Joseph H. Plona
Site Vice President

6400 N. Dixie Highway, Newport, MI 48166
Tel: 734.586.5910 Fax: 734.586.4172

DTE Energy

October 23, 2009
NRC-09-0053

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

Reference: 1) Enrico Fermi Atomic Power Plant, Unit 1
NRC Docket No. 50-16
NRC License No. DPR-9

2) Detroit Edison Letter, NRC-09-0017, "Proposed License Amendment – License Termination Plan", dated, March 25, 2009

Subject: **Enrico Fermi Atomic Power Plant, Unit 1**
Information Regarding the Fermi 1 License Termination Plan

The NRC requested that certain documents be submitted and docketed to aid in the technical review of the EF1 License Termination Plan.

The following documents are being submitted to support the NRC's review:

1. NSEF-09-0027 EF1 Historical Site Assessment (HSA) Volume 1
2. NSEF-09-0028 EF1 Historical Site Assessment (HSA) Volume 2
3. Technical Based Document, NSEF-08-0018 - Radionuclide Selection for DCGL Development
4. Technical Based Document, NSEF-08-0022, Revision 1 – Instrument Efficiency Determination for use in Minimum Detectable Concentration Calculations
5. Technical Based Document, NSEF-09-0023 - Effects of asbestos encapsulant on survey instrument efficiencies

NMSS01
FSME

6. Technical Based Document, NSEF-09-0025 – Derived Concentration Guideline Levels for Embedded Piping, Revision 1
7. NRC Correspondence, NRC-87-0174, dated September 25, 1987, – Transmittal of "Supplemental Environmental Information Enrico Fermi Atomic Power Plant, Unit 1"

Should you have any questions, please contact Lynne Goodman, Manager Fermi 1, at (734)586-1205.

Sincerely,

Joseph H. Plona
Site Vice President, Nuclear Generation

JHP/ME/ljd

Attachments (7)

cc: NRC Regional Administrator, Region III w/o attachments
T. Smith, NRC (Washington, D.C.) w/electronic attachments
NRC Resident Inspector- Fermi 2 w/o attachments
P. Lee, NRC Region III w/o attachments
T. Strong (Michigan Dept. of Environmental Quality) w/o attachments

bcc: w/o attachments
J. Austerberry
D. Breiding
A. Bodipo-Memba
C. Byrd
W. Colonnello
J. Conner
J. Conen
L. Goodman
R. Johnson
K. Lindsey
R. Nearhoof
D. Niemeyer
J. Robinson
S. Stasek
J. Thorson
T. VanderMey
Fermi 1 Staff

Information Management (140 NOC) - Fermi 1 Records w/electronic attachments
NRR Chron File (Licensing) w/o attachments
NRC Notebook (Fermi 1) w/o attachments

NSEF-09-0027

ENRICO FERMI 1
HISTORICAL SITE ASSESSMENT
VOLUME 1

DETROIT EDISON

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VOLUME II HISTORICAL SITE ASSESSMENT AND CLASSIFICATION SUMMARIES

1.0 Acronyms and Abbreviations

AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
cpm	Counts Per Minute
DCGL	Derived Concentration Guideline Level
$DCGL_{EMC}$	DCGL for small areas of elevated activity, used with the EMC
$DCGL_W$	DCGL for average concentrations over a wide area, used with statistical tests
DOT	Department of Transportation
dpm	Disintegrations Per Minute
DQA	Data Quality Assessment
DQO	Data Quality Objectives
DRIWR	Detroit River International Wildlife Refuge
EMC	Elevated Measurement Comparison
EPA	Environmental Protection Agency
GM	Geiger-Mueller
GPS	Global Positioning System
HSA	Historical Site Assessment
LLD	Lower Limit of Detection
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCA	Multi-Channel Analyzer
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MDCR	Minimum Detectable Count Rate
MSL	Mean Sea Level
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
PRDC	Power Reactor Development Company
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control

RRA	Radiologically Restricted Area
RP	Radiation Protection
RSSI	Radiation Survey and Site Investigation
SARA	Superfund Amendments and Reauthorization Act
SOP	Step-Off Pad
Tech Spec	Technical Specification (part of plant license)
TRU	Transuranics

2 Executive Summary

This Historical Site Assessment (HSA) describes the Enrico Fermi Unit 1 (EF1) site. The HSA documents the construction, operational, decommissioning histories and the current use of the EF1 site. The HSA identifies the contaminants potentially present at the EF1 site due to plant operations and describes the media likely to contain these contaminants. The HSA describes impacted areas and the known distribution of contaminants within these areas as well as documenting the historical information used to justify survey area classifications (Class 1, Class 2 or Class 3) as described in NUREG-1575.

The HSA contains two volumes.

Volume I is a summary report that:

- Outlines the methodology used to perform the HSA.
- Describes the history and current status of the site.
- Provides findings from review of the site documents.

Volume II provides the following for each survey area:

- Survey area description.
- Survey area history.
  - Translocation pathways.
  - Scoping/characterization activities preformed in the area.
  - Decommissioning activities performed in the area.
- Findings.
  - Current status summary.
  - Classification statement.
- Tables identifying samples collected to date and comparison of the results with the site criteria.

