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NRC-91-0026

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) Appendix A, Facility Operating License No. NPF-43, Technical Specification 6.9.1.8

Subject: Semi-Annual Radiological Effluent Release Report

The Semi-Annual Effluent Release Report for Fermi 2 is attached. This report is being transmitted in compliance with Reference 2 and Regulatory Guide 1.21, Revision 1. The attached report covers the period from July 1 through December 31, 1990. In addition, a correction of a typographical error on page 14 of the February 1989 Semi-Annual Effluent Release Report is provided for the record.

During this reporting period there were no instances of unmonitored or unplanned radioactive releases from the site.

Please direct any questions or requests for additional information to Joseph Pendergast, Compliance Engineer, at (313) 586-1682.

Sincerely,

WSOrser

cc: A. B. Davis
R. W. DeFayette
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DETROIT EDISON COMPANY

FERMI 2 NUCLEAR POWER PLANT

OPERATING LICENSE NO. NPF. - 43

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

for the period of

July 1, 1990 through December 31, 1990

PREFACE

The Fermi 2 Nuclear Power Plant maintains a comprehensive program of monitoring and controlling the release of radioactive material from the site. The releases covered in this report are of three types: liquid releases, gaseous releases, and radioactive waste shipments.

In a liquid release, a tank containing radioactive water is sampled prior to discharge. Based on the analysis of this sample, both the amount of radioactivity in the tank and the potential radiation dose to a member of the public are determined, and these figures are compared to federal limits. In calculating the radiation dose, very conservative assumptions are used. For example, it is assumed that an individual eats 46 pounds of fish per year from Lake Erie directly offshore of the Fermi 2 plant. The tank may be released only after it is determined that no federal limits are exceeded. As it is released, the contents of the tank are diluted by clean water in a ratio of about 400 gallons of clean water to one gallon of tank water, and the release is continuously monitored by radiation detectors. Fermi 2 is actively trying to eliminate all liquid releases, and none occurred the second half of 1990.

Gaseous releases occur at Fermi 2 in conjunction with building ventilation systems. There are six ventilation system release points, or "stacks", each of which is monitored by a sophisticated radiation monitor which continuously extracts a sample from the stack effluent. Since any gaseous radioactive material is diluted by building ventilation, the stack concentrations are small. In fact, radioactive material is not detected in most stack samples. Of course, all sample results are compared with federal limits to ensure compliance. If the amount of radioactivity in the effluent of any stack would get close to a federal limit, an alarm would be received in the Fermi 2 control room so that operators can evaluate the situation, order increased sampling, shut down building ventilation, or divert the effluent stream to a special standby treatment system so that federal limits are not exceeded.

Radioactive shipments of solid waste from the Fermi 2 site consist of waste generated in the process of cleaning plant water, radioactive trash, and irradiated components. Federal regulations and limits governing these shipments are extensive, and Fermi 2 also complies with internal, sometimes more restrictive, procedures. Shipment destinations are either licensed burial sites or intermediate processing facilities.

This report also contains data on <u>potential</u> radiation doses due to liquid and gaseous releases. These doses are calculated according to methods approved by the Nuclear Regulatory Commission, and many conservative assumptions are used in the calculations. As mentioned above, in calculating dose due to liquid releases it is assumed that an individual consumes 46 pounds of fish per year caught just offshore of Fermi 2. To calculate a maximum dose due to gaseous releases, it is assumed that a hypothetical infant drinks 87 gallons per year of milk from a milk animal which is fed exclusively from feed grown at the same location at which the infant lives. Most dose calculations assume that the individual receiving dose spends the entire year at a given location, and that he is not protected by shelters such as houses. Because of assumptions such as these, it is likely that the radiation doses listed in this report are overestimates of the doses actually received. Even so, no calculated dose exceeds 1% of any federal limit.

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1. INTRODUCTION

The Detroit Edison Fermi 2 Nuclear Power Plant is designed and operated to strictly control and monitor the release of radioactive effluents to the environment in accordance with Nuclear Regulatory Commission (NRC) and Detroit Edison Company requirements. This Semiannual Radioactive Effluent Release Report is submitted in accordance with Fermi 2 Technical Specification 6.9.1.8 and NRC Regulatory Guide 1.21. This report provides the following information required by those references:

1. Summation of the quantities of radioactive material (in the form of gases and liquids) released from the plant and analysis of the radiological impact of these releases

2. Summation of quantities of radioactive material contained in solid waste packaged and shipped for off-site disposal

3. Changes to the Process Control Program (PCP)

4. Changes to the Offsite Dose Calculation Manual (ODCM)

This report covers the period of July 1 through December 31, 1990.

During 1990, the total gaseous and liquid radioactive effluent releases and resulting dose to the public were maintained As Low As Reasonably Achievable (ALARA). A summary of the dose due to radioactive effluents in comparison to NRC limits is shown below:

NRC DOSE LIMITS (10CFR50 APPENDIX I)	FERMI 2 ESTIMATED DOSE IN 1990	PERCENT OF ALLOWABLE LIMITS
A. GASEOUS EFFLUENTS		
Noble Gas Dose to Air (Site Boundary)		
≤10 mrad/year gamma	4.58 E-2 mrad	0.46%
≤20 mrad/year beta	2.76 E-2 mrad	0.14%
I-131, I-133, Tritium, and Particulates with half lives > 8 days		
≤15 mrem/year to any organ	5.69 E-2 mrem	0.38%
B. LIQUID EFFLUENTS		
≤3 mrem/year to total body	5.13 E-3 mrem	0.17%
≤10 mrem/year to any organ	1.11 E-2 mrem	0.11%

Section 11 of this report presents data supporting this summary.

2. REGULATORY LIMITS

The Nuclear Regulatory Commission limits on liquid and gaseous effluents are incorporated in the Fermi 2 Technical Specifications. These limits prescribe the maximum quantities and rates of release for radioactive effluents resulting from normal operation of Fermi 2. The limits are defined in several ways to limit the overall impact on persons living near the plant. The limits are described below:

A. Gaseous Effluents

1. Dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to the following:

   a. Noble gases

      Less than or equal to 500 mrem/year to the total body
      Less than or equal to 3000 mrem/year to the skin

   b. Iodine 131, 133, tritium, and for all radionuclides in particulate form with half lives greater than 8 days

      Less than or equal to 1500 mrem/year to any organ.

2. Air dose due to noble gases released in gaseous effluents from the reactor to areas at and beyond the site boundary shall be limited to the following:

   a. Less than or equal to 5 mrads for gamma radiation
      Less than or equal to 10 mrads for beta radiation
      -During any calendar quarter

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

3. Dose to a member of the public from Iodine-131, 133, tritium, and all radionuclides in particulate form with half lives greater than 8 days in gaseous effluents released from the reactor to areas at and beyond the site boundary shall be limited to the following:

   a. Less than or equal to 7.5 mrems to any organ
      -During any calendar quarter

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

B. Liquid Effluents

1. The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to the concentrations specified in Title 10 of the Code of Federal Regulations Part 20 (Standards for Protection Against Radiation), 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 2E-4 (.0002) microcuries/ml total activity.

2. The dose or dose commitment to a member of the public from radioactive materials in liquid effluents released from the reactor to unrestricted areas shall be limited to:

   a. Less than or equal to 1.5 mrem to the total body
      Less than or equal to 5 mrem to any organ
      -During any calender quarter

   b. Less than or equal to 3 mrem to the total body
      Less than or equal to 10 mrem to any organ
      -During any calender year

3. MAXIMUM PERMISSIBLE CONCENTRATION (MPC)

Fermi 2 Technical Specifications implement the MPC requirements of 10 CFR 20 and NRC Regulatory Guide 1.21 by means of the following dose rate limits:

A. Gases

The dose rate due to gaseous effluents is calculated in accordance with the Fermi 2 Offsite Dose Calculation Manual (ODCM). The maximum permissible dose rates for gaseous releases are defined in Fermi 2 Technical Specifications:

Technical Specification 3.11.2.1.a (Dose rate at the site boundary from noble gases):

-Less than or equal to 500 mrem/year to the total body
-Less than or equal to 3000 mrem/year to the skin

Technical Specification 3.11.2.1.b (Dose rate at the site boundary from I-131, I-133, and particulates with half lives greater than 8 days):

-Less than or equal to 1500 mrem/year to any organ

B. Liquids

Allowable liquid release rates are calculated in accordance with the Fermi 2 Offsite Dose Calculation Manual (ODCM). The maximum permissible concentration (MPC) for liquids used for these calculations are taken from 10 CFR 20, Appendix B, Table II, Column 2. The most restrictive MPC is used in all cases. For dissolved and entrained gases the MPC of 2E-4 microcuries/ml is applied. This MPC is based on the Xe-135 MPC in air (submersion dose) converted to an equivalent concentration in water as discussed in the International Commission on Radiological Protection (ICRP) Publication 2.

4. AVERAGE ENERGY

The calculated site boundary dose rates for Fermi 2 are based on identification of individual isotopes and on use of dose factors specific to each identified isotope or a highly conservative dose factor. Average energy values are not used in these calculations, and therefore need not be reported.

5. MEASUREMENTS AND APPROXIMATIONS OF TOTAL ACTIVITY

As required by NRC Regulatory Guide 1.21, this section describes the methods used to measure the total radioactivity in effluent releases and to estimate the overall errors associated with these measurements. The effluent monitoring systems are described in Chapter 11.4 of the Fermi 2 Updated Final Safety Analysis Report (UFSAR).

A. Gaseous Effluents

1. Fission and Activation Gases

Samples are obtained from each of the seven plant radiation monitors which continuously monitor the six ventilation exhaust points and from the Offgas Vent Pipe which carries the gland seal condenser exhaust, mechanical vacuum pump exhaust, and treated offgas streams. The fission and activation gases are quantified by gamma spectroscopy analysis of periodic samples. The following are typical fission and activation gases that are quantified for dose calculations:

Krypton (Kr)-85m	Xenon (Xe)-133	Xenon (Xe)-135
Xenon (Xe)-135m	Xenon (Xe)-137	Xenon (Xe)-138
Argon (Ar)-41		

The values reported in Section 9 are the sums of all fission and activation gases quantified at all monitored release points.

Considering the inherent variability in radiation measurement, the variability in effluent stream composition, and the uncertainties in effluent flow rate and instrument calibration, Detroit Edison estimates that the uncertainty of the fission and activation gas total release figures is less than plus or minus 8 percent.

2. Radioiodines

Samples are obtained from each of the seven plant radiation monitors, which continuously monitor the six ventilation exhaust points. The radioiodines are entrained on charcoal and then quantified by gamma spectroscopy analysis. For each sample the duration of sampling and continuous flow rate through the charcoal are used in determining the concentration of radioiodines. From the flow rate of the ventilation system a rate of release can be determined. The radioiodines usually quantified for dose calculations are the following:

Iodine (I)-131	Iodine (I)-132
Iodine (I)-133	Iodine (I)-135

The values reported in Section 9 are the sums of all radioiodines quantified at all continuously monitored release points.

Considering the inherent variability in radiation measurements, the variability in effluent stream composition, and the uncertainty in sample and effluent flow rates, Detroit Edison estimates that the uncertainty of the total radioiodine release figures is less than plus or minus 5 percent.

3. Particulates

Samples are obtained from each of the seven plant effluent radiation monitors, which continuously monitor the six ventilation exhaust points. The particulates are collected on a filter and then quantified by gamma spectroscopy analysis. For each sample the duration of sampling and continuous flow rate through the filter are used in determining the concentration of particulates. From the flow rate of the ventilation system a rate of release can be determined. Radioactive activation and fission products that are typically found include the following:

Manganese (Mn)-54	Iron (Fe)-59	Cobalt (Co)-58
Cobalt (Co)-60	Zinc (Zn)-65	Chromium (Cr)-51
Barium (Ba)-139	Barium (Ba)-140	Lanthanum (La)-140
Yttrium (Y)-91m	Strontium (Sr)-91	Rubidium (Rb)-89
Cesium (Cs)-138	Technetium (Tc)-99m	

A composite of the filters from each ventilation release point are analyzed monthly for gross alpha radioactivity using gas proportional counting methods. Quarterly the filters are radiochemically separated and analyzed for Strontium (Sr)-89/90 using various analytical methods. If found these radionuclides are reported as total particulate activity.

The values reported in Section 9 are the sums of all particulates quantified at all monitored release points.

Considering the inherent variability in radiation measurements, the variability in effluent stream composition, and the uncertainties in instrument calibration and in sample and effluent flow rates, Detroit Edison estimates that the the uncertainty of the total particulate release figures is less than plus or minus 3 percent.

4. Tritium

Samples are obtained for each of the seven plant effluent radiation monitors which continuously monitor the six ventilation exhaust points. The sample is passed through a bottle containing water and the tritium is "washed" out to the collecting water. Portions of the collecting water are analyzed for tritium using liquid scintillation counting techniques. For each sample, the duration of sample and sample flow rate are used to determine the concentration. From the flow rate of the ventilation system a release rate can be determined.

The values reported in Section 9 are the sums of all tritium quantified at all monitored release points.

Considering the inherent variability in radiation measurement, the variability in effluent stream composition, and the uncertainties in instrument calibration, sample and effluent flow rates, and collection efficiency, Detroit Edison estimates that the uncertainty of total gaseous tritium release figures is less than plus or minus 34 percent.

5. Gross Alpha

The gaseous particulate filters from the seven plant effluent radiation monitors are stored for one week to allow for decay of naturally occurring alpha emitters. These filters are then analyzed for gross alpha radioactivity by gas proportional counting, and any such radioactivity found is assumed to be plant related. The quantity of alpha emitters released can then be determined from sample flow rate, sample duration, and stack flow rate.

The values reported in Section 9 are the sums of all alpha emitters quantified at all monitored release points.

Considering the inherent variability in radiation measurements, the variability in effluent stream composition, and the uncertainties in instrument calibration and in sample and effluent flow rates, Detroit Edison estimates that the uncertainty of the total gaseous gross alpha release figures is less than plus or minus 10 percent.

B. Liquid Effluents

The liquid radwaste processing system and the liquid effluent monitoring system are described in the Fermi-2 UFSAR.

1. Fission and activation products

Before the contents of each holding tank is discharged to the environment, a representative sample of the tank's contents is taken and retained. The sample allows for the determination of radioactive material concentrations and establishes the rate at which the radioactive material can be discharged to the environment. Radioactive activation and fission products that are typically found include the following:

Manganese (Mn)-54	Iron (Fe)-59	Chromium (Cr)-51
Cobalt (Co)-58	Cobalt (Co)-60	Silver (Ag)-110m
Zinc (Zn)-65	Barium (Ba)-131	Technetium (Tc)-99m

At the end of the calendar quarter a composite sample is made of all discharge samples taken during the quarter. This composite sample consists of portions of each discharge sample which are proportional to the volumes discharged. The composite sample is analyzed for Iron (Fe)-55 and Strontium (Sr)-89/90. Radiochemical separations and various analytical methods are used to quantify the amounts of Sr-89/90 and Fe-55.

The values reported in Section 8 are the sums of all fission and activation products found in all batch releases.

Considering the inherent variability in radiation measurement and the uncertainties in volume measurements and instrument calibration, Detroit Edison estimates that the uncertainty in total liquid fission and activation product release figures is less than plus or minus 5 percent.

2. Tritium

Before the contents of each holding tank is discharged to the environment, a representative sample of the tank contents is taken and retained. At the end of the calendar month a composite sample is made of all discharge samples taken during the month. This composite sample consists of portions of each discharge sample which are proportional to the volumes discharged. The composite sample is analyzed for tritium by liquid scintillation counting.

The values reported in Section 8 are the sums of all tritium quantified from all batch releases.

Considering the inherent variability in radiation measurement and the uncertainties in volume measurement and instrument calibration, Detroit Edison estimates the uncertainty in total tritium release figures is less than plus or minus 15 percent.

3. Dissolved and Entrained Gases

Prior to releasing liquid radioactive waste to the environment a sample is taken from the radwaste holding tank. This sample is representative of the tank's contents. The sample is examined using gamma spectroscopy to determine the dissolved and entrained noble gases. The following radiogases are typical of those which may be found:

Xenon (Xe)-133	Xenon (Xe)-135

The values reported in Section 8 are the sums of all radiogases found for all batch releases.

Considering the inherent variability in radiation measurement and the uncertainties in instrument calibration and volume measurements, Detroit Edison estimates that the uncertainty in total dissolved and entrained gas release figures is less than plus or minus 15 percent.

