 for the dose to the liver at 7.09 E + 05 mrem/hr per uCi/ml. (The dose to the liver is the third largest organ dose.) As Cs-134 is easily measured with gamma spectroscopy, has a long half-life, and a high organ dose conversion factor, it is used as the controlling radionuclide for the simplified maximum organ dose assessment.

Simplified Method

For evaluation of compliance with the dose limits ODCM 3.11.1.2, the following simplified equations may be used:

Total Body

$$D_{tb} = \frac{1.67\ E - 02 * VOL}{DF * Z} * A_{(Cs-134,tb)} * \sum C_i$$

(A-1)

where:

D_{tb} = dose to the total body (mrem)

VOL = volume of liquid effluents released (gal)

DF = average circulating water reservoir decant line flow (gal/min)

Z = 5, near field dilution factor (derived from Regulatory Guide 1.109)

$A_{(Cs-134,tb)}$ = 5.80 E + 05 mrem/hr per uCi/ml, the total body ingestion dose factor for Cs-134

C_i = total concentration of all radionuclides (uCi/ml)

1.67 E - 02 = 1 hr/60 min

Substituting the value for the Cs-134 total body dose conversion factor, the equation simplifies to:

$$D_{tb} = \frac{9.69\ E + 03 * VOL}{DF * Z} * \sum C_i$$

(A-2)

Maximum Organ

$$D_{max} = \frac{1.67\ E - 02 * VOL}{DF * Z} * A_{(Cs-134,liver)} * \sum C_i$$

(A-3)

where:

D_{max} = maximum organ dose (mrem)

$A_{(Cs-134,liver)}$ = 7.09 E + 05 mrem/hr per uCi/ml, the liver ingestion dose factor for Cs-134

Substituting the value for the Cs-134 liver dose conversion factor, the equation simplifies to:

$$D_{max} = \frac{1.18E+04 * VOL}{DF * Z} * \sum C_i \qquad \text{(A-4)}$$

Tritium is not included in the limited analysis dose assessment for liquid releases, because the potential dose resulting from normal reactor releases is relatively negligible. Furthermore, the release of tritium is a function of operating history and is essentially unrelated to radwaste system operations.

TABLE A-1

Relative Dose Significance of Radionuclides in Liquid Effluents

	Estimated Annual Releases	Relative Dose Significance A_{io} * Curies							Percent Dose Contribution (% total)						
Nuclide*	Curies	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI	Bone	Liver	T Body	Thyroid	Kidney	Lung	GI-LLI
Na-24	.00440	1.87	1.87	1.87	1.87	1.87	1.87	1.87	.69	.72	.98	.27	1.71	7.26	1.42
P-32	.00011	152.70	9.49	5.90	0	0	0	17.17	56.37	3.63	3.10	0	0	0	13.06
Mn-56	.00970	0	1.08	.19	0	1.37	0	[illegible].47	0	.41	.10	0	1.25	0	26.23
Cu-64	.01300	0	.14	.07	0	.36	0	12.05	0	.05	.03	0	.33	0	9.17
Zn-65	.00011	2.55	8.13	3.67	0	5.44	0	5.12	.94	3.11	1.93	0	4.97	0	3.90
Sr-91	.00160	.75	0	.03	0	0	0	3.57	.28	0	.02	0	0	0	2.72
Sr-92	.00200	.36	0	.02	0	0	0	7.04	.13	0	.01	0	0	0	5.36
Y-92	.00270	.00	0	.00	0	0	0	2.82	.00	0	.00	0	0	0	2.15
Y-93	.00160	.00	0	.00	0	0	0	9.61	.00	0	.00	0	0	0	7.31
Te-131m	.00005	.08	.04	.03	.06	.41	0	4.07	.03	.02	.02	.01	.38	0	3.09
I-131	.00220	.43	.61	.35	200.42	1.05	0	.16	.16	.23	.18	28.54	.96	0	.12
I-132	.01100	.10	.28	.10	9.76	.44	0	.05	.04	.11	.05	1.39	.41	0	.04
I-133	.02500	1.66	2.88	.88	423.96	5.03	0	2.59	.61	1.10	.46	60.38	4.60	0	1.97
I-135	.01800	.37	.98	.36	64.33	1.56	0	1.10	.14	.37	.19	9.16	1.43	0	.84
Cs-134	.00017	50.74	120.74	98.71	0	39.08	12.97	2.11	18.73	46.20	51.79	0	35.70	50.29	1.61
Cs-136	.00044	13.75	54.26	39.06	0	30.19	4.14	6.17	5.07	20.76	20.49	0	27.59	16.04	4.69
Cs-137	.00011	42.07	57.54	37.69	0	19.53	6.49	1.11	15.53	22.02	19.77	0	17.85	25.17	.85
Cs-138	.00400	1.06	2.09	1.04	0	1.54	.15	.00	.39	.80	.54	0	1.40	.59	.00
W-187	.00014	.04	.03	.01	0	0	0	11.38	.02	.01	.01	0	0	0	8.66
Np-239	.00360	.00	.00	.00	0	.00	0	3.00	.00	.00	.00	0	.00	0	2.28
TOTAL		268.53	260.16	189.98	700.40	107.87	25.62	125.46	99.13	99.54	99.67	99.75	98.58	99.35	95.47