3 Purpose of the Historical Site Assessment

The purpose of the HSA is to document a comprehensive investigation that identifies, collects, organizes and evaluates historical information relevant to the EF1 site. The HSA focuses on open land areas and those structures that will remain at the time of final status survey.

The HSA describes the site's physical configuration, identifies the radioactive constituents of site contamination, assesses the migration of contaminants, identifies contaminated media and classifies impacted areas. Guidance contained in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM) was used to classify site areas as required by the License Termination Plan (LTP) for the EF1 site.

4.0 Property Identification

4.1 License

4.1.1 License Holder

Detroit Edison Company is the holder of Possession Only License (POL) No. DPR-9

Detroit Edison Company
One Energy Plaza
Detroit, Michigan 48226

4.2 Physical Characteristics

4.2.1 Location

Enrico Fermi Atomic Power Plant Unit No. 1
6400 North Dixie Highway
Newport, Michigan 48166

Fermi 1 is located on the same site as Fermi 2, within the same owner controlled area and outside the Fermi 2 protected area. The site is on the western shore of Lake Erie, also referred to as Lagoona Beach, Frenchtown Township, Monroe County, Michigan. The plant is approximately 6 miles east-northeast of Monroe, Michigan; 30 miles southwest of downtown Detroit, Michigan; and 25 miles northeast of downtown Toledo, Ohio. Figure 1 illustrates the general layout, as it was during operation, of the EF1 site.

4.2.2 Topography

The location of EF1 is identified on the USGS 7.5 minute quadrangle map Department of Natural Resources Michigan map, Stony Point (Shown in Figure 2).

4.2.3 Stratigraphy

The bedrock is composed of dense dolomite from the bottom of the swamp deposits at a depth of 15 feet to a depth of approximately 80 feet. From 80 feet to a depth of 200 feet the layer is of shale and shaley dolomite. From 200 feet to 300 feet the rock is dense dolomite and shaley dolomite.

4.3 Environmental Setting

The information contained in Section 4 pertaining to Geology, Hydrogeology/Hydrology and Meteorology was taken from the original geological site assessment, the Golder Associates, Inc., "Report on Groundwater Characterization", the F1SAR, and various State of Michigan resources.

4.3.1 Geology/Hydrogeology

Beginning at the original ground level of around 573.5 feet above mean sea level (MSL) Golder's review of pre-construction boring logs that were obtained from EF1 indicates that inside the license boundary, the unconsolidated native sediments and the bedrock consisted of the following typical sequence:

- 0 - 7 feet: Soft black muck and peat.
- 7 - 12 feet: Glaciolacustrine laminated gray clay and silt, with traces of humus.
- 12 - 18 feet: Hard mottled gray to yellowish sandy clay (glacial till).
- > 18 feet: Dolomitic bedrock of the Bass Islands Group.

Following the removal of the native glacial deposits and construction of the reactor building in 1956, approximately 27 feet of predominantly clayey fill was added to the top of the bedrock in order to bring the ground inside much of the current Controlled Area (excluding the Health Physics Building pad and portions of the Sodium Building) up to an elevation of approximately 590 feet MSL. Outside the Controlled Area, 10 feet of fill was added, bringing the existing ground elevation up to approximately 583.5 feet.

Some of the EF1 buildings and were constructed entirely or partly below grade. These include the FARB, reactor basement, sodium tunnel, and sodium galleries. Collectively, the groundwater sample results to date have shown neither indications of detectable fission products nor of tritium (i.e., via liquid scintillation) or naturally occurring activity above background. These observations indicate that detectable activity in the EF1 monitor well samples is consistent with the normally occurring radioactive materials in area groundwater. Golder's report findings indicated there was no evidence of radiological impact to groundwater from EF1 as of June 2007. Samples analyzed since June 2007 are consistent with this finding.

5.0 Historical Site Assessment and Survey Area Delineation

5.1 Approach and Rationale

The HSA documents those events and circumstances occurring during the history of the facility that contributed to the contamination of portions of the site environs above background levels. Information relevant to changes in the radiological status of the site following publication of the HSA will be considered a part of the ongoing characterization evaluations and decommissioning activities.

The HSA involved collecting, organizing and evaluating information that described the EF1 site in terms of physical configuration and the extent to which the site was radioactively contaminated as a result of plant operations and decommissioning activities. The HSA information was used to bound and classify survey areas. The boundaries of the identified survey areas, as depicted in Figures 3 and 4; were based on operational history, including recorded significant events and common radiological profiles. The preliminary survey area classifications and sizes are shown in Table 7.1 for structures and for open land areas. Survey areas for structures will be divided into multiple survey units, where appropriate, in order to meet the survey unit size limitations recommended by NUREG-1575. All open land survey area boundaries have been sized to meet the NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM) size recommendations.

The general criteria used to classify the survey areas were drawn from the regulatory guidance of NUREG-1575 as follows:

Non-impacted Area: Areas where there is no reasonable possibility (extremely low probability) of residual contamination. Non-impacted areas are typically off-site and may be used as background reference areas. There are no non-impacted survey units at EF1.

Impacted Area: Areas not classified as non-impacted. These are areas that could possibly contain residual radioactivity in excess of natural background or fallout levels. All impacted areas must be classified as Class 1, 2 or 3 as described in NUREG-1575.