4. Gross Alpha

Before the contents of each holding tank is discharged to the environment, a representative sample of the tank's contents is taken and retained. At the end of the calendar month a composite sample is made of all discharge samples taken during the month. This composite sample consists of portions of each discharge sample which are proportional to the volumes discharged. The composite sample is analyzed for gross alpha radioactivity by gas proportional counting.

The values reported in Section 8 are the sums of the gross alpha radioactivity from all batch releases.

Considering the inherent variability in radiation measurement and the uncertainty in volume measurements and instrument calibration, Detroit Edison estimates that the uncertainty in total liquid gross alpha release figures is less than plus or minus 43 percent.

6. ABNORMAL RELEASES

For the purpose of this report, an abnormal release is any release of radioactive material not performed in accordance with the Fermi 2 license and implementing procedures. No abnormal releases occurred during the reporting period.

7. BATCH RELEASES

No batch liquid releases occurred between July 1, 1990 and December 31, 1990.

The only batch gaseous releases from Fermi 2 are the venting or purging of the primary containment (drywell) atmosphere. These venting or purging releases pass through the reactor building ventilation or standby gas treatment system and are monitored by the final effluent monitors for these pathways. Separate data on these venting or purging releases are not reported because the associated data are already included in the gaseous effluent release data (Section 5.A and Section 9).

8. LIQUID EFFLUENT SUMMARY

REPORT CATEGORY	: SEMIANNUAL SUMMMATION OF ALL RELEASES BY QUARTER
TYPE OF ACTIVITY	: ALL LIQUID EFFLUENTS
REPORTING PERIOD	: QUARTER 3 AND QUARTER 4

During the third and fourth quarters of 1990, there were no liquid releases.

9. GASEOUS EFFLUENT SUMMARY

REPORT CATEGORY : SEMIANNUAL SUMMMATION OF ALL RELEASES BY QUARTER
TYPE OF ACTIVITY : ALL AIRBORNE EFFLUENTS
REPORTING PERIOD : QUARTER 3 AND QUARTER 4

TYPE OF EFFLUENT	UNIT	QUARTER 3	QUARTER 4
A. FISSION AND ACTIVATION GASES			
1. TOTAL RELEASE	CURIES	2.98E+01	1.75E+01
2. AVERAGE RELEASE RATE FOR PERIOD	uCi/sec	3.75E+00	2.20E+00
B. RADIOIODINES			
1. TOTAL IODINE - 131	CURIES	7.78E-04	3.42E-04
2. AVERAGE RELEASE RATE FOR PERIOD	uCi/sec	9.79E-05	4.30E-05
C. PARTICULATES			
1. PARTICULATES (HALF-LIVES>8 DAYS)	CURIES	4.42E-03	9.69E-04
2. AVERAGE RELEASE RATE FOR PERIOD	uCi/sec	5.56E-04	1.22E-04
3. GROSS ALPHA RADIOACTIVITY	CURIES	9.58E-07	3.13E-07
D. TRITIUM			
1. TOTAL RELEASE	CURIES	0.00E+00	0.00E+00
2. AVERAGE RELEASE RATE FOR PERIOD	uCi/sec	0.00E+00	0.00E+00

9. GASEOUS EFFLUENT SUMMARY (continued)

REPORT CATEGORY :SEMIANNUAL AIRBORNE CONTINUOUS RELEASES
TYPE OF ACTIVITY :FISSION GASES, IODINES, AND PARTICULATES
REPORTING PERIOD :QUARTER 3 AND QUARTER 4

	MIXED MODE RELEASES		
NUCLIDE	UNIT	QUARTER 3	QUARTER 4
PARTICULATES			
Cr-51	CURIES	3.76E-03	5.96E-04
Mn-54	CURIES	2.62E-05	1.09E-06
Co-58	CURIES	1.38E-04	1.17E-05
Co-60	CURIES	7.84E-05	3.90E-06
Na-24	CURIES	1.57E-03	2.53E-04
Zn-65	CURIES	8.97E-05	*<2.0E-13
Tc-99m	CURIES	6.78E-03	1.75E-03
Ba-139	CURIES	2.87E-01	1.34E-01
Ba-140	CURIES	3.06E-04	2.79E-04
La-140	CURIES	2.26E-04	1.81E-04
Y-91m	CURIES	1.76E-03	8.04E-04
Sr-91	CURIES	2.87E-03	2.10E-03
Ba-131	CURIES	6.10E-06	*<1.3E-13
As-76	CURIES	2.81E-05	*<1.7E-13
Rb-89	CURIES	1.58E-01	1.60E-01
Cs-138	CURIES	1.92E-01	8.79E-02
Mn-56	CURIES	4.08E-04	*<7.8E-14
Ag-110m	CURIES	*<1.6E-13	5.98E-06
Zn-69m	CURIES	1.12E-05	*<6.3E-14
Br-82	CURIES	4.86E-06	*<8.2E-14
Sr-89	CURIES	1.17E-05	7.00E-05
Sr-90	CURIES	4.45E-07	1.12E-06
Cs-134	CURIES	*<5.1E-14	*<5.1E-14
Cs-137	CURIES	*<6.4E-14	*<6.4E-14
Ce-141	CURIES	*<6.9E-14	*<6.9E-14
Ce-144	CURIES	*<2.9E-13	*<2.9E-13
Total for Period	CURIES	6.55E-01	3.88E-01

* Less than the Lower Limit of Detection (LLD), i.e. the maximum sensitivity of measurement in units of microcuries per milliliter (uCi/ml)

9. GASEOUS EFFLUENT SUMMARY (continued)

REPORT CATEGORY : SEMIANNUAL AIRBORNE CONTINUOUS RELEASES
TYPE OF ACTIVITY : FISSION GASES, IODINES, AND PARTICULATES
REPORTING PERIOD : QUARTER 3 AND QUARTER 4

NUCLIDE	UNIT	MIXED MODE RELEASES QUARTER 3	QUARTER 4
FISSION GASES			
Ar-41	CURIES	4.99E+00	5.69E+00
Xe-135m	CURIES	8.24E-01	5.26E-01
Xe-138	CURIES	2.70E+00	1.47E+00
Xe-135	CURIES	2.11E-01	7.74E-02
Kr-85m	CURIES	1.32E+00	8.96E-01
Xe-137	CURIES	7.93E+00	3.49E+00
Kr-88	CURIES	8.05E+00	9.00E-01
Kr-89	CURIES	3.17E+00	4.48E+00
Xe-133	CURIES	6.02E-01	*<7.2E-08
Total for Period	CURIES	2.98E+01	1.75E+01
IODINES			
I-131	CURIES	7.78E-04	3.42E-04
I-132	CURIES	9.99E-04	2.56E-04
I-133	CURIES	3.42E-03	1.49E-03
I-134	CURIES	*<2.0E-13	*<2.0E-13
I-135	CURIES	7.93E-04	*<4.2E-13
Total for Period	CURIES	5.99E-03	2.09E-03

* Less than the Lower Limit of Detection (LLD), i.e. the maximum sensitivity of measurement in units of microcuries per milliliter (uCi/ml)

10. SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. Solid Waste Shipped Offsite for burial or disposal (not irradiated fuel)

1. Type of Waste	Unit	6 month period	Est. Total Error %
a. Spent resins, filter sludges, evaporator bottoms, etc.	m^3 Curies	1.28E+02 3.50E+02	+/- 25 +/- 25
b. Dry compressible waste, contaminated equipment, etc.	m^3 Curies	7.54E+02 2.21E+00	+/- 25 +/- 25
c. Irradiated components, control rods, etc.	m^3 Curies	3.25E+00 1.98E+04	+/- 25 +/- 25
d. Other		0	

2. Estimate of major nuclide composition (by type of waste)

a. Spent resins, filter sludges, evaporator bottoms, etc. (All waste of this type was Class A and was shipped in LSA containers.)

Nuclide	Percent of Total Activity	Curies
Cr-51	25.1	8.79E+01
Mn-54	7.5	2.63E+01
Fe-55	36.9	1.29E+02
Co-58	4.9	1.71E+01
Co-60	12.1	4.24E+01
Fe-59	0.1	3.63E-01
Ni-63	0.3	9.86E-01
Zn-65	11.6	4.06E+01
H-3	<0.1	6.57E-02
C-14	0.3	9.32E-01
Zr-95	1.3	4.47E+00
Tc-99	<0.1	2.90E-04
I-129	<0.1	3.15E-04
Sb-124	<0.1	5.47E-02
I-131	<0.1	2.35E-02

b. Dry compressible waste, contaminated equipment, etc. (All waste of this type was Class A and was shipped in LSA containers.

Nuclide	Percent of Total Activity	Curies
Cr-51	3.4	7.56E-02
Mn-54	8.0	1.76E-01
Fe-55	74.2	1.64E+00
Co-58	3.0	6.68E-02
Co-60	9.4	2.08E-01
Fe-59	1.8	3.96E-02
C-14	0.1	2.19E-03
Tc-99	<0.1	7.85E-04
I-129	<0.1	8.72E-04

c. Irradiated components, control rods, etc. (All waste of this type was class C and was shipped in type B containers.)

Nuclide	Percent of Total Activity	Curies
Cr-51	<0.1	6.99E+00
Mn-54	6.1	1.21E+03
Fe-55	59.0	1.17E+04
Co-60	30.7	6.08E+03
Ni-63	1.2	2.33E+02
Sb-124	2.5	4.95E+02
Sb-125	0.3	5.48E+01
H-3	0.3	5.04E+01
C-14	<0.1	3.65E-01
Tc-99	<0.1	5.00E-03
Ni-59	<0.1	1.57E+00
Nb-94	<0.1	5.01E-03
Np-237	<0.1	2.32E-08
Pu-238	<0.1	7.78E-05
Pu-239/240	<0.1	1.96E-05
Pu-242	<0.1	6.68E-09
Am-241	<0.1	9.71E-07
Am-243	<0.1	3.52E-08
Cm-242	<0.1	1.76E-04
Cm-243/244	<0.1	3.63E-06
Pu-241	<0.1	1.89E-03

Note: Activities of all principal radionuclides were determined by measurement.

3. Solid Waste Disposition

Type of shipment/ solidification process	Number of shipments	Mode of Transport	Destination
Dewatered resin	15	truck	Barnwell, SC
Dry active waste	10	truck	Oak Ridge, TN
	2	truck	Channahon, IL
Irradiated components, control rods, etc.	2	truck	Barnwell, SC

4. Irradiated Fuel Shipments:

None

11. RADIOLOGICAL IMPACT ON MAN

A. Dose Due to Liquid Effluents

As discussed in Section 2.5.1 of the Fermi 2 Offsite Dose Calculation Manual, compliance with Technical Specification 3.11.1.2, which limits dose to a member of the public to any organ and to the total body due to liquid effluents, is evaluated by calculating the dose to a hypothetical individual who both eats fish from Lake Erie and drinks water extracted from Lake Erie at the water intake for the city of Monroe. Conservative assumptions are made about the quantity of fish and water consumed. The individual organ and total body doses for 1990 to this hypothetical individual were calculated according to Section 2.5.1 of the ODCM and are listed below.

Organ	1990 Liquid Effluent Dose
Bone	3.96 E-3 mrem
Liver	9.94 E-3 mrem
Thyroid	2.80 E-3 mrem
Kidney	6.98 E-3 mrem
Lung	1.14 E-3 mrem
GI-LLI	1.11 E-2 mrem
Total body	5.13 E-3 mrem

B. Dose Due to Gaseous Effluents

As discussed in Section 3.8.1 of the Fermi 2 Offsite Dose Calculation Manual, compliance with Technical Specification 3.11.2.3, which limits dose due to I-131, I-133, H-3, and particulates with half lives greater than 8 days in gaseous effluents to any organ of a member of the public, is evaluated by calculating the dose to a hypothetical individual who receives the highest single organ dose of any member of the public. This hypothetical individual is an infant who is assumed to live at an offsite location known to have milk animals. This infant is assumed to drink milk from these animals, and to also be exposed by the inhalation and ground plane pathways. The individual organ and total body doses to this individual due to I-131, I-133, H-3, and particulates with half lives greater than 8 days were calculated according to Section 3.8.1 of the ODCM and are listed below.

Organ	1990 Gaseous Effluent Dose to Receptor with Highest Single Organ Dose
Bone	4.31 E-4 mrem
Liver	3.22 E-4 mrem
Thyroid	5.69 E-2 mrem
Kidney	3.30 E-4 mrem
Lung	1.09 E-4 mrem
GI-LLI	1.55 E-4 mrem
Total body	2.04 E-4 mrem

C. Dose Due to Direct Radiation and Compliance with 40CFR190

Title 40, Part 190 of the Code of Federal Regulations requires that dose to an individual from the uranium fuel cycle be limited to 25 mrem/yr to the total body and 75 mrem/yr to the thyroid. The sources of fuel cycle dose not analyzed above are due to other fuel cycle facilities and dose due to direct radiation. As discussed in Section 4.2 of the Fermi 2 Offsite Dose Calculation Manual, no other fuel cycle facilities contribute significantly to dose in the vicinity of Fermi 2. With respect to direct radiation, none of the offsite TLD locations listed in Table 6.0-1 of the ODCM showed 1990 TLD readings which were consistently greater than the TLD readings at the control locations. Since other facilities and direct radiation did not contribute significantly to offsite dose, and since the preceding sections of this report show compliance with the more restrictive requirements of 10CFR50 Appendix I, Fermi 2 was in compliance with 40CFR190 in 1990.

D. Dose to Visitors on Site

As discussed in Section 4.0 of the Fermi 2 Offsite Dose Calculation Manual, "visitors" to the Fermi 2 site may receive dose due to their activities within the site boundary. For purposes of this analysis, visitors are members of the public who spend time within th[illegible] boundary, and who do not do work associated with the operation of Fe[illegible] ODCM considers two categories of visitors: persons ice fishing on La[illegible] and persons spending time in the Fermi 2 Visitors Center.

The ODCM lists the maximum amount of time an individual is likely to spend in these activities and the dispersion factors and exposure pathways which apply. Exposure by direct radiation from noble gases and by inhalation of radioactive particulates, iodines, and tritium are considered. (These pathways are in addition to those aleady considered, such as fish consumption in the case of ice fishermen.)

Based on these assumptions, the maximum dose in 1990 to a visitor at the Visitors Center is 1.45 E-4 mrem to total body and 1.59 E-4 mrem to the maximally exposed organ (thyroid). The maximum dose in 1990 to an ice fisherman is 1.82 E-2 mrem to the total body and 1.99 E-2 mrem to the maximally exposed organ (thyroid).

12 RADIATION INSTRUMENTATION

Fermi 2 Technical Specifications 3.3.7.11, Radioactive Liquid Effluent Monitoring Instrumentation, and 3.3.7.12, Radioactive Gaseous Effluent Monitoring Instrumentation, require that those monitors which exceed the time specified for out of service be reported in the next Semiannual Effluent Release Report. During this reporting period, July through December of 1990, the time specified in the action statements for these monitors was not exceeded.

13. METEOROLOGICAL DATA SUMMARY

The meteorological monitoring system is described in the Fermi 2 UFSAR. In accordance with Regulatory Guide 1.21, data recorded by that system is provided here to permit the Nuclear Regulatory Commission to assess the radiological impact of Fermi 2 releases independently. The data format required by Regulatory Guide 1.21 is used. Appendix A contains the meteorological data tables.

14. CHANGES TO THE PROCESS CONTROL PROGRAM (PCP)

As required by the Fermi 2 license, the operator (Detroit Edison) is required to establish a program that will reasonably assure the complete processing of radioactive wastes. This program assures processed wastes are completely solidified and are free of standing water. Changes to the PCP Manual are provided to document changes to established conditions and to ensure that controls are in place to assure that the radioactive waste is solidified.

During this reporting period, July through December of 1990, there were no changes to the PCP.

15. CHANGES TO DOSE CALCULATION AND ENVIRONMENTAL MONITORING LOCATIONS

As a result of analysis of 1990 Land Use Census data and changes in public participation in the environmental sampling program, several changes were made in the sampling locations. Also, the reported distances of several locations were changed due to distance recalculation by Detroit Edison cartographers. The updated sampling tables are presented in the revised Offsite Dose Calculation Manual (Appendix B).

16. CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL (ODCM)

During this reporting period the ODCM was revised. The revised ODCM and site documents explaining the changes are presented in Appendix B.

17. MAJOR CHANGES TO RADIOACTIVE WASTE SYSTEMS

During this reporting period, July through December of 1990, there were no major changes to the liquid, gaseous, or solid radioactive waste treatment systems.