* Radionuclide distribution from Fermi 2 UFSAR, Section 11.2, Table 11.2-9. Radionuclides contributing less than 1% of the total relative dose for any organ have been deleted.

END

APPENDIX B: TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS GASEOUS RADWASTE EFFLUENTS

Overview

Dose evaluations for releases of gaseous radioactive effluents may be simplified by the use of an effective dose factor rather than radionuclide-specific dose factors. These effective dose factors are applied to the total radioactive release to approximate the various doses in the environment; i.e., the total body, gamma-air, and beta-air doses. The effective dose factors are based on the typical radionuclide distribution in the gaseous radioactive effluents. This approach reduces the analyses to a single multiplication (K_{eff}, M_{eff}, or N_{eff}) times the quantity of radioactive gases released, rather than individual analyses for each radionuclide and summing the results to determine the dose. Yet the approach provides a reasonable estimate of the actual doses since under normal operating conditions there is relatively little variation in the radionuclide distribution.

Determination of Effective Dose Factors

Effective dose transfer factors are calculated by the following equations:

$$K_{eff} = \sum (K_i * f_i) \quad \text{(B-1)}$$

where:

K_{eff} = the effective total body dose factor due to gamma emissions from all noble gases released (mrem/yr per uCi/m^3, effective)

K_i = the total body dose factor due to gamma emissions from each noble gas radionuclide i released (mrem/yr per uCi/m^3, from Table 7.0-2)

f_i = the fractional abundance of noble gas radionuclide i relative to the total noble gas activity

$$(L + 1.1\ M)_{eff} = \sum ((L_i + 1.1\ M_i) * f_i) \quad \text{(B-2)}$$

where:

$(L + 1.1\ M)_{eff}$ = the effective skin dose factor due to beta and gamma emissions from all noble gases released (mrem/yr per uCi/m^3, effective)

$(L_i + 1.1\ M_i)$ = the skin dose factor due to beta and gamma emissions from each noble gas radionuclide i released (mrem/yr per uCi/m^3, from Table 7.0-2)

$$M_{eff} = \sum (M_i * f_i) \qquad \text{(B-3)}$$

where:

M_{eff} = the effective air dose factor due to gamma emissions from all noble gases released (mrad/yr per uCi/m^3, effective)

M_i = the air dose factor due to gamma emissions from each noble gas radionuclide i released (mrad/yr per uCi/m^3, from Table 7.0-2)

$$N_{eff} = \sum (N_i * f_i) \qquad \text{(B-4)}$$

where:

N_{eff} = the effective air dose factor due to beta emissions from all noble gases released (mrad/yr per uCi/m^3, effective)

N_i = the air dose factor due to beta emissions from each noble gas radionuclide i released (mrad/yr per uCi/m^3, from Table 7.0-2)

Normally, past radioactive effluent data would be used for the determination of the effective dose factors. Fermi 2, however, does not have a sufficient operating history at or near full power to provide a reasonable data base for determination of the typical radionuclide distribution in gaseous effluents. Therefore, the UFSAR estimate of radionuclide concentrations at the site boundary is used as the initial typical distribution. The effective dose factors derived from this distribution are presented in Table B-1.