Class 1 Area: Impacted areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological surveys) above DCGL. Size limitations are $\leq 100\ m^2$ for structures (floor dimensions) and $\leq 2000\ m^2$ for open land areas.

Class 2 Area: Impacted areas that have a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGL. Size limitations are $\leq 1000\ m^2$ for structures (floor dimensions) and $\leq 10,000\ m^2$ for open land areas.

Class 3 Area: Impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the DCGL, based on site operating history and previous radiological surveys. There are no size limitations for Class 3 areas.

The collection and evaluation of site radiological information are conducted under approved site procedures. The output of this process is the information generated for each survey area that is used in the preparation of survey plans. Information collected for each survey area includes a detailed description of the survey area, an operational history, an evaluation of past and current translocation pathways and a description of the status of decommissioning activities. The findings section for each survey area includes an assessment of radiological contaminants, contaminated media, and current radiological status, results of any subsurface mitigation or remedial efforts and remaining decommissioning activities.

The general process for integrating the HSA with continuing characterization and the Final Status Survey (performed after remediation to confirm that the site release criteria have been met) is shown in the flowchart on the following page.

Process for Integrating HSA with Characterization and FSS

Review EF1 operational history and identify significant events contributing to Contamination of the site

↓

Establish Survey Area boundaries based on common history

↓

Assemble available historical reference documentation into Survey Area packages

↓

Assign survey area Classification

↓

Publish Historical Site Assessment document

↓

Obtain Site-specific DCGLs

↓

Update Survey Area packages as decommissioning activities progress. Include results of continuing characterization activities and document progress of remediation/mitigation of survey areas

↓

Evaluate Data Quality in survey area packages using DQO/DQA process and prepare characterization survey plans

↓

Obtain additional characterization if necessary and document turn-over surveys

↓

Begin Final Status Survey process as areas become available

Typically the term "remediation" is used in reference to any process involving the removal of radioactive media. For the purpose of license termination activities, "remediation" is narrowly defined as efforts specifically conducted to reduce the quantity or concentration of radioactivity to a level below the appropriate DCGL. Other processes may be referred to as "mitigation" or routine decommissioning activities.

5.2 Boundaries of the Site

The Enrico Fermi Atomic Power Plant, Unit 1 (EF1) is located on the same site as Fermi 2, within the same owner controlled area and outside the Fermi 2 protected area. The site is on the western shore of Lake Erie, Frenchtown Township, Monroe County, Michigan. Figure 3, "License Boundary," located at the end of Volume I, shows the boundaries of the site and the Controlled Area (area in red).

Detroit Edison Company owns and controls all of the land and structures located within the licensed site property boundary.

Perimeter Road, located within Fermi 2 controlled area, encircles the EF1 site and forms the License Termination boundary. During the early site history, rail spurs ran into the industrial area. The rail spurs facilitated construction of EF1. Currently, a small portion of rails remain within the EF1 site boundary; however these rails are not used.

The EF1 area surrounding the Controlled Area is mostly level with several structures and open land areas contained within. The Controlled Area is slightly elevated and contains most of the structures required for original plant operation.

5.3 Documents Reviewed

In performing the EF1 HSA, selections from the following documents were reviewed:

- License and Technical Specifications
  - Technical Specification Changes
  - License Amendments and Revisions
  - Fermi 1 Manual
  - F1SAR
- Original Plant Design
  - Function and purpose of systems and structures
  - Plant operating parameters
  - Plant operating procedures
  - PRDC Technical Information and Hazards Summary Report
- Original Plant Construction Drawings and Photographs
  - Specifications for systems and structures
  - Field Changes/as built drawings

  - Site Conditions
- Plant Operating History
  - Reports
  - Plant Operating Procedures Regarding Spills and Unplanned Releases
  - Shift Supervisor Logbooks
  - Radiological Environmental Monitoring Program and Golder Report on Groundwater Characterization
  - Monthly Plant Operational Reports
  - EF1 Alumni Questionnaires
- Work Control Documents and Site Modifications
  - Work Packages
  - Plant Alterations
  - Engineering Design Change Requests (EDCR)
  - Plant Modifications
  - Maintenance Reports
- Radiological Surveys and Assessments
  - Radiological surveys performed in support of normal plant operations and maintenance
  - Radiological surveys performed in support of special plant operations and maintenance
  - Radiological assessments performed in response to radioactive spills or events
  - Scoping and characterization surveys performed
  - Remediation support surveys conducted during decommissioning activities
- The EF1 Retirement Report
- Documentation of remediation area stabilization and restoration activities
- Fermi 1 Decommissioning Evaluation Report
- Enrico Fermi 1 History of Underground Systems, Pipes and Structures

5.4 Property Inspections

The EF1 site is in the equipment removal stage of decommissioning. The reactor vessel and some of its associated piping have yet to be removed. All fuel assemblies and blankets have been removed. The residual sodium inside of the reactor and three loops has been reacted and the remaining liquid (caustic/neutralized caustic solution) has been drained to the extent practical. The portion of the site historically identified as the Radiologically Restricted Area (RRA) is posted and restricted for personnel access and radioactive material control. RRA access is maintained through the Radiation Protection (RP) group.