APPENDIX A: METEROLOGICAL DATA TABLES

JOINT FREQUENCY DISTRIBUTION (JFD) AT
THE 10-METER LEVEL
1990

```
PROGRAM: JFD     VERSION: PC-1.1

PRINTOUT OF INPUT CONTROL DATA

TITLE:   DECO FERMI2 JFD AT 10-METERS FOR 1990
BEGIN DATE:   89 12 30 13
END DATE:     90 12 28 16
OPTION TO PRINT MONTHLY JFDS:  NO
OPTION TO PRINT SEASONAL JFDS:  NO
OPTION TO PRINT STABILITY BY HOUR OF DAY: NO
OPTION TO PLACE JFD IN FILE FORMATTED FOR PAVAN/XOQDOQ:  YES
OPTION TO USE 12  WIND SPEED CLASSES
INPUTTED WIND SPEED CLASSES IN MPH :     .75   2.50   4.50   6.50   8.50  11.50  14.50  18.50  23.50  30.50  39.50    .00

PRIMARY MEASUREMENTS BASED ON:
       WIND SPEED MEASURED AT   10.0 METERS    IN  MPH
         BAD WIND SPEED DATA CODED: 999.90
         WIND SPEED THRESHOLD:   .75 MPH
       WIND DIRECTION MEASURED AT  10.0 METERS
         BAD WIND DIRECTION DATA CODED:  999.0
       STABILITY BASED ON 1=A,2=B,...,7=G
         BAD STABILITY CODED:   8.0

BACK-UP MEASUREMENTS BASED ON:
       NO BACKUP WIND SPEED MEASUREMENTS
       NO BACKUP WIND DIRECTION MEASUREMENTS
       NO BACKUP STABILITY MEASUREMENTS

WIND SPEED HEIGHT TO BE USED FOR JFD:  10.00 METERS

CONVERSION FACTOR TO CONVERT SIGMA RANGE TO SIGMA THETA:   6.0

FORMAT TO READ INPUT DATA: (4I2,F5.1,F3.0,10X,F1.0,27X,A6,T11,A3,A3,T27,A1)

FIRST DATA RECORD READ: FERMI2     89 12 30 13     6.6    45.0     2.0
```

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 10-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS A

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	5	8	0	0	1	0	0	0	0	0	0	1	3	1	5	2	26
2.51- 4.50	12	5	8	3	0	1	5	1	1	1	2	2	3	7	3	4	58
4.51- 6.50	11	1	4	1	4	4	3	6	5	4	7	2	4	5	1	5	67
6.51- 8.50	5	2	9	2	7	4	8	6	3	1	1	12	11	14	16	5	106
8.51-11.50	12	3	10	4	8	1	5	11	16	7	12	17	20	20	11	16	173
11.51-14.50	8	4	26	11	6	1	2	2	11	3	12	5	14	23	18	1	145
14.51-18.50	0	1	5	6	11	2	2	0	0	1	5	2	0	8	2	0	45
18.51-23.50	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
23.51-30.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	53	24	60	27	37	13	26	26	36	17	39	41	55	78	56	33	621

STABILITY CLASS B

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	5
2.51- 4.50	3	1	2	0	0	1	0	1	0	1	1	1	1	1	3	2	18
4.51- 6.50	0	1	4	2	3	2	1	1	0	1	0	2	4	7	4	5	37
6.51- 8.50	2	2	8	2	5	6	4	2	5	6	6	5	2	9	3	8	[illegible]
8.51-11.50	6	0	7	7	2	[illegible]	2	7	14	10	13	13	15	11	10	5	128
11.51-14.50	2	3	10	5	2	3	[illegible]	0	2	6	12	11	4	9	9	1	79
14.51-18.50	0	0	1	3	3	0	0	0	0	2	6	0	1	4	1	0	21
18.51-23.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
23.51-30.50	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	14	8	34	19	15	20	9	11	21	26	38	32	25	41	31	22	366

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 10-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS C

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	3	0	0	0	0	1	0	1	0	0	0	1	0	0	2	1	9
2.51- 4.50	1	3	3	1	1	0	4	0	0	0	0	1	3	1	2	0	20
4.51- 6.50	1	7	3	5	5	3	5	1	8	5	1	7	12	2	8	7	80
6.51- 8.50	2	3	6	6	5	2	4	5	10	9	15	13	5	9	11	8	111
8.51-11.50	10	0	5	8	5	6	4	3	16	25	18	15	21	9	11	6	162
11.51-14.50	0	1	1	6	4	2	3	1	2	7	10	13	2	18	9	1	80
14.51-18.50	0	0	0	0	1	0	0	0	0	4	7	5	5	7	0	0	29
18.51-23.50	0	0	0	0	0	0	0	0	0	1	0	1	0	0	4	0	6
23.51-30.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	17	14	16	26	21	14	20	11	36	51	51	56	48	46	47	23	497

STABILITY CLASS D

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	33
.76- 2.50	1	2	3	0	1	1	1	2	4	4	4	2	6	0	4	5	40
2.51- 4.50	8	13	12	8	6	5	18	9	18	8	31	27	20	27	18	13	241
4.51- 6.50	13	21	47	10	16	29	42	36	45	38	38	48	40	30	29	36	518
6.51- 8.50	22	24	53	22	27	48	78	59	43	55	49	51	32	45	38	33	681
8.51-11.50	55	31	64	45	47	64	62	43	57	94	87	65	64	59	33	27	897
11.51-14.50	23	11	16	15	27	36	23	14	17	74	64	19	38	37	22	9	435
14.51-18.50	2	2	1	20	12	15	4	0	4	29	43	11	20	9	7	1	180
18.51-23.50	0	0	0	7	2	0	0	0	0	2	25	3	2	0	0	0	41
23.51-30.50	0	0	0	0	3	0	0	0	0	0	8	0	0	0	0	0	11
30.51-39.50	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	124	104	196	127	141	196	228	163	190	305	350	226	214	207	151	124	3079

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 10-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS E

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	4
.76- 2.50	5	5	5	2	4	5	4	15	4	7	5	16	4	4	13	5	103
2.51- 4.50	29	22	8	11	5	16	8	13	44	34	74	90	64	40	27	25	510
4.51- 6.50	24	25	30	7	11	15	34	39	59	95	69	66	63	61	51	48	697
6.51- 8.50	21	14	22	9	15	22	48	33	89	113	59	30	23	43	27	23	591
8.51-11.50	12	20	11	17	11	16	32	58	77	166	79	23	13	18	13	21	587
11.51-14.50	3	5	2	7	2	9	10	12	29	66	38	8	10	15	8	0	224
14.51-18.50	0	0	0	1	2	5	3	4	7	5	17	4	2	4	0	0	54
18.51-23.50	0	0	0	0	0	2	0	1	0	6	5	0	0	0	0	0	14
23.51-30.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	94	91	78	54	50	90	139	175	309	492	346	237	179	185	139	122	2784

STABILITY CLASS F

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	3
.76- 2.50	5	4	4	4	2	2	5	4	3	12	10	7	14	7	10	8	101
2.51- 4.50	19	10	2	1	3	12	9	11	13	24	41	49	26	54	31	15	320
4.51- 6.50	17	8	2	1	2	10	21	19	21	24	16	2	6	21	25	16	211
6.51- 8.50	2	6	0	2	4	6	13	11	12	31	7	0	0	1	0	1	96
8.51-11.50	0	0	0	0	1	9	9	15	29	37	5	0	0	0	0	0	105
11.51-14.50	0	0	0	0	0	2	4	5	10	22	0	0	1	0	0	0	44
14.51-18.50	0	0	0	0	0	0	3	3	2	1	0	0	0	0	0	0	9
18.51-23.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.51-30.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	43	28	8	8	12	41	64	68	90	151	79	58	47	83	66	40	[illegible]

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 ,'d AT 10-METERS FOR 1990
SITE ID-...FIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS G

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	5	3	0	0	0	2	1	1	2	3	5	4	9	9	12	9	65
2.51- 4.50	13	2	0	1	2	5	9	6	2	9	5	18	26	44	25	26	193
4.51- 6.50	3	1	0	0	2	3	9	8	2	24	1	1	0	6	12	8	80
6.51- 8.50	1	0	0	1	1	4	7	9	9	19	1	0	0	0	0	0	52
8.51-11.50	0	0	0	1	5	10	3	12	8	9	0	0	0	0	0	0	48
11.51-14.50	0	0	0	0	1	2	0	4	0	0	0	0	0	0	0	0	7
14.51-18.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.51-23.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.51-30.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	22	6	0	3	11	26	29	40	23	64	12	23	35	59	49	43	445

STABILITY CLASS ALL

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 10.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	40
.76- 2.50	25	23	14	6	8	11	11	23	13	26	24	31	36	21	46	31	349
2.51- 4.50	85	56	35	25	17	40	53	41	78	77	154	188	143	174	109	85	1360
4.51- 6.50	69	64	90	26	43	66	115	110	140	191	132	128	129	132	130	125	1690
6.51- 8.50	55	51	96	44	64	92	164	125	173	234	138	111	73	121	95	78	1714
8.51-11.50	95	54	97	82	79	114	117	149	217	348	214	133	131	117	78	75	2100
11.51-14.50	36	24	53	44	42	53	42	38	71	178	136	56	61	102	66	12	1014
14.51-18.50	2	3	7	30	29	22	12	7	13	42	78	22	28	32	10	1	338
18.51-23.50	0	0	0	7	2	2	1	1	0	9	30	4	2	0	5	0	63
23.51-30.50	0	0	0	0	3	0	0	0	0	0	8	0	0	0	0	0	11
30.51-39.50	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	367	275	392	264	287	400	515	494	705	1106	915	673	603	699	539	407	8681

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 10-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 10.0 METERS
WIND THRESHOLD AT: .75 MPH

TOTAL NUMBER OF OBSERVATIONS: 8681
TOTAL NUMBER OF VALID OBSERVATIONS: 8681
TOTAL NUMBER OF MISSING OBSERVATIONS: 0
PERCENT DATA RECOVERY FOR THIS PERIOD: 100.0 %
MEAN WIND SPEED FOR THIS PERIOD: 7.9 MPH
TOTAL NUMBER OF OBSERVATIONS WITH BACKUP DATA: 0

PERCENTAGE OCCURRENCE OF STABILITY CLASSES

A	B	C	D	E	F	G
7.15	4.22	5.73	35.47	32.07	10.24	5.13

DISTRIBUTION OF WIND DIRECTION VS STABILITY

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM
A	53	24	60	27	37	13	26	26	36	17	39	41	55	78	56	33	0
B	14	8	34	19	15	20	9	11	21	26	38	32	25	41	31	22	0
C	17	14	16	26	21	14	20	11	36	51	51	56	48	46	47	23	0
D	124	104	196	127	141	196	228	163	190	305	350	226	214	207	151	124	33
E	94	91	78	54	50	90	139	175	309	492	346	237	179	185	139	122	4
F	43	28	8	8	12	41	64	68	90	151	79	58	47	83	66	40	3
G	22	6	0	3	11	26	29	40	23	84	12	23	35	59	49	43	0
TOTAL	367	275	392	264	287	400	515	494	705	1106	915	673	603	699	539	407	40

PROGRAM: JFD VERSION: PC-1.1

LAST DATA RECORD READ: FERMI2 90 12 28 16 7.1 168.0 4.0

OUTPUT FILE NAME :JFD10M90.OUT

JOINT FREQUENCY DISTRIBUTION (JFD) AT
THE 60-METER LEVEL
1990

NUS CORPORATION

```
PROGRAM: JFD     VERSION: PC-1.1

PRINTOUT OF INPUT CONTROL DATA

TITLE:   DECO FERMI2 JFD AT 60-METERS FOR 1990
BEGIN DATE:   89 12 30 13
END DATE:     90 12 28 16
OPTION TO PRINT MONTHLY JFDS:  NO
OPTION TO PRINT SEASONAL JFDS:  NO
OPTION TO PRINT STABILITY BY HOUR OF DAY: NO
OPTION TO PLACE JFD IN FILE FORMATTED FOR PAVAN/XOQDOQ:  NO
OPTION TO USE 12  WIND SPEED CLASSES
INPUTTED WIND SPEED CLASSES IN MPH :    .75   2.50   4.50   6.50   8.50  11.50  14.50  18.50  23.50  30.50  39.50    .00

PRIMARY MEASUREMENTS BASED ON:
       WIND SPEED MEASURED AT   60.0 METERS    IN  MPH
         BAD WIND SPEED DATA CODED: 999.90
         WIND SPEED THRESHOLD:   .75 MPH
       WIND DIRECTION MEASURED AT  60.0 METERS
         BAD WIND DIRECTION DATA CODED:  999.0
       STABILITY BASED ON 1=A,2=B,....,7=G
         BAD STABILITY CODED:   8.0

BACK-UP MEASUREMENTS BASED ON:
       NO BACKUP WIND SPEED MEASUREMENTS
       NO BACKUP WIND DIRECTION MEASUREMENTS
       NO BACKUP STABILITY MEASUREMENTS

WIND SPEED HEIGHT TO BE USED FOR JFD:  60.00 METERS

CONVERSION FACTOR TO CONVERT SIGMA RANGE TO SIGMA THETA:   6.0

FORMAT TO READ INPUT DATA: (4I2,T38,F5.1,F3.0,T27,F1.0,T55,A6,T40,A3,A3,T27,A1)

FIRST DATA RECORD READ: FERMI2      89 12 30 13    10.6    56.0     2.0
```

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 60-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS A

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	1	1	1	8	2	0	0	0	0	1	1	1	0	0	2	3	21
2.51- 4.50	7	7	6	12	3	1	2	0	0	1	5	1	1	1	2	1	50
4.51- 6.50	5	10	2	1	2	4	4	4	2	3	4	0	2	5	2	1	51
6.51- 8.50	1	1	2	3	2	6	7	5	5	3	1	2	1	1	1	4	45
8.51-11.50	4	0	8	2	3	0	2	7	4	3	2	5	9	9	11	9	78
11.51-14.50	6	7	3	13	5	2	3	8	3	9	2	11	10	14	4	13	113
14.51-18.50	3	8	2	13	8	0	1	1	9	12	1	12	13	13	12	7	115
18.51-23.50	0	4	14	12	10	1	4	0	1	4	5	18	12	17	16	3	121
23.51-30.50	0	0	0	0	5	0	0	0	0	0	1	3	5	9	1	0	24
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	3
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	27	38	38	64	40	14	23	25	24	36	22	55	53	69	51	42	621

STABILITY CLASS B

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	4
2.51- 4.50	2	4	1	1	1	0	0	1	0	0	0	0	0	0	0	0	10
4.51- 6.50	1	0	2	0	1	2	1	1	0	2	0	1	1	0	3	1	16
6.51- 8.50	2	1	1	2	3	2	2	0	0	4	0	2	1	4	1	1	26
8.51-11.50	3	0	1	7	1	6	8	2	1	2	1	0	5	6	1	2	46
11.51-14.50	4	2	6	5	3	6	0	2	4	9	4	7	9	5	2	7	66
14.51-18.50	4	1	3	12	2	4	1	1	5	15	4	13	13	10	5	6	99
18.51-23.50	0	2	7	0	5	1	0	0	2	0	5	20	8	9	10	4	73
23.51-30.50	0	0	0	0	0	0	0	0	0	1	3	8	4	7	2	0	25
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
TOTAL	16	10	21	29	18	21	12	7	12	33	17	51	32	41	25	21	366

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 60-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS C

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	4
2.51- 4.50	0	2	2	2	1	2	2	1	0	0	0	0	1	0	2	0	15
4.51- 6.50	0	1	0	5	4	2	4	0	0	2	0	0	0	3	1	0	22
6.51- 8.50	1	0	4	4	3	1	3	2	2	6	2	2	3	2	3	2	40
8.51-11.50	4	4	3	5	8	2	3	5	7	9	4	6	8	7	1	6	82
11.51-14.50	5	2	5	2	5	2	2	3	6	11	6	14	3	7	5	11	89
14.51-18.50	5	0	3	2	7	3	2	1	5	15	13	27	12	8	6	6	115
18.51-23.50	0	1	1	0	5	0	0	0	1	11	8	11	15	12	8	10	83
23.51-30.50	0	0	0	0	0	0	0	0	0	2	5	12	8	11	1	0	39
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	3	1	0	3	0	7
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
TOTAL	15	12	18	21	34	12	16	12	21	56	38	75	51	50	31	35	497