Application

To provide an additional degree of conservatism, a factor of 2.0 is introduced into the dose calculation when the effective dose factor is used. This conservatism provides additional assurance that the evaluation of doses by the use of a single effective dose factor will not significantly underestimate any actual doses in the environment.

For evaluating compliance with the dose limits of ODCM 3.11.2.2 the following simplified equations may be used:

$$D_\gamma = 2.0 * 3.17\text{ E} - 08 * X/Q * M_{eff} * \sum Q_i \qquad \text{(B-5)}$$

and

$$D_\beta = 2.0 * 3.17\text{ E} - 08 * X/Q * N_{eff} * \sum Q_i \qquad \text{(B-6)}$$

where:

D_γ = air dose due to gamma emissions for the cumulative release of all noble gases (mrad)

D_β = air dose due to beta emissions for the cumulative release of all noble gases (mrad)

X/Q	=	atmospheric dispersion to the controlling site boundary (sec/m^3)
M_{eff}	=	2.7 E + 03, effective gamma-air dose factor ($mrad/yr$ per uCi/m^3)
N_{eff}	=	2.3 E + 03, effective beta-air dose factor ($mrad/yr$ per uCi/m^3)
Q_i	=	cumulative release for all noble gas radionuclides (uCi)
3.17 E - 08	=	conversion factor (yr/sec)
2.0	=	conservatism factor to account for the variability in the effluent data

Combining the constants, the dose calculation equations simplify to:

$$D_\gamma = 1.71 \text{ E} - 04 * X/Q * \sum Q_i \qquad \text{(B-7)}$$

and

$$D_\beta = 1.46 \text{ E} - 04 * X/Q * \sum Q_i \qquad \text{(B-8)}$$

The effective dose factors are used for the purpose of facilitating the timely assessment of radioactive effluent releases, particularly during periods when the computer or ODCM software may be unavailable to perform a detailed dose assessment.

TABLE B-1

Effective Dose Factors - Noble Gas Effluents

Isotope	Fractional* Abundance	Total Body Dose Factor K_{eff} (mrem/yr per uCi/m^3)	Skin Dose Factor $(L+1.1M_{eff})$ (mrem/yr per uCi/m^3)	Gamma Air Dose Factor M_{eff} (mrad/yr per uCi/m^3)	Beta Air Dose Factor N_{eff} (mrad/yr per uCi/m^3)
Kr-85m	0.10	1.2E+02	2.8E+02	1.2E+02	2.0E+02
Kr-85	0.01	1.6E-01	1.4E+01	1.7E-01	2.0E+01
Kr-88	0.04	5.9E+02	7.6E+02	6.1E+02	1.2E+02
Kr-89	0.06	1.0E+03	1.7E+03	1.0E+03	6.4E+02
Xe-133	0.67	2.0E+02	4.7E+02	2.4E+02	7.0E+02
Xe-135	0.02	3.6E+01	7.9E+01	3.8E+01	4.9E+01
Xe-137	0.02	2.8E+01	2.8E+02	3.0E+01	2.5E+02
Xe-138	0.07	6.2E+02	1.0E+03	6.4E+02	3.3E+02
TOTAL		2.6E+03	4.6E+03	2.7E+03	2.3E+03

* Radionuclide distribution derived from Fermi 2 UFSAR, Section 11.3, Table 11.3-6. Kr-90, Kr-91, Xe-139, and Xe-140 have been excluded from the UFSAR distribution because of short half-lives and subsequent decay during environmental transport. Kr-87, Xe-131m, and Xe-133m have been excluded because of their negligible fractional abundance.

END