5.5 Personnel Interviews

In February of 1997 a reunion comprised of Fermi 1 alumni was held. As part of the reunion, questionnaires were passed out consisting of discussion topics for the gathering. The purpose of the questionnaires was to glean any additional information from former employees that would be of benefit in the historical site assessment. A total of fifteen responses were received with the following items of interest:

- Mention was made of an explosion/fire in the cold-trap room in the FARB.
- Mention of the partial fuel melting event in October, 1966.
- Mention of an explosion of the #1 S/G rupture disc in Steam Generator Building.
- No mention of spills of contaminated material.

On October 29, 2002 during a Fermi 1 Alumni gathering the following items of interest were mentioned during a group discussion:

- The ring header embedded around the perimeter of the building is the air intake for the ventilation system.
- Pipe was washed in the overflow canal (not radioactive).
- Sodium barrel dropped on ground north of the FARB. Left in the rain and some reacted.
- Fuel pools had good integrity. No indications of leakage.
- Potential sodium leakage from Cask Car. Need to be diligent when performing final surveys.
- Transfer tank cold trap pump explosion – no additional details given.

In response to the questionnaire distributed during the October gathering, 14 individuals responded by November 29, 2002, with the following items of interest:

- Check Peaking Boiler House supply line for leakage (not radioactive).
- Debris was dumped into the Fermi 2 quarry including a 30 or 55 gallon drum of non-radioactive sodium.
- Lots of cables and wires are buried at Fermi 1 - probably not on drawings.
- Mercury spill in the Waste Gas building during preoperational testing. Area was cleaned up.
- Chlorine spill at Screen House – possibly in 1962.
- Non-radiological Na/water and NaK/water experiments at Sibley quarry.

An exit interview of a Fermi 1 employee retiring was performed in 2007. The interview made mention of a spill that occurred in the "Uranium Room" of the FARB. Additionally, there was mention of a number of small contaminated sodium spills in the Trestleway that were remediated.

6.0 History

6.1 Licensing History

On May 10, 1963 the Atomic Energy Commission (AEC) granted an operating license, DPR-9, to Power Reactor Development Company (PRDC) a consortium of corporations specifically formed to own and operate a nuclear reactor at the EF1 site. Detroit Edison Company owned the power generating portion of the plant and the surrounding land. This area is now part of the larger Fermi 2 owner controlled area.

The reactor was tested at low power in its first couple years of operation. Power ascension testing above 1 Mwt commenced in December 1965, immediately following receipt of the high power operating license. In October 1966, during a power ascension, zirconium plates at the bottom of the reactor vessel became loose and blocked sodium coolant flow to some fuel subassemblies. Two subassemblies started to melt. Radiation monitors alarmed and the operators manually shut down the reactor. No abnormal releases to the environment occurred. Three years and nine months later, the cause had been determined, cleanup completed, fuel replaced, and Fermi 1 was restarted.

In 1972, the core was approaching the burnup limit. In November, 1972, PRDC made the decision to decommission Fermi 1. The fuel and blanket subassemblies were shipped offsite in 1973. The non-radioactive secondary sodium system was drained and the sodium sent to Fike Chemical Company. The radioactive primary sodium was stored in storage tanks and in 55 gallon drums until the sodium was shipped offsite in 1984. Decommissioning of EF1 was originally completed in December of 1975. Effective January 23, 1976 DPR-9 was transferred to Detroit Edison Company as a "possession only" license. Based on current regulatory requirements, EF1 is identified as being in the final stage of SAFSTOR status.

6.2 Regulatory Involvement

NRC inspectors from Region III offices perform routine onsite inspections of EF1 site activities. Periodic calls are also held with NRC headquarters and Region III staff to monitor plant status and decommissioning progress. The NRC is notified of any incidents on site per the existing protocol established with NRC Region III and NRC reporting regulations. The NRC headquarters reviews all license amendment requests and other submittals. Periodic meetings are being held with the NRC headquarter staff relative to license termination planning.

The Michigan Department of Environmental Quality provides oversight of Fermi 1 decommissioning and license termination activities.

6.3 Facility Description

The Enrico Fermi Atomic Power Plant, Unit 1 (Fermi 1) was a fast breeder reactor power plant cooled by sodium and operated at essentially atmospheric pressure. The reactor plant was designed for a maximum capability of 430 Mwt; however, the maximum reactor power with the first core loading (Core A) was 200 Mwt.

6.3.1 Description of Circumstances Impacting Site Radiological Status

Table 6.1 provides a summary of unplanned events that impacted various EF1 survey areas.

Table 6.1
List of Unplanned Events

Impacted Survey Area	Date	Description
NOL-01	8/1/67	Leak in Waste Gas drain line
NOL-01	4/30/68	Leak in Waste Gas discharge line
NOL-01 and OOL-01	5/6/68	Leak in the Health Physics/Chemistry Bldg. Waste Discharge line
FRB-01	Unknown	Spill in the Uranium Room
RXB-01, TRW-01, VNB-01 and FRB-01	5/20/08	Fire in the Reactor Building Basement
RXB-01	2008 multiple	Processing liquid leaks in the Reactor Building Basement
TRW-01	Unknown	Minor leaks in Trestleway
FRB-01	Unknown	Explosion in FARB cold-trap room

6.4 Adjacent Land Use

The following paragraphs describe the features and uses of land within 8 miles of the plant. Included is a summary of the population centers within 10 miles of EF1.