STABILITY CLASS D

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	2	3	3	2	0	0	1	4	1	2	0	0	0	2	0	1	21
2.51- 4.50	3	5	3	6	5	4	5	7	5	4	2	3	3	5	2	3	65
4.51- 6.50	8	1	10	6	12	13	28	15	11	10	9	6	10	8	9	5	161
6.51- 8.50	9	7	15	12	17	16	34	47	27	25	15	15	12	8	12	12	283
8.51-11.50	19	18	43	39	19	46	61	53	39	30	39	54	35	23	26	41	585
11.51-14.50	18	24	43	48	37	39	29	15	29	51	50	40	30	28	37	35	553
14.51-18.50	34	30	51	23	24	40	27	21	24	46	62	80	56	57	38	28	641
18.51-23.50	10	17	22	18	27	21	10	1	14	61	88	74	56	45	24	19	507
23.51-30.50	2	0	0	3	7	8	0	0	2	29	51	36	33	23	14	2	210
30.51-39.50	0	0	0	2	4	0	0	0	0	1	17	13	7	0	0	0	44
>39.50	0	0	0	0	1	0	0	0	0	0	7	1	0	0	0	0	9
TOTAL	105	105	190	159	153	187	195	163	152	259	340	322	242	199	162	146	3079

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 60-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS E

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	1
.76- 2.50	1	0	0	2	2	0	1	1	2	3	0	1	0	0	0	0	13
2.51- 4.50	5	3	3	9	7	8	6	8	5	3	6	2	2	4	5	3	79
4.51- 6.50	5	4	21	8	6	12	10	18	15	9	6	8	9	6	7	8	152
6.51- 8.50	6	8	12	9	7	17	18	21	23	23	11	9	7	16	9	12	208
8.51-11.50	25	12	30	20	6	15	20	38	54	46	46	53	52	30	20	31	498
11.51-14.50	26	20	15	19	7	12	17	36	57	67	98	101	66	36	40	34	651
14.51-18.50	19	18	15	17	8	20	15	29	48	101	120	69	37	61	32	22	631
18.51-23.50	2	4	5	2	0	4	10	9	24	94	116	45	18	20	14	8	375
23.51-30.50	0	0	0	0	3	2	7	2	21	27	48	11	13	15	6	0	155
30.51-39.50	0	0	0	0	0	6	0	0	0	2	8	4	1	0	0	0	21
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	89	69	101	86	46	96	104	162	249	375	459	303	205	188	133	118	2784

STABILITY CLASS F

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	0	0	0	3	0	0	1	0	1	0	0	1	0	0	1	0	7
2.51- 4.50	0	3	2	7	5	4	2	5	2	3	2	5	1	4	0	1	46
4.51- 6.50	3	2	8	4	2	3	7	5	8	6	9	7	4	2	2	1	73
6.51- 8.50	3	5	4	6	2	1	8	6	5	14	8	8	2	3	4	0	79
8.51-11.50	7	9	11	3	1	3	15	13	21	24	12	17	17	6	10	9	178
11.51-14.50	10	5	5	1	1	2	9	12	11	27	16	14	17	21	29	17	197
14.51-18.50	9	6	0	0	0	1	11	7	8	23	29	11	8	19	14	5	151
18.51-23.50	0	0	0	0	0	3	9	3	17	31	25	3	0	0	0	0	91
23.51-30.50	0	0	0	0	0	2	0	7	14	34	7	0	1	0	0	0	65
30.51-39.50	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	32	30	30	24	11	19	62	58	88	163	108	66	50	55	60	33	889

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 60-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY CLASS G

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0
.76- 2.50	0	0	1	4	1	0	3	1	0	0	1	1	0	0	1	0	13
2.51- 4.50	1	0	2	3	4	2	2	5	1	2	5	1	1	4	3	1	37
4.51- 6.50	4	0	5	1	1	4	1	4	4	5	5	8	3	6	1	2	54
6.51- 8.50	1	4	3	1	0	0	0	0	4	2	5	4	4	0	3	3	36
8.51-11.50	7	1	4	0	0	1	2	3	3	3	5	1	6	10	9	6	61
11.51-14.50	6	0	2	0	1	2	5	5	5	6	9	7	9	12	8	6	83
14.51-18.50	11	0	0	0	0	2	5	6	10	12	18	0	4	7	3	5	83
18.51-23.50	0	0	0	0	1	3	3	6	10	21	13	1	1	0	0	0	59
23.51-30.50	0	0	0	0	0	4	2	4	3	2	4	0	0	0	0	0	19
30.51-39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>39.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	30	5	17	9	8	18	23	34	40	53	65	23	28	39	30	23	445

STABILITY CLASS ALL

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION IN HOURS AT 60.00 METERS

SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	1
.76- 2.50	4	6	5	22	8	0	6	6	4	6	2	4	0	2	4	4	83
2.51- 4.50	18	24	19	40	26	21	19	27	13	13	20	12	9	18	14	9	302
4.51- 6.50	26	18	48	25	28	40	55	47	40	37	33	30	29	30	25	18	529
6.51- 8.50	23	26	41	37	34	43	72	81	66	77	42	42	30	34	35	34	717
8.51-11.50	69	44	100	76	38	73	111	121	129	117	109	136	132	91	78	104	1528
11.51-14.50	75	60	79	88	59	65	65	81	115	180	185	194	135	123	125	123	1752
14.51-18.50	85	63	74	67	49	70	62	66	109	224	247	212	143	175	110	79	1835
18.51-23.50	12	28	49	32	48	33	36	19	69	222	260	172	110	103	72	46	1309
23.51-30.50	2	0	0	3	15	16	9	13	40	95	119	70	64	65	24	2	537
30.51-39.50	0	0	0	2	4	6	0	0	1	4	25	22	9	0	3	1	77
>39.50	0	0	0	0	1	0	0	0	0	0	7	1	0	0	2	0	11
TOTAL	314	269	415	392	310	367	435	461	586	975	1049	895	661	641	492	418	8681

PROGRAM: JFD VERSION: PC-1.1

DECO FERMI2 JFD AT 60-METERS FOR 1990
SITE IDENTIFIER: FERMI2
DATA PERIOD EXAMINED: 12/30/89 - 12/28/90

*** ANNUAL ***

STABILITY BASED ON 1=A,2=B,...,7=G
WIND MEASURED AT: 60.0 METERS
WIND THRESHOLD AT: .75 MPH

TOTAL NUMBER OF OBSERVATIONS: 8681
TOTAL NUMBER OF VALID OBSERVATIONS: 8681
TOTAL NUMBER OF MISSING OBSERVATIONS: 0
PERCENT DATA RECOVERY FOR THIS PERIOD: 100.0 %
MEAN WIND SPEED FOR THIS PERIOD: 14.1 MPH
TOTAL NUMBER OF OBSERVATIONS WITH BACKUP DATA: 0

PERCENTAGE OCCURRENCE OF STABILITY CLASSES

A	B	C	D	E	F	G
7.15	4.22	5.73	35.47	32.07	10.24	5.13

DISTRIBUTION OF WIND DIRECTION VS STABILITY

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM
A	27	38	38	64	40	14	23	25	24	36	22	55	53	69	51	42	0
B	16	10	21	29	18	21	12	7	12	33	17	51	32	41	25	21	0
C	15	12	18	21	34	12	16	12	21	56	38	75	51	50	31	35	0
D	105	105	190	159	153	187	195	163	152	259	340	322	242	199	162	146	0
E	89	69	101	86	46	96	104	162	249	375	459	303	205	188	133	118	1
F	32	30	30	24	11	19	62	58	88	163	108	66	50	55	60	33	0
G	30	5	17	9	8	18	23	34	40	53	65	23	28	39	30	23	0
TOTAL	314	269	415	392	310	367	435	461	586	975	1049	895	661	641	492	418	1

PROGRAM: JFD VERSION: PC-1.1

LAST DATA RECORD READ: FERMI2 90 12 28 16 11.7 176.0 4.0

APPENDIX B: REVISED OFFSITE DOSE CALCULATION MANUAL

LICENSING CHANGE REQUEST

LCR 89-2001-0DM

Revision 3 Page 1 of 81

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

A) Document Offsite Dose Calculation Manual

B) Section(s), Table(s), Figure(s), etc. Affected
0.0, 1.0, 2.3.1, 2.3.2, 2.3.3, 2.6, Fig. 2.0-1, 3.2.2, 3.3, 3.5, 3.6.1, 3.8.1, 3.9, Tables 3.0-2, 4, +5, Tables 4.0-1 and 6.0-1, Figures 6.0-1 through 6.0-5, 5.0, App A

C) Reason for Change
Correct tables with updated values, improve readability, revise calculation methods, etc.

D) Reference and Source Documents (Identify)

EDP
PDC
ABN
DER
Test
Effectiveness Review (Attached) [ ]Yes [ ]No

Tech Spec
Procedure
SE (Attached)
PE (Attached)
Drawing No.

Other NUREG-0133, Reg Guide 1.109, 10CFR50
Drawings, Design Calculations, Correspondence, etc.

PART 2: OPERATING LICENSE CHANGES [X]NA

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

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

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

D) Is UFSAR change required?
[ ] Yes [ ] No LCR No

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

Explanation

F) NRC Letter No.

G) Amendment No.

PART 3: APPROVALS

A) Originator — Date 9-10-90

B) Technical Expert [ ]See Attached — Date 11/12/90

C) Nuclear Generation Unit Head — Date 11/12/90

D) General Director, Nuclear Engineering [X]NA [ ]See Attached — Date

E) Plant Manager [ ]See Attached R. McKeon — Date 11/15/90

F) Other — Date

G) Director, Nuclear Licensing [ ]See Attached — Date 11/16/90

H) OSRO [ ]NA [ ]See Attached — Date 11/27/90

I) NSRG [X]NA [ ]See Attached — Date

Form FIP-RA2-01 Att 1 P1/1 050190 DTC: File:

EFFECTIVENESS REVIEW

Reference LCR 89 - 200 (012) - 00

Revision 3 Page 1 of 8

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

A) Quality Assurance Program

[ ]Yes [X] No — 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 [X] No — Does the change(s) significantly decrease the level of fire protection in the plant?

[ ]Yes [X] No — Does the change(s) result in failure to complete Fire Protection Program approved by the NRC prior to license issue?

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

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

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

[ ] Yes [X] 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 criteria for solid wastes in accordance with 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 accuracy or reliability of the dose calculations or setpoint determinations in in accordance with Technical Specification 6.14?

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

******************************* PART 6: APPROVALS *******************************

A) Originator [signature] Date 11-19-90

B) Technical Expert [signature] Date 11/19/90

C) Quality Assurance (For Security Plans only) Date

D) OSRO (Not required for UFSAR Changes) [signature] Date 11/27/90

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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.

Section/Page	Change	Basis
0.0-3 and 4	Delete Appendix A and Table A-1	Liquid radwaste effluent monitor setpoints are based on actual nuclide concentrations in each release hatch, and there is no need to refer to UFSAR estimated values.
2.0-6	1) Revise radwaste effluent monitor sensitivity value to conform to nuclide mixes in actual releases.	1) The Cs-137 sensitivity value is not conservative for actual releases, but the Cr-51 value is conservative.
	2) Revise setpoint when no nuclides are detected to prevent spurious alarms.	2) The 2 times background setpoint may cause spurious alarms due to background fluctions. When no nuclides are detected, no monitor response is expected, therefore, a limit of one half the previous discharge is conservative.

EFFECTIVENESS REVIEW DOCUMENTATION

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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.

Section/Page	Change	Basis
2.0-7	Add safety factor to circulating water monitor setpoint calculation.	The omissison of a safety factor for this setpoint is an apparent error in the current ODCM; adding a safety factor adds conservatism.
2.0-8	Revise section on generic setpoint for circulating water monitor since actual release data is now used.	Actual release data have made the generic UFSAR setpoint obsolete; the current setpoint is based on an evaluation of actual release data and is conservative.
2.0-14,15	Revise dose projection section to allow projections based on data from a previous quarter.	Dose projections made in the first few days of a quarter should be based on the previous quarters dose, but the present wording does not allow this. This revision allows more meaningful dose projections.

EFFECTIVENESS REVIEW DOCUMENTATION

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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.

Section/Page	Change	Basis
3.0-16	Allow use of current vent flow rates.	Engineering periodically redetermines flow rates due to plant changes.
2.0-18	Improve readability of figure.	N/A
3.0-3	Clarify exceptions to increased sampling and analysis schedule.	Revise current wording to conform to Tech Specs; increased sampling is required if either of 2 conditions exist; this is more conservative then present ODCM
3.0-5	1) Allow noble gas monitor setpoints to be calculated using actual monitor response.	1) Basing setpoints on actual monitor response allows more accurate setpoint calculation because assumptions about correct monitor response to current nuclide mix (and correct calibration constant) are not necessary.

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Section/Page	Change	Basis
	2) Allow application of additional safety factors in setpoint calculation.	2) The allocation factor may provide an insufficient margin of safety in Equation 3-3. This insertion adds conservatism.
	3) Emphasize that generic setpoints in Table 3.0-2 may have been superseded by setpoints based on grab samples.	3) Alerts reader that more accurate or current data may be in use. See change in 1.0-1.
3.0-7 through 9	Revise section to base noble gas release quantities on noble gas grab samples at the Offgas Vent Pipe and the RB Exhaust Plenum rather than on noble gas monitor readings.	The Offgas Vent Pipe sample point must be added because most noble gases are below the threshold of detection at the RB Exhaust Plenum. Release reports should not be based on monitor readings due to uncertainty about correct response to current nuclide mix and about

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Section/Page	Change	Basis
		calibration constant
		accuracy for current
		conditions.
3.0-10	Revise simplified dose	This change clarifies
	rate evaluation to base	the simplified method
	the Tech Spec compliance	and deletes the 11Ci
	evaluation on the I-131	criterion which is
	dose factor and a direct	dependent on assumptions
	comparison with the	about current critical
	1500 mrem/yr limit.	pathways and dispersion
		factors. The 11 Ci
		criterion is simply a
		convenience which is
		unnecessary. 1500
		mrem/yr is the Tech
		Spec limit and I-131 has
		the most conservative
		dose factor.
3.0-12	Provide the conversion of	This change allows for
	grass-cow-milk dose	more accurate dose
	factors to grass-goat-milk	calculation which is
	dose factors.	consistent with the
		guidance in NUREG-0133
		and Reg Guide 1.109.

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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.

Section/Page	Change	Basis
3.0-14	Revise dose projection section to allow projections based on data from previous quarter.	Dose projection made in the first few days of a quarter should be based on the previous quarters dose, but the present wording does not allow this. This revision allows more meaningful dose projections.
3.0-16	Correct reactor building ventilation flow rate value.	Old value is drywell purge flow rate, this is corrected.
3.0-18	Revise table to include X/Q and D/Q values from each release point from latest meterological analysis	Each February NUS Corp. provides us with new X/Q and D/Q values based on previous year's meterological data.
3.0-19 through 33	Correct errors in table and improve readability	N/A
3.0-34	Improve readability of figure	N/A

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Section/Page	Change	Basis
4.0-7	Update dispersion factors based on latest meterological data analysis	See basis of 3.0-18
5.0-1,2,3	Revise land use census assessment section to identify more locations, to evaluate dose using actual release data, to facilitate critical receptor identification and define critical receptor, and to delete onsite land use data collection requirment.	Identifying more locations is conservative since it presents more candidates for critical receptor; evaluating relative dose based on actual release data allows more accurate dose comparisons between receptors; defining critical receptor eliminates ambiguity and facilitates correct critical receptor identification; the onsite land use data collection must be performed throughout the year and should not be exclusively a land use

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Section/Page	Change	Basis
		census activity.
		Additionally, per the
		bases of T.S. 3/4.12.2,
		the land use census is
		for areas at and beyond
		site boundary, so it is
		not meant to cover areas
		within the boundary
		anyway.
6.0-8,11,12	Update and correct REMP	Sampling locations
	tables based on current	change because of land
	sampling locations and	use census data partici-
	new distance calculations	pation by the public in
	and latest land use census	the REMP, critical
		receptor analysis, and
		distance recalculation
		by DECo cartographers.
6.0-15 through 19	Improve readability of	N/A.
	maps.	

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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.

Section/Page	Change	Basis
4.0-4	Deleted examples of environmental samples, instead referred to Tech Specs.	Examples are inaccurate: samples were never taken as described in examples. Samples are taken per approved Tech Spec program. List of samples is unnecessary in the paragraph, another list is contained on same page.

DETROIT EDISON - FERMI 2
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APPENDICES

TABLES

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END OF SECTION 0.0

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1.0 INTRODUCTION

The Fermi 2 Offsite Dose Calculation Manual (ODCM) describes the methodology and parameters used in:

1.1 Determining radioactive material release rates and cumulative releases

1.2 Calculating radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip set points

1.3 Calculating the corresponding dose rates and cumulative quarterly and yearly doses.

The methodology provided in this manual is acceptable for use in demonstrating compliance with concentration limits of 10 CFR 20.106 and the cumulative dose criteria of 10 CFR 50, Appendix I and 40 CFR 190, and the Fermi 2 (Radiological Effluent) Technical Specifications.

More conservative calculational methods and/or conditions (e.g., location and/or exposure pathways) expected to yield higher computed doses than appropriate for the maximally exposed person may be assumed in the dose evaluations for controlling the release of radioactive material from Fermi 2.

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 Technical Specifications or common acronyms.

Section 2.0 of the ODCM describes equipment for monitoring and controlling liquid effluents, sampling requirements, and dose evaluation methods. Section 3.0 provides similar information on gaseous effluent controls, sampling, and dose evaluation. Section 4.0 describes special dose analyses required for compliance with Fermi 2 Technical Specifications and 40 CFR 190. Section 5.0 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 6.0 describes the Radiological Environmental Monitoring Program.

END OF SECTION 1.0

ARMS - INFORMATION SERVICES 1-28-91 T. Vandermey

Date approved: 11-27-90 Release authorized by: ~~PD PER T. Vandermey~~

Change numbers incorporated: LCR 89-200-ODM

DSN ______ Rev 3 ______ Date ______

DTC TMPLAN ______ File 1715.02 ______ Recipient ______

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2.0 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 Technical Specifications. Methods for calculating alarm setpoints for the liquid effluent monitors are presented. Also, methods for evaluating doses from liquid effluents are provided.

2.1 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 Fermi 2 Technical Specifications and ODCM.

2.1.1 Technical Specification (TS) 3.3.7.11 Requirement

Fermi 2 TS 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 TS 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 TS 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 TS 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 TS 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 TS 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.

2.1.2 Non Technical Specification Monitor

An additional monitor not required by Fermi 2 TS 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 a TS 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.

2.2 Sampling and Analysis of Liquid Effluents

The program for sampling and analysis of liquid waste is prescribed in the Fermi 2 Technical Specifications, Table 4.11.1.1.1-1. This table distinguishes two types of liquid releases:

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

2.2.2 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.

2.2.1 **BATCH Releases**

Fermi 2 TS 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 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 2.2.2 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.

2.2.2 **CONTINUOUS Releases**

Fermi 2 TS 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 TS 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 TS requirement.

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2.3 Liquid Effluent Monitor Setpoints

Technical Specification 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. TS 3.3.7.11 requires that radiation monitor setpoints be establisned to alarm and trip prior to exceeding the limits of TS 3.11.1.1.

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

$$SP \leq \frac{CL\ (DF + RR)}{RR} \tag{2-1}$$

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 (TS 3.11.1.1) implementing 10 CFR Part 20.106 (i.e., MPC at discharge point) in uCi/ml, defined in Equation (2-4)

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 (2-1) 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.

2.3.1 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 TS Table 4.11.1.1.1-1 and as discussed in ODCM Section 2.2.1, 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.

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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:

$$MPCF = \sum \frac{C_i}{MPC_i} \qquad (2-2)$$

where:

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

C_i = concentration of each 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:

$$MAX\ RR = \frac{DF}{MPCF} * SF \qquad (2-3)$$

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 = 0.5, administrative safety factor to account for variations in monitor response and flow rates. The SF value of 0.5 provides for 100% variation caused by statistical fluctuation and/or errors in measurements. Also, this factor provides conservatism, accounting for the presence of radionuclides that may not be detected by the monitors (i.e., non-gamma emitters).

MPCF = As previously defined by equation 2-2.

NOTE: Equation (2-3) 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

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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:

$$CL = \frac{\sum C_i}{MPCF} \qquad (2\text{-}4)$$

Based on the Release Rate RR and Dilution Flow DF and by substituting Equation (2-4) for CL in Equation (2-1), the alarm setpoint is calculated by the equation:

$$SP = \frac{\sum (C_i * SEN_i) * DF}{MPCF * RR} + Bkg \qquad (2\text{-}5)$$

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))

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

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

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 (2-3) is used to determine the allowable release rate in accordance with Technical Specification 3.11.1.1. Equation (2-5) is used to determine the D11-N007 alarm setpoint in accordance with TS 3.3.7.11.

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

Technical Specification 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 2.3.1 for the Liquid Radwaste Effluent Line Monitor. Equation (2-1) 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 (2-1) simplifies to:

$$SP \leq CL \qquad (2\text{-}6)$$

Substituting Equation (2-4) for CL and introducing a safety factor, the D11-N402 alarm setpoint can be calculated by the equation:

$$SP \leq \frac{C_i * SF}{MPCF} \qquad (2\text{-}7)$$

where:

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

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

SF = 0.5, administrative safety factor

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

2.3.3 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 (2-7). 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.

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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.

2.3.4 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 2.3.1 based on the actual system flows, dilution and release paths in effect at the time.

2.3.5 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 TS 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 TS 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:

$$\left[\sum\left(\frac{C_i}{MPC_i}\right) * \frac{RR}{DF + RR}\right] \leq 1 \qquad (2\text{-}8)$$

where:

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

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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 $(C_i/MPC_i) \leq 1$.

2.3.6 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 (2-2). The MPCF of the CWR is used to determine the available dilution flow as follows:

CWR Dilution Flow = CWR Decant Flow Rate (GPM) * (1-CWR MPCF)

(2-9)

The resulting dilution flow rate is substituted in equation (2-3) to determine the maximum allowable release rate for discharges from the radwaste system. Substituting the available CWR dilution flow from equation (2-9), the Liquid Radwaste Monitor maximum release rate can be determined using equation (2-3).

Once the available dilution flow and maximum allowable release rate have been determined the radwaste monitor setpoint can be determined using equation (2-5).

2.4 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 2.2.2, 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 TS, 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.

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- 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 2-2) to ensure releases are within the limits of TS 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 2.3.2. If the calculated setpoint based on the measured distribution is greater than the current setpoint (see ODCM Section 2.3.3) no adjustment to the setpoint is required.

- Samples will be composited in accordance with TS 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 2.5.

2.5 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 TS. The limits in the Fermi 2 TS are specified as quarterly and calendar year limits. This assures that the average over the year is kept as low as reasonably achievable.

2.5.1 MEMBER OF THE PUBLIC Dose - Liquid Effluents

Technical Specification 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

≤ 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:

$$D_o = \frac{1.67\ E\text{-}02 * VOL}{DF * Z} * \sum (C_i * A_{io}) \tag{2-10}$$

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

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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 2-1. They were derived in accordance with guidance of NUREG-0133 from the following equation:

$$A_{io} = 1.14\ E + 05\ (U_W / D_W + U_F * BF_i)\ DF_i \tag{2-11}$$

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 2-2 (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 TS 3.11.1.2 are those identified by gamma spectral analysis of the liquid waste samples collected and analyzed per the requirements of TS 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 TS 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 TS 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.

2.5.2 Simplified Liquid Effluent Dose Calculation

In lieu of the individual radionuclide dose assessment presented in Section 2.5.1, the following simplified dose calculation may be used for demonstrating compliance with the dose limits of TS 3.11.1.2. (Refer to Appendix A for the derivation of this simplified method.)

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Total Body

$$D_{tb} = \frac{9.69 E + 03 * VOL}{DF * Z} * \sum C_i \qquad (2-12)$$

Maximum Organ

$$D_{max} = \frac{1.18 E + 04 * VOL}{DF * Z} * \sum C_i \qquad (2-13)$$

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 2.0-1)
1.18 E + 04	=	0.0167 (hr/min) * 7.09 E + 05 (mrem/hr per uCi/ml, Cs-134 liver dose factor from Table 2.0-1)

2.5.3 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 TS 3.11.1.2. ODCM Section 2.4 described the methods for quantifying and controlling releases from the CWR System.

For calculating the dose to a MEMBER OF THE PUBLIC, Equation (2-10) 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 2.4.

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- 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 2.4.

2.6 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 TS 3.11.1.3. This TS 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 2-1. 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 TS 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 TS 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:

$$D_{tbp} = D_{tb} (31 / d) \qquad (2-14)$$

$$D_{maxp} = D_{max} (31 / d) \qquad (2-15)$$

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 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_{tb} = the cumulative total body dose for all releases to date in the reference calendar quarter (normally the current quarter) as determined by equation (2-10) or (2-12) (mrem)

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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 (2-10) or (2-13) (mrem)

d = the number of days from the beginning of the reference calendar quarter to the date of the most recent release in the reference calendar quarter.

31 = the number of days in projection

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TABLE 2.0-1

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

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TABLE 2.0-1

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

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TABLE 2.0-2

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.

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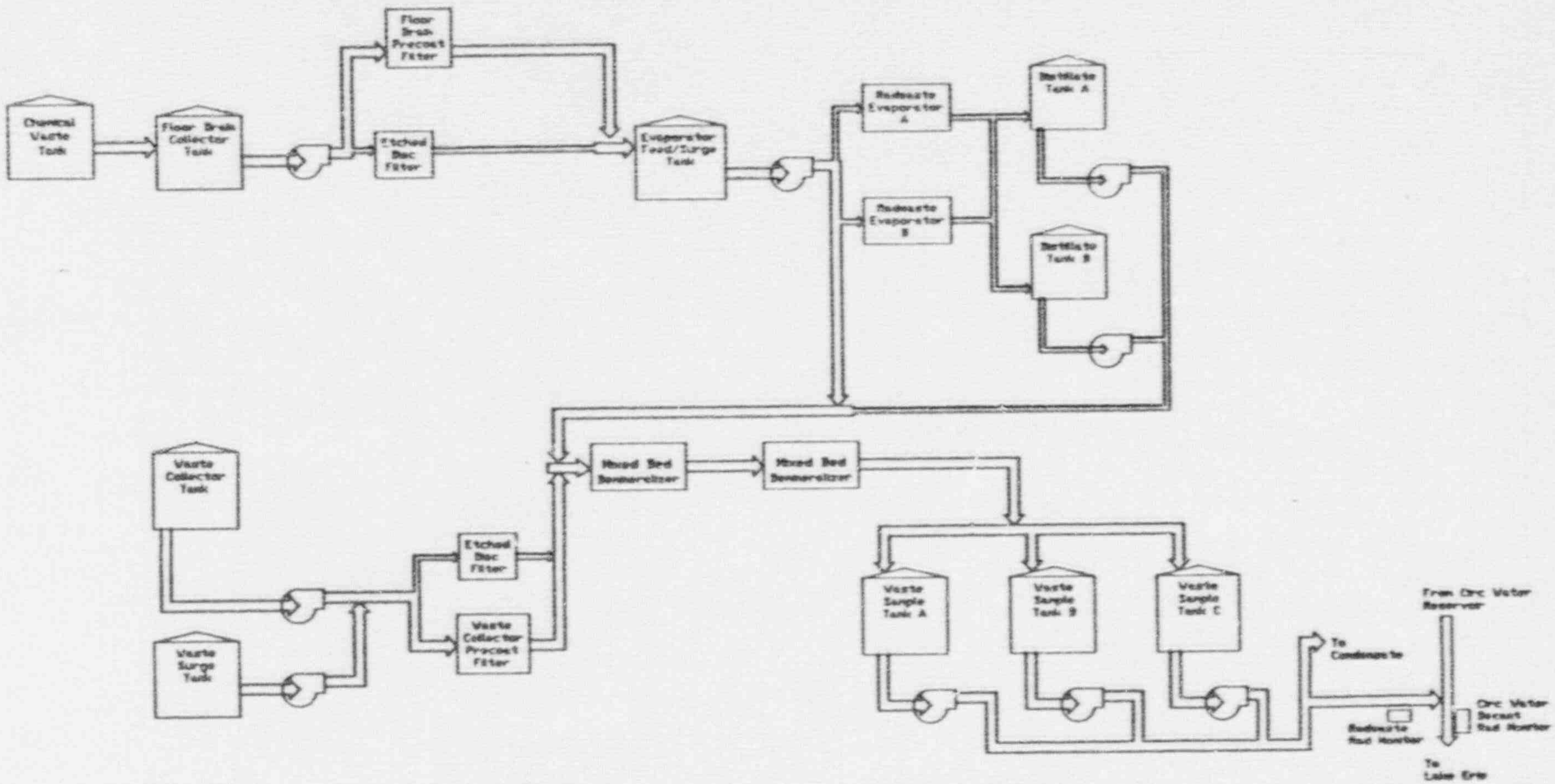
FIGURE 2.0-1

Liquid Radioactive Effluent Monitoring and Processing Diagram



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3.0 GASEOUS EFFLUENTS

3.1 Radiation Monitoring Instrumentation and Controls

3.1.1 Effluent Monitoring - Ventilation System Releases

The gaseous effluent monitoring instrumentation required at Fermi 2 for controlling and monitoring radioactive effluents are specified in TS 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 TS 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.

3.1.2 Main Condenser Offgas Monitoring

TS Table 3.3.7.12-1 specifies monitoring requirements for the Offgas System at the 2.2 minute delay line. The following monitors are required:

- Hydrogen Monitor - used to ensure the hydrogen concentration in the Offgas Treatment System is maintained less than 4% by volume as required by TS 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 TS 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.

3.1.3 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 TS but are important in controlling containment venting/purging.

3.2 Sampling and Analysis of Gaseous Effluents

The program for sampling and analysis of gaseous waste is prescribed in Fermi 2 TS 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.

3.2.1 Containment PURGE

TS 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. TS Table 4.11.2.1.2-1 Footnote i and TS 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 3.3. This evaluation is necessary to ensure compliance with the dose rate limits of TS 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 TS limits.

3.2.2 Ventilation System Releases

TS 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.

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- 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).

TS 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 TS require more frequent sampling and analysis following reactor startup, shutdown, or change in thermal power exceeding 15% within one hour. The TS allow 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.

3.3 Gaseous Effluent Monitor Setpoint Determination

3.3.1 Ventilation System Monitors

Per the requirements of TS 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 TS 3.11.2.1. This TS 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 TS 3.11.2.1, by the equation:

$$FRAC = \frac{1.67\ E + 01 * X/Q * VF * \sum (C_i * K_i)}{500} \quad (3\text{-}1)$$

$$FRAC = \frac{1.67\ E + 01 * X/Q * VF * \sum (C_i * [L_i + 1.1\ M_i])}{3000} \quad (3\text{-}2)$$

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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 3.0-4 (sec/m^3)
VF	=	Ventilation System flow rate for the applicable release point and monitor (liters/minute)
C_i	=	concentration of noble gas radionuclide i as determined by gamma spectral analysis of grab sample (uCi/cc)
K_i	=	total body dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 3.0-3)
L_i	=	beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 3.0-3)
M_i	=	gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per uCi/m^3, from Table 3.0-3)
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:

$$SP = \frac{(AF * \sum C_i)}{FRAC} + Bkg \qquad (3-3)$$

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 3.0-2) 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.

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C_i = concentration of Noble Gas Radionuclide i as determined by gamma spectral analysis of grab sample (uCi/cc)
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 Technical Specification 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 3.0-2. These values may be changed in the future as warranted by operational experience, provided the site releases comply with TS 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 combined with 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.

3.3.2 Conservative, Generic Alarm Setpoints

A conservative alarm setpoint can be established in lieu of the individual radionuclide evaluation (described above) based on the grab sample analysis. This approach eliminates the need to adjust the setpoint periodically to reflect minor changes in radionuclide distribution or release flow rate. The alarm setpoint may be conservatively determined based on the UFSAR design radionuclide distribution values as summarized in Table 3.0-1. If due to a change in plant conditions this UFSAR radionuclide mix is no longer conservative, setpoints based on the UFSAR mix will be recalculated using data from plant samples.

For the radionuclide distribution given in UFSAR Table 11.3-5, the estimated total body dose rate is higher than the estimated skin dose rate. Therefore, the more restrictive setpoint is based on the total body dose rate limit and is calculated with Equations (3-1) and (3-3). The calculated setpoints are presented in Table 3.0-2. These setpoints are not necessarily the current setpoints.

3.3.3 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 TS 3.11.2.1. Not exceeding alarm setpoints constitutes a demonstration that release rates have been maintained within the TS 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 TS 3.11.2.1a:

$$D_{tb} = 1.67\ E + 01 * X/Q * VF * \sum (K_i * C_i) \quad (3\text{-}4)$$

$$D_s = 1.67\ E + 01 * X/Q * VF * \sum ([L_i + 1.1\ M_i] * C_i) \quad (3\text{-}5)$$

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 3.0-3)

L_i = beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 3.0-3)

M_i = gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per uCi/m^3, from Table 3.0-3)

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)

3.4 Containment Drywell VENTING and PURGING

3.4.1 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 TS Table 4.11.2.1.2-1, the allowable release rate can be calculated by the following equation:

$$RR_{tb} = \frac{500 * AF}{1.67\ E + 01 * X/Q * \sum (K_i * C_i)} \quad (3\text{-}6)$$

or

$$RR_s = \frac{3000 * AF}{1.67\ E + 01 * X/Q * \sum ([L_i + 1.1\ M_i] * C_i)} \quad (3\text{-}7)$$

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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 3.0-2 (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.