Major Bodies of Water: Lake Erie is located to the east of EF1.

Industry: The area surrounding EF1 is predominately farmland. The major industrial areas lie in Monroe, including employers such as DTE, Tenneco and La-Z-Boy.

Public lands and Conservation Areas: Detroit River International Wildlife Refuge (DRIWR), DTE Fermi, resides within the Fermi 2 site. The 650 acre tract is part of a cooperative management agreement signed with the DRIWR.

Pointe Mouillee State Game Area is a 4,000 acre spit of land approximately 4 miles northeast of the Fermi 1 site at the northwest corner of Lake Erie, which jets into Lake Erie near the Huron River. It is owned by the Michigan Department of Natural Resources.

Wm. C. Sterling State Park, the only state park on Lake Erie, consists of 1,300 acres of state-owned lands with recreational swimming, fishing, camping, hiking and wildlife viewing. Sterling State Park is approximately 5.2 miles southwest of the Fermi 1 site on Brest Bay. The bay sits just north of where the Raisin River spills into Lake Erie. The park is situated in Monroe County just south of Detroit Beach/Sandy Creek and north of the city of Monroe.

Schools: Newport has a total of four schools, 2 public and 2 private. Monroe has a total of 23 public schools and 9 private schools.

Farms: Monroe County has an area of about 550 square miles of which approximately 70% is farmland. The majority of crops grown on the farms in the area are corn, winter wheat and soybeans.

Water Supplies: Currently potable water is supplied to the Fermi 1 complex from the Frenchtown public water supply. The Frenchtown and Monroe public water supplies have intakes from Lake Erie approximately three miles from the Fermi 1 site.

Population: Monroe County, in which Fermi 1 is located, extends about 10 miles north, 25 miles west, and 20 miles south-west of the site and has a population of about 146,000. The only substantially populated communities within a 10 mile radius are Newport, located approximately 3.5 miles away with a population of about 11,000 and Monroe located approximately 8 miles away with a population of about 54,800.

7.0 Findings

7.1 Overview

In-depth assessments of the operational history were used to bound and classify survey areas in accordance with NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Of the less than 2 acres that comprise the EF1 site, all of the area was impacted by plant operations and decommissioning activities. The preliminary boundaries of the impacted areas are depicted in Figure 4. Table 7.1 lists the survey area dimensions and their classifications in a tabular format. Impacted area classifications are shown in Figure 5 on a color-coded site map.

Of the approximately 2 acres that are impacted, the perimeter areas are minimally impacted and, as such, are classified as a Class 3 open land survey area.

Table 7.1
Survey Area Summary Information

Survey Area Designator	Name/Building	Total Area Footprint (Square Feet)	Total Area Footprint (Square Meters)	Classification
OOL	Open Land Area	80495	7478	Class 3
SGB	Steam Generator Building	16434	1527	Class 3
CTB	Control Building	22332	2075	Class 3
TBN	Turbine Building	67113	6235	Class 3 and Class 2
OFB	Office Building	12595	1170	Class 3
NOL	Open Land Area (impacted)	25753	2392	Class 2
RXB	Reactor Building	8144	757	Class 1, Class 2 and Class 3
FRB	Fuel and Repair Building	29561	2746	Class 1 and Class 2
TRW	Trestleway	5862	545	Class 1 and Class 2
NAB	Sodium Building	12016	1116	Class 1 and Class 2
VNB	Ventilation Building	1880	175	Class 1 and Class 2
NAT	Sodium Tunnel	540	50	Class 2
ESG	East Sodium Gallery (including FPD Bldg)	1055	98	Class 2
WSG	West Sodium Gallery	721	67	Class 2
WGB	Waste Gas Building	3264	303	Class 2
IGB	Inert Gas Building	5021	466	Class 2

7.2 Potentially Contaminated Areas

The summary assessments provided in Section 7.3.2 include a description, key elements of the history, contaminated media and an evaluation of the principle radionuclides expected to be present in the area. Detailed information for each survey area is provided in Volume II of the HSA and titled with survey area designators (e.g., OOL-01). These detailed survey area descriptions and operational histories also include the current decommissioning status as of October, 2008 and a description of the work remaining in order to attain the anticipated end-state.

A survey area classification statement is provided at the end of each detailed assessment. The classifications are based on historical information about activities performed in these survey areas. These classifications are substantiated by historical data from soil sample analyses and surveys. In the context of MARSSIM surveys, these sample data are considered scoping data. Summaries of the survey shown in Table 7.2 were compiled from information gathered from a characterization performed in 2005.