3.4.2 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 TS 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 (3-1), (3-2) and (3-3). In Equations (3-1) and (3-2), 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.

3.5 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 releases. For noble gases, these quantities must be based on actual noble gas grab samples.

3.5.1 Sampling Protocol

As required by TS 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 3.2.2, this gas sample is analyzed by gamma spectroscopy to identify individual radionuclides (noble gases). To date (May 1990) 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 3.2.1). These samples are evaluated using Equations (3-4) and (3-5) to ensure that the site boundary dose rate limits of TS 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 TS 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 3.3.2.

3.5.2 **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

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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 (3-8) to determine the quantity of noble gases released.

3.5.3 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:

$$Q_i = 1.0\,E + 03 * VF * T * C_i \qquad (3\text{-}8)$$

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 3.5.2

3.6 Site Boundary Dose Rate - Radioiodine and Particulates

TS 3.11.2.1.b limits the dose rate to ≤ 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:

$$D_o = X/Q * \sum (R_i * Q_i) \qquad (3\text{-}9)$$

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 3-4

R_i = dose parameter for radionuclide i, (mrem/yr per uCi/m^3) for the child inhalation pathway from Table 3-5

Q_i = average release rate over the appropriate sampling period and analysis frequency for radionuclide i -- I-131, I-133, tritium or other radionuclide in particulate form with half-life greater than 8 days (uCi/sec)

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

Where:

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

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

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

3.6.1 Simplified Dose Rate Evaluation for Radioiodines and Particulates

It is conservative to perform a simplified evaluation of allowable releases by applying the I-131 dose factor to all measured radionuclides. If the I-131 dose factor is used for each nuclide in Equation (3-9) and if the calculated dose rate does not exceed 1500 mrem/year, no additional analyses are needed to verify compliance with the TS 3.11.2.1.b limits on allowable release rate.

3.7 Noble Gas Effluent Dose Calculations - 10 CFR 50

3.7.1 UNRESTRICTED AREA Dose - Noble Gases

TS 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:

$$D_\gamma = 3.17 E - 08 * X/Q * \sum (M_i * Q_i) \quad (3-10)$$

and

$$D_\beta = 3.17 E - 08 * X/Q * \sum (N_i * Q_i) \quad (3-11)$$

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 3.0-3)

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N_i = air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per uCi/m^3, Table 3.0-3)

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

3.7.2 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 Technical Specification 3.11.2.2. (Refer to Appendix C for the derivation and justification of this simplified method.)

$$D_{\gamma} = 2.0 * 3.17 E - 08 * X/Q * M_{eff} * \sum Q_i \qquad (3\text{-}12)$$

and

$$D_{\beta} = 2.0 * 3.17 E - 08 * X/Q * N_{eff} * \sum Q_i \qquad (3\text{-}13)$$

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

3.8 Radioiodine and Particulate Dose Calculations - 10 CFR 50

3.8.1 UNRESTRICTED AREA Dose - Radioiodine and Particulates

In accordance with requirements of TS 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:

$$D_{aop} = 3.17 E - 08 * W * SF_p * \sum (R_i * Q_i) \qquad (3\text{-}14)$$

Where:

D_{aop} = dose or dose commitment via controlling Pathway p and Age Group a (as identified in Table 3.0-4) to Organ o, including the total body (mrem)

W = atmospheric dispersion parameter to the controlling location(s) as identified in Table 3.0-4:

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W = X/Q, atmospheric dispersion for inhalation pathway and H-3 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 3.0-5 for each Age Group (a) and the applicable Pathway (p) as identified in Table 3.0-4. 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 3.0-5 multiplied by 1.2.

Q_i = cumulative release over the period of interest for radionuclide i -- I-131 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 3-5). 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 3.0-4 need be evaluated for compliance with TS 3.11.2.3.

3.8.2 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 TS 3.11.2.3.

$$D_{max} = 3.17\ E - 08 * W * SF_p * R_{I-131} * \sum Q_i \qquad (3-15)$$

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 identif d by the annual land-use census (Technical Specification 3.12.2). Otherwise, the dose should be evaluated based on the predetermined controlling pathways identified in Table 3.0-4.

3.9 Gaseous Effluent Dose Projection

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

TS 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 3-1 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:

$$D_{maxp} = D_{max} * (31 / d) \quad (3-16)$$

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 (3-14) or (3-15) (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 3.0

TABLE 3.0-1

Default Noble Gas Radionuclide Distribution*
of Gaseous Effluents

Radionuclide	Fraction of Total ($A_i / \sum A_i$)
Kr-85m	0.10
Kr-85	0.01
Kr-88	0.04
Kr-89	0.06
Xe-133	0.67
Xe-135	0.02
Xe-137	0.02
Xe-138	0.07
TOTAL	0.99

NOTE:

* Data adapted from Fermi 2 UFSAR, Section 11.3, Table 11.3-5. Kr-90, Kr-91, Xe-139, and Xe-140 have been excluded from the distribution. Because of their short half-lives, they decay during transport off site to negligible levels of activity. Kr-87, Xe-131m, and Xe-133m have been excluded because of their negligible fractional abundance.

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TABLE 3.0-2

Generic Values for Evaluating
Gaseous Release Rates and Alarm Setpoints

Release Point	Flow Rate* (liter/min)	Allocation Factor (AF)	Allocated Dose Rate Limit (mrem/year)	Generic Alarm Setpoint (uCi/ml)
Reactor Building Exhaust Plenum D11-P280	2.67E6	0.50	T Body = 250 Skin = 1500 Organ = 375	1.02E-4+ Bkg
Standby Gas Treatment System Div I D11-P275	1.07E5	0.10	T Body = 25 Skin = 150 Organ = 75	6.12E-4+ Bkg
Standby Gas Treatment System Div II D11-P276	1.12E5	0.10	T Body = 25 Skin = 150 Organ = 75	6.17E-4+ Bkg
Turbine Building Ventilation D11-P279	8.67E6	0.20	T Body = 50 Skin = 300 Organ = 150	1.06E-5+ Bkg
Service Building Ventilation D11-P282	9.06E5	0.01	T Body = 2.5 Skin = 15 Organ = 7.5	7.93E-6+ Bkg
Radwaste Building Ventilation D11-P281	1.13E6	0.02	T Body = 5 Skin = 30 Organ = 15	6.22E-6+ Bkg
Onsite Storage Building Ventilation D11-P281	3.06E5	0.02	T Body = 5 Skin = 30 Organ = 15	1.93E-4+ Bkg
Reactor Building Ventilation** Gulf Atomic Monitors D11-N408, N410	2.57E6	0.50	T Body = 125 Skin = 750	9.19E-6 cpm

* Ventilation flow rate values are subject to change due to plant modifications and changing plant conditions; therefore updated values 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. Alarm setpoints for these monitors are not required by Fermi 2 TS but have been included in this table for completeness.

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TABLE 3.0-3

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

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TABLE 3.0-4

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

Technical Specification	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 (0.36 mi, NE)	noble gases direct exposure	N/A	RB: 2.75E-6 TB: 1.35E-5 RW: 6.12E-6	N/A
3.11.2.1b	site boundary (0.36 mi, NE)	inhalation	child	RB: 2.75E-6 TB: 1.35E-5 RW: 6.12E-6	N/A
3.11.2.2	site boundary (0.36 mi, NE)	gamma-air beta-air	N/A	RB: 2.75E-6 TB: 1.35E-5 RW: 6.12E-6	N/A
3.11.2.3	residence (2.1 mi, WNW)	milk, inhalation, and ground plane	infant	RB: 1.24E-7 TB: 3.24E-7 RW: 2.02E-7	9.57E-10 1.60E-9 1.20E-9

NOTE:

* The identified controlling locations and pathways have been determined from the 1989 land-use census data. The atmospheric dispersion factors for these locations were derived from meteorological data records for the period 1/1/89 to 12/31/89. Dispersion factors are given for the three gaseous release points from which radioactive releases other than natural products have been detected: the reactor building (RB), the turbine building (TB), and the radwaste building (RW). Dispersion factors for other release points are available from the X/Q and D/Q data tables. New dispersion factors are calculated at the end of each calendar year based on the previous year's meterological data; such new factors should be used to calculate dose for the February Semiannual Effluent Release Report pending revision of this table.

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Table 3-5
Gaseous Effluent Pathway Dose Commitment Factors
$R_{i,a}$, Inhalation Pathway Dose Factors - ADULT

(mrem/yr per µCi/m³)

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	-	-	-	-	-	[illegible]	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+	1.01E+5	1.26E+4
Te-125m	3.42E+3	1.58E+3	1.05E+3	1.24E+4	3.14E[illegible]	7.06E+4	4.67E+2
Te-127m	1.26E+4	5.77E+3	3.29E+3	4.58E+4	9.60E[illegible]	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

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Table 3-5 (continued)

R_{i}, 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	[illegible]	4.66E+4	6.24E+4
Zn-69	4.83E-2	9.20E-2	-	6.02E-2	[illegible]	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	[illegible]	6.01E+1	7.25E+1	4.39E+2	2.38E+5	6.21E+5	4.02E+1
Te-131	[illegible]	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	1.37E+5
Cs-137	6.70E+5	8.48E+5	-	3.04E+5	1.21E+5	8.48E+3	3.11E+5
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

Appvl [illegible]
Date 12/1/90

Table 3-5 (continued)

R_{ia}, Inhalation Pathway Dose Factors - CHILD

(mrem/yr per µCi/m^3)

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	1.56E+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	-	2.92E+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	7.4[illegible]E+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	-	-	6.70E+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

Appvl Ro.
Date 4/1/90

Table 3-5 (continued)

R_{io}, 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	2.46E+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	-	-	-	-	-	-	3.8[illegible]E+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	2.59E+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	2.49E+4	1.88E+1

Appvl RW
Date 12/1/90

Table 3-5 (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	5.62E-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	-	[illegible]	-	2.20E+10	3.20E+7
Sb-124	2.57E+7	4.86E+5	6.24E+4	-	[illegible]	7.31E+8	[illegible]
Sb-125	2.04E+7	2.28E+5	2.08E+4	-	1.58E+7	[illegible]	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	-	7.33E+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

Appvl [handwritten initials]
Date 12/1/90

Table 3-5 (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	*	6.94E-1	1.33E-3
Fe-55	4.45E+7	[illegible]	*	*	2.00E+7	1.37E+7	7.36E+6
Fe-59	5.20E+7	[illegible]	*	*	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	*	*	*	*	*	*	5.66E+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+5	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	6.59E+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	6.10E+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	2.55E+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

Appvl [illegible]
Date [illegible]

Table 3-5 (continued)

Ris, 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	-	1.68E-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	1.41E+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	-	1.57E+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+5	-	2.82E+5	-	1.33E+8	8.66E+4
Pr-143	7.23E+2	2.17E+2	-	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

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Table 3-5 (continued)

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

(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	-	2.38E+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+4	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	1.62E+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

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Date 1/1/93

Table 3-5 (continued)

R_{io}, 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+6
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	1.09E-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+3	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

Appvl [illegible]
Date 2/1/90

Table 3-5 (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	1.67E-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+9	-	-	-	-	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	3.48E+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	-	5.90E+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

Appvl [illegible]
Date [illegible]

Table 3-5 (continued)

R_{i}, 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	-	4.04E+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

Appvl [illegible]
Date 12/7/90

Table 3-5(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	3.76E+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	-	2.08E+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	-	1.75E+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	-	1.65E+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

Appvl [illegible]
Date 12/1/90

Table 3-3 (continued)

$R_{i,a}$, 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	8.47E-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	4.16E+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	4.4[illegible]E-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

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Date 2/1/90

Table 3-5 (continued)

R_i, Vegetation Pathway Dose Factors - CHILD

(mrem/yr per μCi/m³) for H-3 and C-14
(m² s 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	5.68E+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

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Table 3-5 (continued)

Ri, 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

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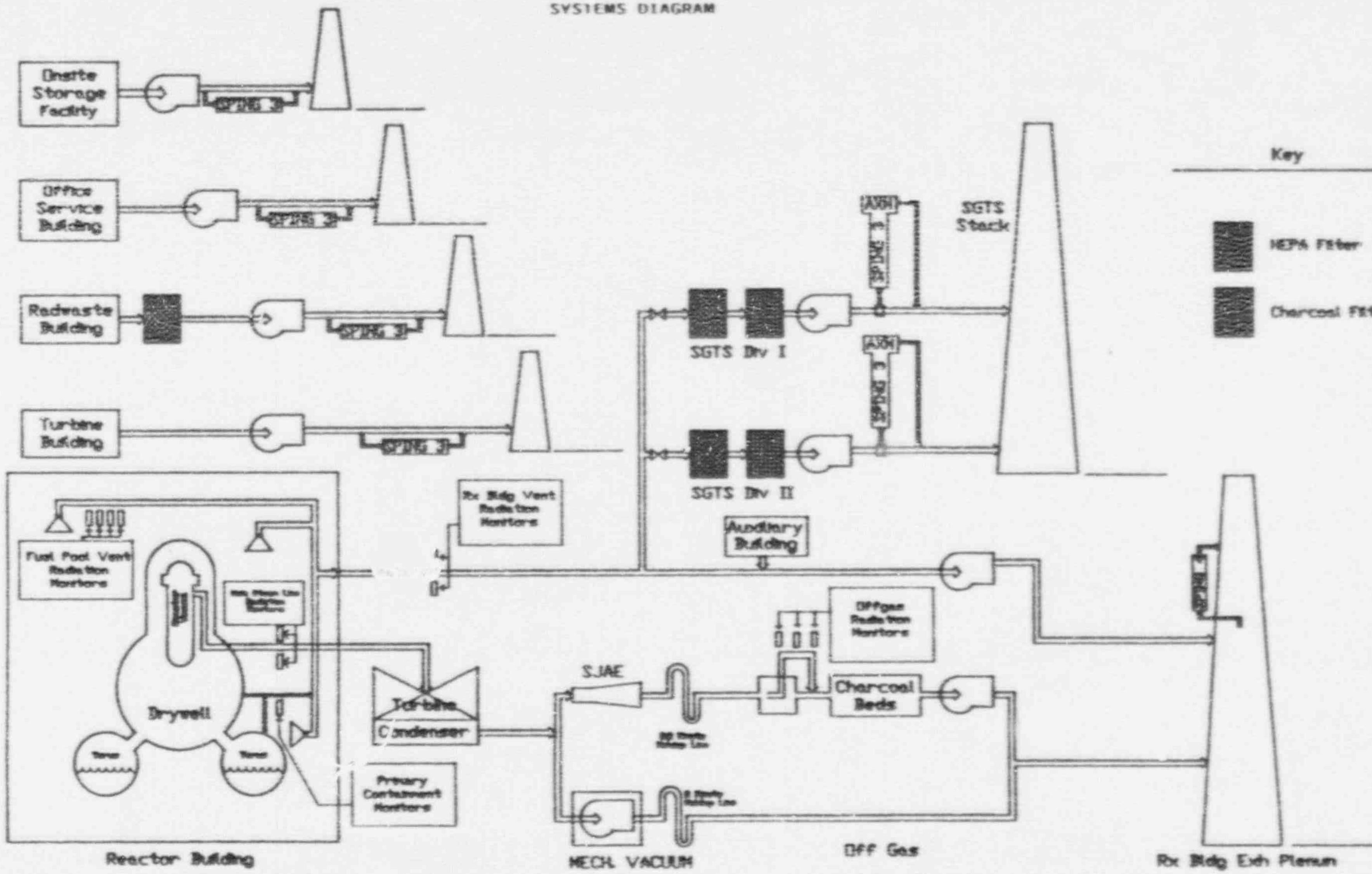
Date 12/1/90

FIGURE 3.0-1

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.

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SPECIAL DOSE ANALYSIS

4.0 SPECIAL DOSE ANALYSES

4.1 Doses Due to Activities inside the SITE BOUNDARY

In accordance with Technical Specification 6.9.1.8, 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 4.0-1. The calculational methods presented in ODCM Sections 3.6 and 3.7 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 mode[illegible] presented in ODCM Section 2.5. Therefore, no additional special dose analyses ar[illegible]quired for this exposure pathway for reporting in the Semiannual Radioactive Effluent Release Report.

4.2 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 fu[illegible]cle facilities contribute significantly to the cumulative dose to a MEMBER OF [illegible]IC in the immediate vicinity of the site. Davis-Besse is the closest fuel cycle fa[illegible]ocated 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.

ARMS - INFORMATION SERVICES 1-28-91

Date approved: 11-27-90 Release authorized by: ~~PD HER~~ T. Vandermay

Change numbers incorporated: LCR 89-200-ODM

DSN ______ Rev 3 Date ______

DTC TMPLAN File 1715.02 Recipient ______

Appvl
Date 12/1/90

As appropriate for demonstrating/evaluating compliance with the limits of Technical Specification 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.

4.2.1 Effluent Dose Calculations

For purposes of implementing the surveillance requirements of TS 3.11.4 and the reporting requirements of 6.9.1.8, dose calculations for Fermi 2 may be performed using the calculational methods contained within this ODCM, the conservative controlling pathways and locations of Table 3.0-4 or the actual pathways and locations as identified by the land use census (TS 3.12.2 and ODCM Section 5.0) may be used. Liquid pathway doses may be calculated using Equation (2-10). Doses due to releases of radioiodines, tritium and particulates are calculated based on Equation (3-14).

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

$$D_{tb} = 3.17 E - 08 * X/Q * \sum (K_i * Q_i) \quad (4-1)$$

and

$$D_s = 3.17 E - 08 * X/Q * \sum ([L_i + 1.1 M_i] * Q_i) \quad (4-2)$$

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 3.0-3)

L_i = skin dose factor due to beta emissions from noble gas radionuclide i (mrem/yr per uCi/m^3) (from Table 3.0-3)

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M_i = gamma air dose factor for noble gas radionuclide i (mrad/yr per uCi/m^3) (from Table 3.0-3)

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).

4.2.2 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.

4.2.3 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:

$$D = C * U * DF \quad (4-3)$$

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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 Technical Specifications. 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:

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

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).

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Exposure - U

Default Exposure Values (U) as recommended in Regulatory Guide 1.109 are presented in Table 4.0-2. 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 th-, 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 4.0-2.

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 Section 3.6 and 4.2.1 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 4.0

TABLE 4.0-1

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)
	1.59E-5 sec/m^3	7.63E-6 sec/m^3

* Meterological data is provided from the monitoring year 1989.

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TABLE 4.0-2

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 1/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 1/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.

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5.0 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 TS 3.12.2 for identifying controlling location/pathway for dose assessment of TS 3.11.2.3; and 2) provide data on actual exposure pathways for assessing realistic doses to MEMBERS OF THE PUBLIC.

5.1 Land Use Census as Required by TS 3.12.2

As required by TS 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 TS 3.11.2.3 (and ODCM Section 3.7 and Table 3.0-4), this new location pathway(s) shall be used for dose assessment. Table 3.0-4 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 TS 3.12.2 and 6.9.1.8, 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 TS 3.12.2.

5.1.1 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 3.0-4. Also, identify any location currently included in the REMP (Table 6-1).

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.

5.1.2 **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.

5.1.3 **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 3.0-4, this location/pathway(s) should replace the previously identified controlling location/pathway in Table 3.0-4. 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 3.0-4, 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 6.0 of the ODCM in accordance with TS 3.12.2, Action Item b.

4. Any changes in either the controlling location/pathway(s) (critical receptor) for the ODCM dose calculations (Section 3.7 and Table 3.0-4) or the REMP (ODCM Section 6.0 and Table 6-1) shall be reported to NRC in accordance with TS 3.12.2, Action Items a. and b. and TS 6.9.1.8.

   NOTE: As permitted by footnote to TS 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 TS 3.11.2.3 (ODCM Section 3.7 and Table 3.0-4), 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.

5.2 Land Use Census to Support Realistic Dose Assessment

The LUC provides data needed to support the special dose analyses of the ODCM Section 4.0. Activities inside the SITE BOUNDARY should be periodically reviewed for dose assessment as required by TS 6.9.1.8 (ODCM Section 4.1). Assessment of realistic doses to MEMBERS OF THE PUBLIC is required by TS 3.11.4 for demonstrating compliance with the EPA Environmental Dose Standard, 40 CFR 190 (ODCM Section 4.2).

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 2.5.

END OF SECTION 5.0

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6.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The Radiological Environmental Monitoring Program (REMP) is conducted in accordance with the requirements of Technical Specification 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 Radiological Assessment Branch Technical Position on Environmental Monitoring.

6.1 Sampling Locations

Sampling locations as required by TS 3.12.1 are described in Table 6-1 and shown on the maps in Figures 6-1, 6-2, 6-3, and 6-4.

NOTE: For purposes of implementing TS 3.12.2, sampling locations will be modified as required to reflect the findings of the land use census as described in ODCM Section 5.1.

6.2 Reporting Levels

TS 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 TS 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 TS 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 TS 3.12.1, Action b, the report shall also be submitted if radionuclides other than those in TS 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 4.2.3 may be used for assessing the potential dose and required reporting for radionuclides other than those in TS Table 3.12.1-2.

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6.3 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 Specification 6.9.1.7.

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 6.0

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TABLE 6.0-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM FERMI 2 SAMPLE LOCATIONS AND ASSOCIATED MEDIA

KEY

1 -	T	TLD Locations (Pg. 6.0-4 to 6.0-6)
2 -	S	Sediments Locations (Pg. 6.0-7)
3 -	F	Fish Locations (Pg. 6.0-7)
4 -	M	Milk Locations (Pg. 6.0-8)
5 -	DW	Drinking Water Locations (Pg. 6.0-9)
6 -	SW	Surface Water Locations (Pg. 6.0-9)
7 -	GW	Ground Water Locations (Pg. 6.0-9)
8 -	API	Air Particulate/Iodine Locations (Pg. 6.0-10)
9 -	FP	Food Products Locations (Pg. 6.0-11)

NOTE: Fermi 1 sampling information is Appendix 1.

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TABLE 6.0-1

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	Tree at the Termination Brancho St (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, NE Corner of Dixie Hwy and Post Rd	Direct Radiation	Q
T9	NNW/334°	1.5 mi	Pole, NW Corner of Trombley and Swan View Rd	Direct Radiation	Q
T10	N/6°	2.1 mi	Pole, S Side of Massarant - 2 Poles W of Chinavarra	Direct Radiation	Q
T11	NNE/23°	6.3 mi	Pointe Mouillee - W Jefferson and Campau Rds, Pole on SE Corner of Bridge	Direct Radiation	Q
T12	NNE/29°	6.3 mi	Pointe Mouillee Game Area - Field Office, Pole near Tree, N Area of Parking Lot	Direct Radiation	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 6.0-1

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 Post 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, Custer, St. Mary's Park Corner of Elm and Monroe St, N Side, next to River (Special Area)	Direct Radiation	Q

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TABLE 6.0-1

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

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TABLE 6.0-1

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

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TABLE 6.0-1

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.

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TABLE 6.0-1

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

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TABLE 6.0-1

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	Corner of Erie St and Pointe Aux Peaux Rds	Radioiodine Particulates	W W

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TABLE 6.0-1

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)

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TABLE 6.0-1

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

Land Use Census

Meteorological Sector	Distance from Reactor (Approx)	Description
NE	1.1 mi	6760 Lakeshore
NNE	1.1 mi	6500 Branchaau
N	1.1 mi	6200 Blanchett
NNW	1.1 mi	5701 Post
NW	1.1 mi	6577 Leroux
WNW	0.7 mi	6200 Langton
W	1.1 mi	6001 Toll
WSW	1.6 mi	4771 Pointe Aux Peaux
SW	1.1 mi	4981 Pointe Aux Peaux
SSW	1.0 mi	5820 Pointe Aux Peaux
S	1.0 mi	4834 Long
ESE-SSE		Lake Erie

NOTE: These locations have been identified as the closest residences in the most recent Land Use Census

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TABLE 6.0-2

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^{o}	0.5 mi	Shoreline behind fuel oil storage tank	SW	SA
Swan Creek	NW/56^{o}	1.9 mi	Area below bridge N. of Dixie Hwy and Swan Creek Rd. (Public Access area)	SW	SA
Reactor Channel	NE/0^{o}	0.4 mi	Area where overflow canal meets Swan Creek	SW	SA
Lake Water #3	SSE/159^{o}	0.4 mi	Fermi 1 inlet E. of pumphouse	SW	SA
Raw City Water					
City of Monroe	S/169^{o}	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^{o}	0.4 mi	Fermi Unit 1 Raw Lake water intake structure	RW	SA
City of Detroit	NNE/28^{o}	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

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TABLE 6.0-2

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^o	0.5 mi	Shoreline behind fuel oil storage tank	Sediment	SA
Reactor Channel	N/0^o	0.4 mi	Area where overflow canal meets Swan Creek	Sediment	SA
Swan Creek	N/W/56^o	1.9 mi	Area below bridge N. of Dixie Hwy. and Swan Creek Rd. (public access area)	Sediment	SA

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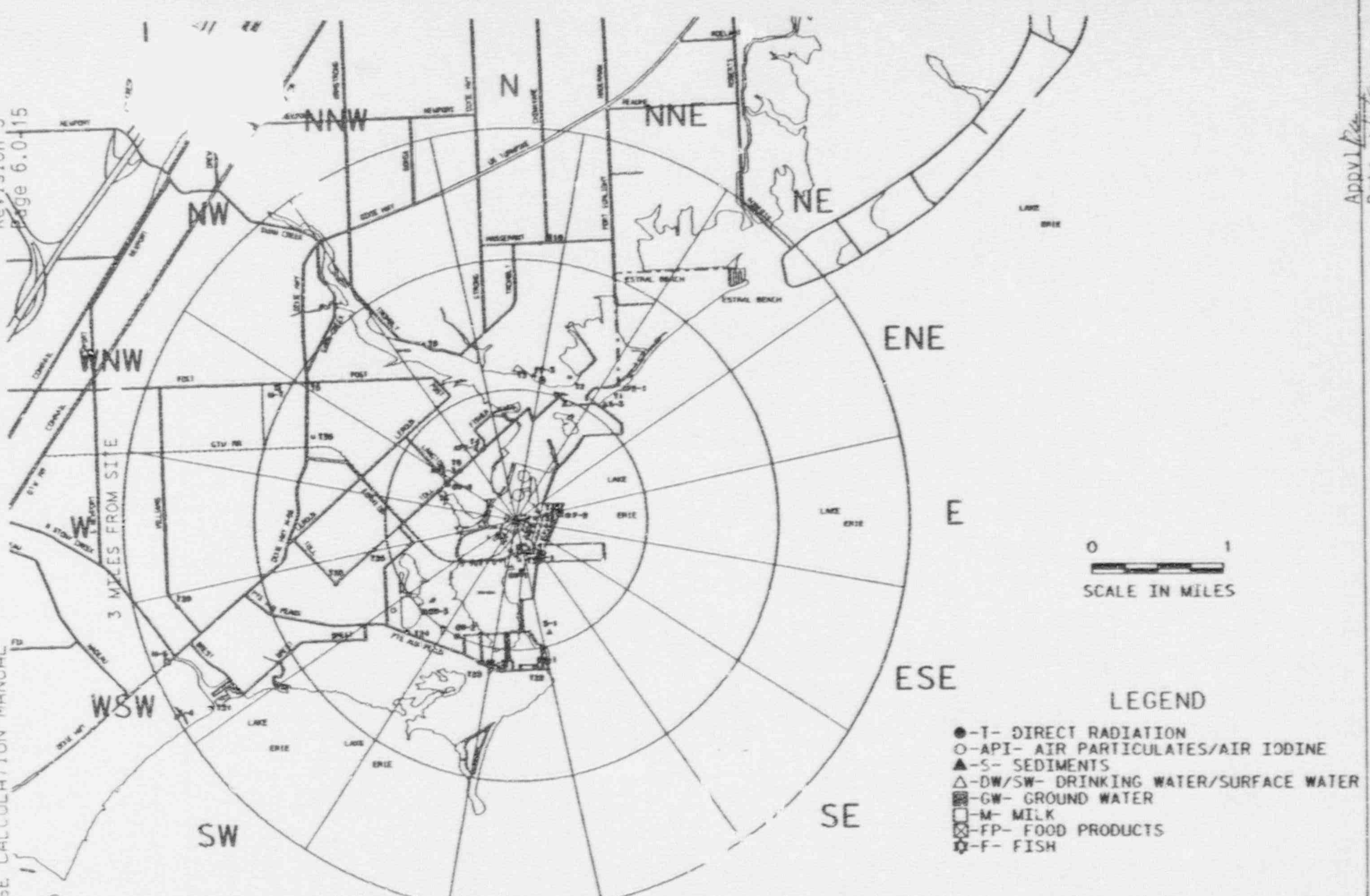

FIGURE 1
SAMPLING LOCATIONS
BY STATION NUMBER
(SITE AREA)

REVISED BY G.I.S. SEPTEMBER 1990

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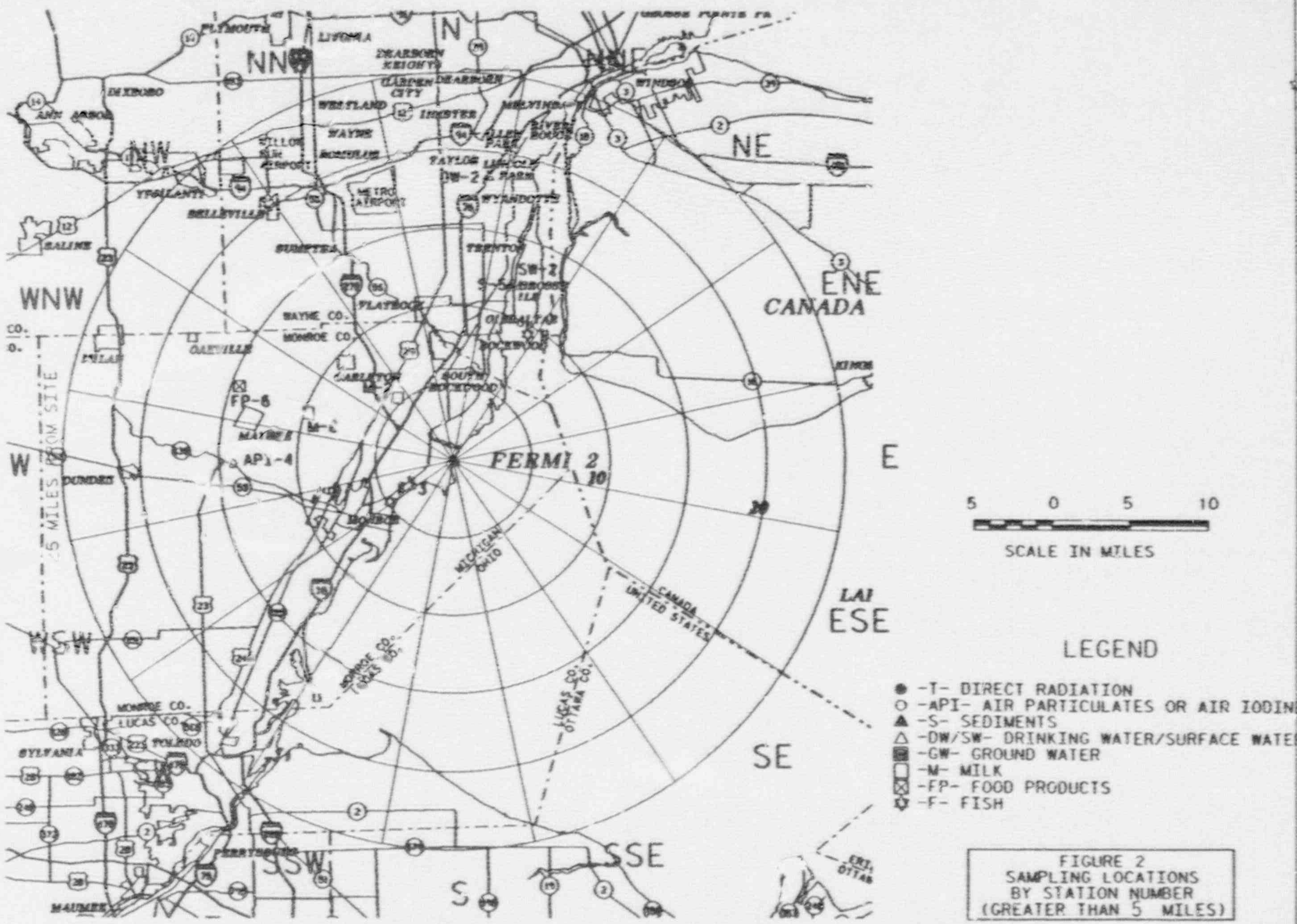