Table 7.2
Building Surface Summary Survey Data

Building/Surface	Fermi-2 Operating (cpm)	Fermi-2 Shutdown (cpm)
FARB 1st Floor Roof	4773 ± 542	3285 ± 304
FARB 2nd Floor Roof	6371 ± 783	3257 ± 275
FARB 3rd Floor Roof	6429 ± 845	2964 ± 392
Steam Generator Bldg. Roof	3660 ± 294	1741 ± 112
Waste Gas Tank Room Floor	2160 ± 147	1952 ± 121
Sodium Bldg. Roof	3874 ± 465	2685 ± 217
Turbine Bldg. Roof	2802 ± 227	1955 ± 129
Turbine Bldg. Driveway	2347 ± 227	1249 ± 180
Turbine Bldg. 3rd Floor, HP Turbine	1963 ± 114	1571 ± 145
FARB East Fuel Pool Area	2602 ± 335	2530 ± 244
FARB West Fuel Pool Area	2407 ± 139	2344 ± 161
FARB Truck Bay	4006 ± 767	2867 ± 1039
Trestleway	3430 ± 353	2987 ± 1430

A soil sampling regime was performed in May, 1997. A total of 34 samples were taken within the boundary of Fermi 1. No radionuclides, other than those of naturally occurring radioactive material, were detected in these samples.

7.2.1 Radionuclides of Concern

Analyses have been performed to determine which radionuclides have potential dose significance at license termination (Technical Based Document NSEF-08-0018 "Radionuclide Selection for DCGL Development"). Based on the sample data available, the Radionuclides-of-Concern at EF1 relative to FSS are; Co-60, Cs-137, Sr-90 and H-3.

7.2.2 Impacted Areas

7.2.2.1 Buildings, Structures and Open Land Areas Inside the Controlled Area

The following designations are used in identifying survey areas inside the Controlled Area:

NOL	Open Land Areas Inside the Controlled Area
RXB	Reactor Building
FRB	Fuel and Repair Building
TRW	Trestleway
NAB	Sodium Building
VNB	Ventilation Building
NAT	Sodium Tunnel
ESG	East Sodium Gallery
WSG	West Sodium Gallery
WGB	Waste Gas Building
IGB	Inert Gas Building

Summary individual survey area assessments are described in Volume II. The current Controlled Area boundary was previously the historical Restricted Area (RA). Portions of the yard within the current Controlled Area contain Radiation Material Areas (RMAs). In general all survey areas within the confines of the Controlled Area have been assigned a Class 1 or Class 2 status.

7.2.2.1.1 Buildings

Reactor Building (RXB-01)

Description:

The Reactor Building is a cylindrical vertical steel vessel, 72 feet in diameter and 120 feet high with the lower 51 feet below finished grade elevation. The inside of the Reactor Building is divided into two regions by a 5-foot thick steel and concrete operating floor. The above floor region is normally accessible to personnel and houses the containment crane. The below floor region housed the reactor vessel and internals, the primary shield tank, the secondary shield, the intermediate heat exchangers, primary sodium pumps, the decay tanks, the primary sodium overflow tank and associated equipment and piping for the primary and secondary sodium coolant systems. The Reactor Building is surrounded by an approximately 3 foot wide annulus that is located below floor level to a depth of about 3 feet below the concrete pedestal on which the steel Reactor Building stands. The annulus contains an access hole to the northwest sodium gallery, and four floor drains that drain into a collection tank and sump pump system in the basement of the Steam Generator Building which discharges into the site storm drain.

History:

All of the areas within RXB-01 are likely to be contaminated as a result of work activities performed in the area as well as unplanned events. All of the structures comprising RXB-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area RXB-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: Reinforced concrete and steel.
3. Continued Investigation: Continued investigation will further evaluate both above grade steel and concrete and below grade reinforced concrete.

Decommissioning/Decontamination Activities:

1. Performed: The machinery dome and above floor portions of the primary shield tank, fuel handling and control rod drives mechanisms have been removed. The upper section of the Reactor Vessel has been removed of all the graphite blocks and "chinkers." The Reactor Vessel and primary loops have undergone processing of the remaining residual sodium. The primary sodium service system and some of the primary sodium piping have been removed. The fuel handling equipment has been removed. Some cables, cable trays and other electrical equipment have been removed. Asbestos insulation and heat tracing was removed.
2. Planned: Planned decommissioning activities for RXB-01 include:
    - Removal of the Reactor Vessel and associated piping
    - Removal of the remainder of large components present in the Reactor Building
    - Removal of cables and cable trays as practical
    - Removal of obstructions in the building to allow FSS
3. Anticipated End-State Configuration: The end-state configuration for RXB-01 is anticipated to include:
    - Reinforced concrete structure now present
    - Steel dome covering the Reactor Building
    - Cables and cables trays not removed during decommissioning activities

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area RXB-01 is designated as a Class 1 area in the areas of the floor to a height of six feet up the walls. The areas from six feet and above on the walls and the ceiling are Class 2 areas. The reactor building basement is Class 1 and the annulus is a Class 3 area.

Trestleway (TRW-01)

Description:

The trestleway is located to the north and adjacent to the Reactor Building and functioned as a connection between the Reactor Building and the Fuel and Repair Building (FARB). The substructure consists of reinforced concrete. The superstructure consists of structural steel with corrugated asbestos (transite) siding and a corrugated steel roof. The fuel transport machine, or cask car, unloaded irradiated fuel from the reactor via the transfer rotor, transported the irradiated fuel in finned pots from the Reactor Building to the FARB via the trestleway and unloaded the pots into the transfer tank rotor.

History:

All of the areas within TRW-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by a characterization survey performed in October and November 2004. All of the structures comprising TRW-01 are of original plant construction, with the exception of the repaired section of roof and wooden doorways from the trestleway into the yard.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area TRW-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: Reinforced concrete, corrugated steel, asbestos panels, steel and wood.
3. Continued Investigation: Continued investigation will further evaluate both above grade steel and below grade reinforced concrete. Concrete volumetric sampling (below grade) will be performed as applicable.

Decommissioning/Decontamination Activities:

1. Performed: No decommissioning activities have been performed on TRW-01.
2. Planned: Planned decommissioning activities for TRW-01 include:
   - Removal of obstructions in the building to allow FSS
   - Decontamination, as necessary
3. Anticipated End-State Configuration: The end-state configuration for TRW-01 is anticipated to include:
   - Reinforced concrete structure now present
   - Structural steel and corrugated walls and roof

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area TRW-01 is designated as a Class 1 area in the areas of the floor to a height of six feet up the walls. The areas from six feet and above on the walls and the ceiling are Class 2 areas.

Fuel and Repair Building (FRB-01)

Description:

The FARB, located approximately 100 feet north of the Reactor Building, is connected to the Reactor Building by a covered transport car track (trestle). The substructure of the FARB consists of heavy reinforced concrete walls and rests on bedrock. The superstructure consists of two different types of construction. The walls above the operating floor in the new fuel receiving and storage area and the irradiated fuel decay and cut-up pool areas are reinforced concrete. All other superstructure walls consist of structural steel with corrugated asbestos siding.

The FARB contained process cells, water-filled decay and cut-up pools, a new fuel handling and storage area, a central control room for fuel handling and waste system operations, a 75-ton crane, and a transport car access area for the performance of fuel handling functions. Space was provided for a repair and cleaning facility for maintenance of contaminated equipment. The fuel transport machine, or cask car, unloaded irradiated fuel from the reactor via the transfer rotor, transported the irradiated fuel in finned pots from the Reactor Building to the FARB via the trestleway and unloaded the pots into the transfer tank rotor. The pot was transferred to a position under a steam cleaning machine that removed the fuel from the pot and positioned the fuel so that the sodium was cleaned from the subassembly by steaming, followed by a water rinse using an automatically programmed cycle. The subassembly was designed to be placed in a container in the cut-up pool, tested for fission product leakage, and transferred to the decay pool for a decay period of approximately 180 days per design before further processing.

The FARB contained a cold trap system (purification system) for the transfer tank sodium in a separate substructure room diagonally adjacent to the fuel transfer tank room. The sodium lines and equipment were shrouded in a welded carbon steel secondary structure, which was inert with nitrogen. The piping outside the walled areas was in the repair pit area and was contained in a concrete vault with a removable cover slab.

History:

All of the areas within FRB-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys and unplanned events. The structures comprising FRB-01 are of original plant construction, except for the repaired wall area and the addition of the warm room.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area FRB-01 are Co-60, Cs-137, Sr-90, and H-3
2. Media: Reinforced concrete, asbestos panels and steel
3. Continued Investigation: Continued investigation will further evaluate both above grade steel and below grade reinforced concrete.

Decommissioning/Decontamination Activities:

1. Performed:
   - Removal of the Transfer Tank.
   - Asbestos insulation abatement
   - FARB cold-trap heat exchange equipment removed
   - Fuel storage racks removed
   - Ventilation system equipment was removed
2. Planned: Planned decommissioning activities for FRB-01 include:
   - Removal of obstructions in the building to allow FSS
   - Remediation of the Cut-up and Decay Pools
   - Removal of the liquid waste tanks and equipment
3. Anticipated End-State Configuration: The end-state configuration for FRB-01 is anticipated to include:
   - Reinforced concrete structure now present
   - Structural steel and corrugated walls and roof

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area FRB-01 is designated as a Class 1 area in the areas of the floor to a height of six feet up the walls. The areas from six feet and above on the walls and the ceiling are Class 2 areas. Steam cleaning chamber and both pools are Class 1 areas. Below floor areas will follow the same classifications as the main floor. As obstructions, cut-up and decay pools, etc. are removed, exposed walls will be characterized and classified in accordance with NUREG-1575.

Sodium Building (NAB-01)

Description:

The Sodium Building is adjacent to the Reactor Building and is connected by an underground concrete tunnel. The Sodium Building housed the equipment used for storing and purifying the primary sodium. The Sodium Building, Waste Gas Building and the Inert Gas Building form one structural complex. The building is divided into four sections:

1. The primary sodium storage tank room is a concrete structure comprised of 30 inch thick cast concrete walls and a 30 inch thick combination pre-cast and poured concrete roof. The room contains the three 15,000 gallon primary sodium storage tanks.

2. The cold trap room has 6-foot thick external concrete walls as well as a 6-foot thick concrete ceiling. Additionally, the cell has a 4-foot thick internal wall separating it from the storage tank room. This room contained the equipment necessary to determine and maintain the purity of the primary sodium.

3. The sodium-potassium (NaK) room is comprised of reinforced concrete floor, walls and ceiling and access is provided via a steel door located in the east wall of the room and double doors on the west wall. The NaK room contained the ventilation equipment and the air-to-NaK heat exchanger equipment for the cold trap.

4. The valve control room occupies the second story region of the Sodium Building and is constructed of concrete block walls and a steel roof deck structure. The valve control room contained the sodium service hand wheels and motors for the

valves, electric panels supporting the induction heating for the piping, and the control panel.