FIGURE 2
SAMPLING LOCATIONS
BY STATION NUMBER
(GREATER THAN 5 MILES)

REVISED BY G.I.S. SEPTEMBER 1990

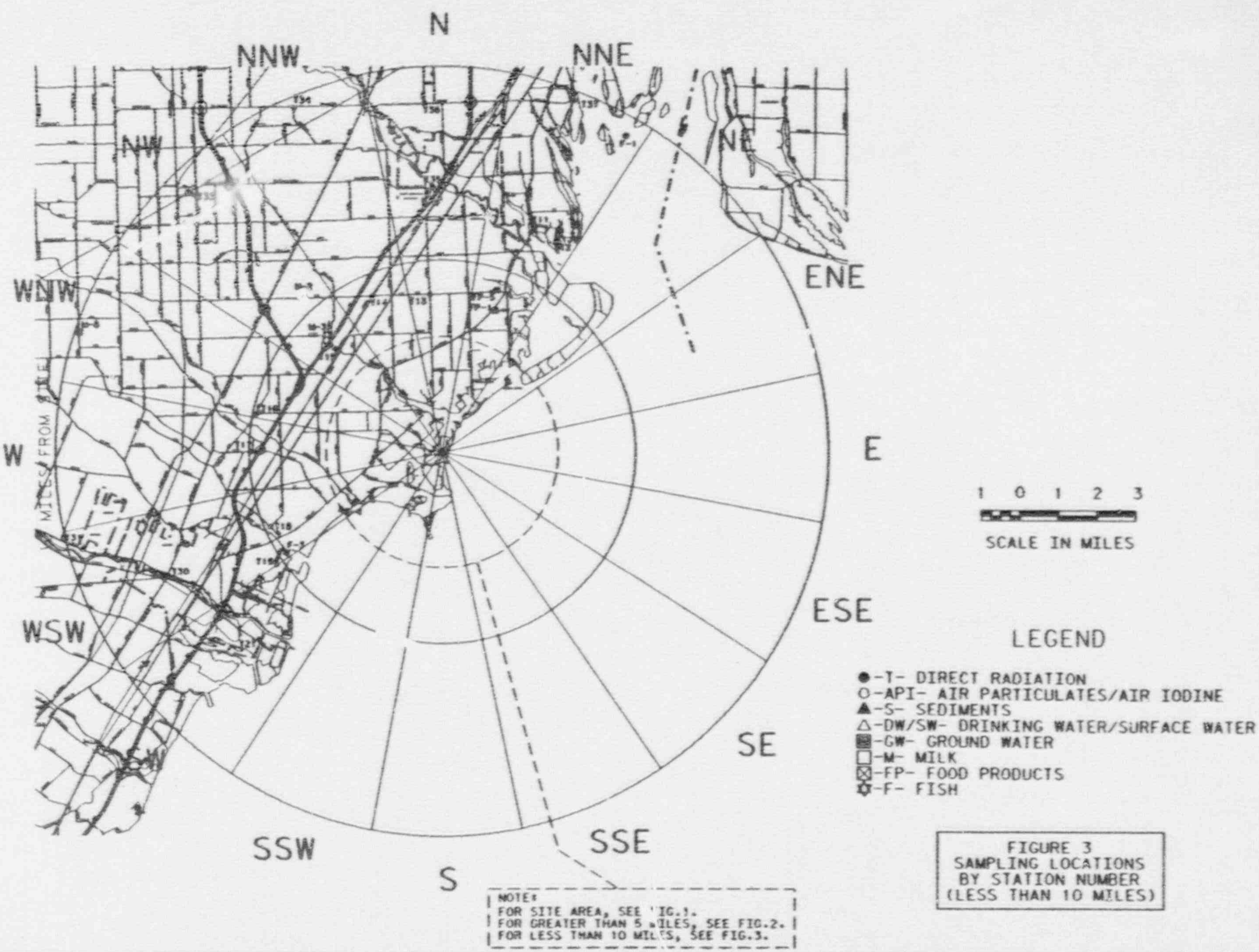

FIGURE 3
SAMPLING LOCATIONS
BY STATION NUMBER
(LESS THAN 10 MILES)

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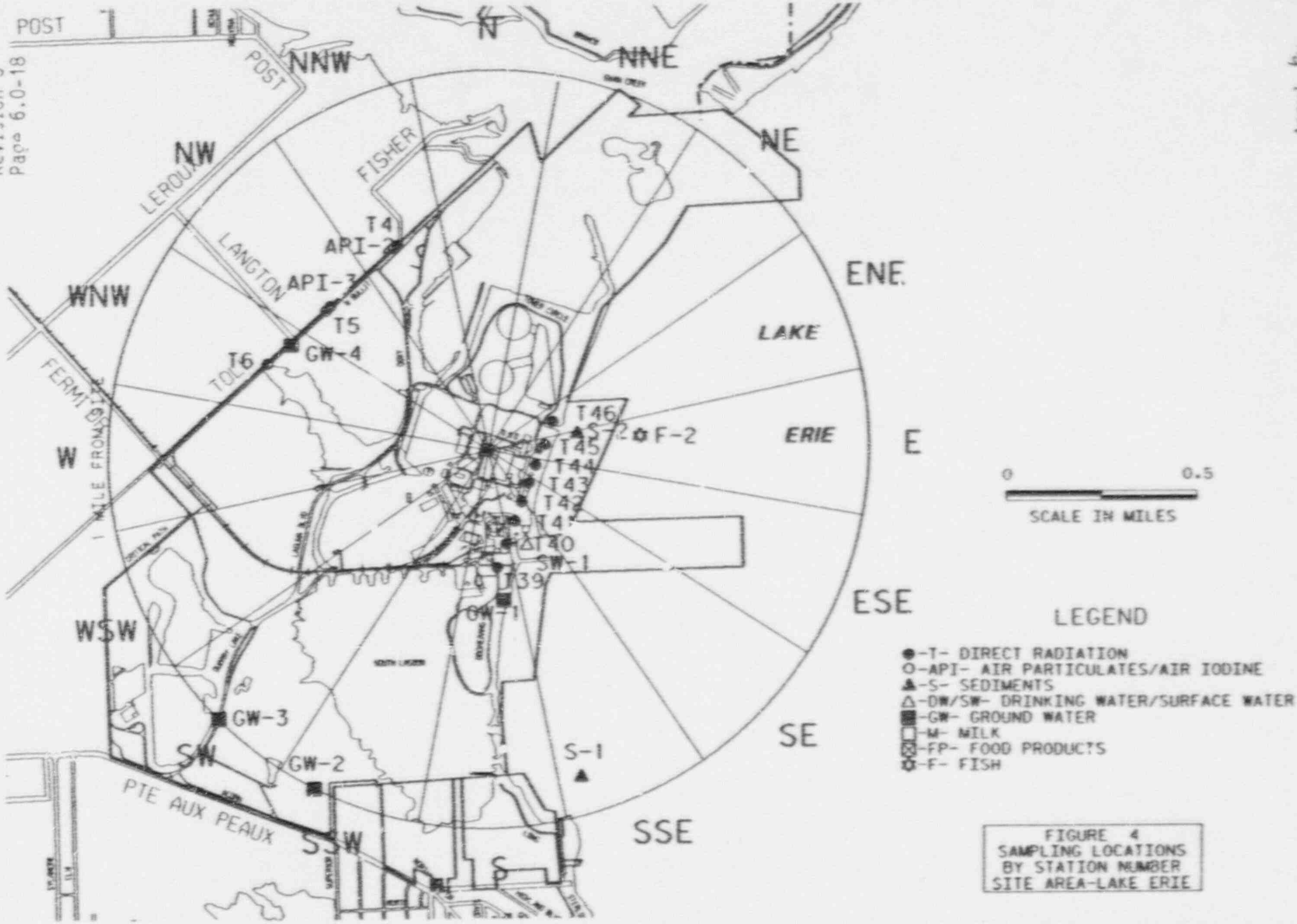
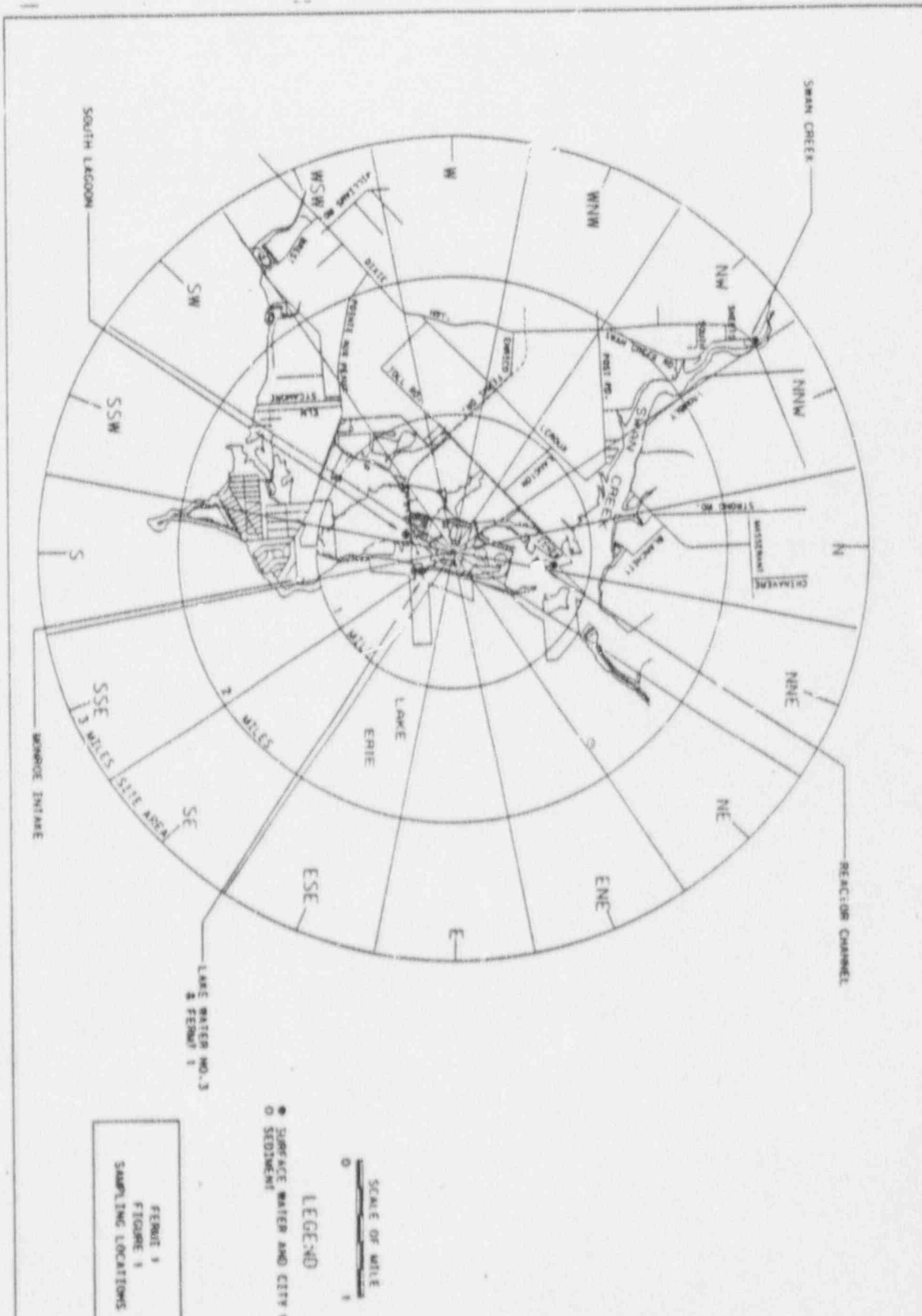


FIGURE 4
SAMPLING LOCATIONS
BY STATION NUMBER
SITE AREA-LAKE ERIE

REVISED BY G.I.S. SEPTEMBER 1990



FERMI 1
FIGURE 1
SAMPLING LOCATIONS

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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 FSAR, 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 2.0-1 were multiplied by the FSAR estimated annual release quantity to determine a relative dose significance. Table B-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 FSAR Table 11.2-9 isotopes evaluated, there are a few radionuclides with a higher dose conversion factor than I-123 for the thyroid dose. Further inspection of Table B-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 compliance with the dose limits of Technical Specification 3.11.1.2, the following simplified equations may be used:

Total Body

$$D_{tb} = \frac{1.67\ E - 02 * VOL}{DF * Z} * A_{(Cs-134,tb)} * \sum C_i \qquad (A-1)$$

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:

$$D_{tb} = \frac{9.69\ E + 03 * VOL}{DF * Z} * \sum C_i \qquad (A-2)$$

Maximum Organ

$$D_{max} = \frac{1.67\ E - 02 * VOL}{DF * Z} * A_{(Cs-134,liver)} * \sum C_i \qquad (A-3)$$

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

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Substituting the value for the Cs-134 liver dose conversion factor, the equation simplifies to:

$$D_{max} = \frac{1.18E+04 * VOL}{DF * Z} * \sum C_i \qquad (A-4)$$

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.

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TABLE A-1

Relative Dose Significance of Radionuclides in Liquid Effluents

Nuclide*	Estimated Annual Releases	Relative Dose Significance A_{io} * Curies							Percent Dose Contribution (% total)						
	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	34.47	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	9.51	.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	.13	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	3.06	.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 FSAR, Section 11.2, Table 11.2-9. Radionuclides contributing less than 1% of the total relative dose for any organ have been deleted.

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Date 12/1/90

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:

$$K_{eff} = \sum (K_i * f_i) \qquad \text{(B-1)}$$

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 3-3)

f_i = the fractional abundance of noble gas radionuclide i relative to the total noble gas activity

$$(L + 1.1\ M)_{eff} = \sum ((L_i + 1.1\ M_i) * f_i) \qquad \text{(B-2)}$$

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 3-3)

$$M_{eff} = \sum (M_i * f_i) \quad \text{(B-3)}$$

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 3-3)

$$N_{eff} = \sum (N_i * f_i) \quad \text{(B-4)}$$

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 3-3)

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 FSAR 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 Technical Specification 3.11.2.2 the following simplified equations may be used:

$$D_\gamma = 2.0 * 3.17\text{ E} - 08 * X/Q * M_{eff} * \sum Q_i \quad \text{(B-5)}$$

and

$$D_\beta = 2.0 * 3.17\text{ E} - 08 * X/Q * N_{eff} * \sum Q_i \quad \text{(B-6)}$$

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)

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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:

$$D_\gamma = 1.71 E - 04 * X/Q * \sum Q_i \qquad (B-7)$$

and

$$D_\beta = 1.46 E - 04 * X/Q * \sum Q_i \qquad (B-8)$$

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.

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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 as presented in ODCM Table 3-1, derived from Fermi 2 UFSAR, Section 11.3, Table 11.3-5. 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

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APPENDIX C: REVISED PAGE FROM FEBRUARY 1989 REPORT

The following page from the February 1989 Semiannual Effluent Release Report, which covers the period from July 1, 1988, through December 31, 1988, contains a typographical error: The total activity of spent resins, filter sludges, evaporator bottoms, etc., is listed as 4.29 E+00 Curies, whereas the correct value is 4.29 E+02 Curies. The listing of individual nuclide activities for this waste category is correct.

10. SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. Solid Waste Shipped Offsite for burial or disposal (not irradiated fuel)

1. Type of Waste	Container Volume	Unit	6 month period	Est. Total Error %
a. Spent resins, filter sludges, evaporator bottoms, etc.	m^3		8.50E+01	±25
		Curies	~~4.29E+00~~ 4.29E+02	±25
b. Dry compressible waste, contaminated equipment, etc.	m^3		4.27E+01	±25
		Curies	1.19E+00	±25
c. Irradiated components, control rods, etc.			0	
d. Other			0	

2. Estimate of major nuclide composition (by type of waste)

a. Spent resins, filter sludges, evaporator bottoms, etc.

Nuclide	Percent of Total Activity	Curies
Cr-51	40.8	1.75E+02
Mn-54	7.6	3.27E+01
Fe-55	20.8	8.91E+01
Co-58	8.2	3.53E+01
Co-60	5.4	2.31E+01
Fe-59	3.0	1.28E+01
Zn-65	6.2	2.64E+01
H-3	<0.1	2.98E-02
C-14	0.5	2.16E+00
Zr-95	<0.1	1.38E-02
Ba-131	4.9	2.10E+01
Ce-144	2.5	1.08E+01
Sr-90	<0.1	6.79E-04
Ni-63	0.1	4.20E-01
Cs-137	<0.1	6.26E-02