History:

All of the areas within NAB-01 are likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys. All of the structures comprising NAB-01 are of original plant construction with the exception of the addition of a door to the cold trap room.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area NAB-01 are Co-60, Cs-137, Sr-90, and H-3.

2. Media: Pre-cast and poured reinforced concrete, concrete block and steel.

3. Continued Investigation: Continued investigation will further evaluate both above grade steel and concrete and below grade reinforced concrete.

Decommissioning/Decontamination Activities:

1. Performed:
   - Performed asbestos abatement.
   - Removal of the majority of original equipment and piping in the NaK room, valve room and cold-trap room.
   - Installation of the Reaction Chamber in the cold-trap room. Installation of sodium processing equipment in the NaK room.
   - Removal of sodium barreling station.
2. Planned: Planned decommissioning activities for NAB-01 include:
   - Removal of obstructions in the building to allow FSS
   - Remediation of contaminated portions of concrete
   - Removal of piping
   - Removal of Storage tanks
   - Removal of the Reaction Chamber and associated piping

3. Anticipated End-State Configuration: The end-state configuration for NAB-01 is anticipated to include:

    - Reinforced concrete structure now present
    - Concrete walls

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area NAB-01 is designated as a Class 2 area with the exception of the Cold-trap room which is Class 1 in the areas of the floor to a height of six feet up the walls. The areas from six feet and above on the walls and the ceiling are Class 2 areas.

Ventilation Building (VNB-01)

Description:

The Ventilation Building consists of a steel reinforced concrete floor with concrete block walls. The roof consists of a structural steel framework covered by corrugated steel. The Ventilation Building housed equipment for the Reactor Building Ventilation System including the supply and exhaust blowers, valves for water supply to the under floor cooling heat exchangers, a control panel, Freon refrigeration equipment for above floor cooling, and space for future equipment additions, such as dehumidifiers. The controlled area fence has been modified to extend past the east doors of the building.

History:

During plant operation the building was not used for handling of radioactive materials, therefore no shielding was provided for the structure. Subsequent demolition activities resulted in the removal of all equipment and piping as well as the plugging of the floor drains. The building is currently used for the storage of miscellaneous materials and equipment, some of which are internally contaminated.

All of the areas within VNB-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys and events. All of the structures comprising VNB-01 are of original plant construction with the exception of the addition of a door/passageway to the sealand/yard area.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area VNB-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: Poured reinforced concrete, concrete block and steel.
3. Continued Investigation: Continued investigation will further evaluate both above grade steel and concrete and below grade reinforced concrete.

Decommissioning/Decontamination Activities:

1. Performed: All ventilation components have been removed from VNB-01.
2. Planned: Planned decommissioning activities for VNB-01 include:
   - Removal of obstructions in the building to allow FSS
3. Anticipated End-State Configuration: The end-state configuration for VNB-01 is anticipated to include:
   - Reinforced concrete structure now present
   - Concrete block walls
   - Roof

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history, the sodium fire in the Reactor Building on May 20, 2008 and as a result of the decommissioning activities currently planned, Survey Area VNB-01 is designated as a Class 1 area in the areas of the floor to a height of six feet up the walls. The areas from six feet and higher on the walls and the ceiling are Class 2 areas.

Sodium Tunnel (NAT-01)

Description:

The Sodium Tunnel consists of a subsurface reinforced concrete structure lined with a ¼" thick carbon steel plate. The tunnel runs from the northwest corner of the Reactor Building annulus to the Cold Trap Room of the Sodium Building. The structure contained some of the primary sodium service system piping and was heated by a 60 cycle induction heating system replacing heat losses when the piping was at 400 degrees Fahrenheit with a 100 degree Fahrenheit ambient temperature. Access to this tunnel is via one of two manholes located between the Cold Trap Room and the Trestle way.

History:

All of the areas within NAT-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys. All of the structures comprising NAT-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area NAT-01 are Co-60, Cs-137, Sr-90, and H-3.

2. Media: Poured reinforced concrete and steel.

3. Continued Investigation: Continued investigation will further evaluate both the steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:

   - Removed the interior wall.

   - Reacted sodium residues in the piping.

   - Performed asbestos abatement and removed some of the shield pipe before sodium residue cleaning.

   - The installed piping is now used to transfer contaminated liquid between the Reactor Building and the Sodium Building.

2. Planned: Planned decommissioning activities for NAT-01 include:

   - Removal of all piping

3. Anticipated End-State Configuration: The end-state configuration for NAT-01 is anticipated to include:

   - Steel lined reinforced concrete structure now present

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning

activities currently planned, Survey Area NAT-01 is designated as a Class 2 area.

East Sodium Gallery (ESG-01)

Description:

The east sodium gallery consists of three chambers (North, Center and South) which held the secondary sodium lines. The east gallery supplied the No. 1 and 2 steam generators. Access to the three east sodium gallery chambers is via horizontal steel doors just above ground level. The east sodium gallery's walls and base slab are of conventional reinforced concrete construction resting on concrete filled pilasters. The roof is constructed of an 8 inch thick precast concrete slab covered with a 10 inch thick concrete layer all of which is beneath approximately 5 feet of earth. Included in this area is the Fission Product Detector (FPD) Building. The FPD building is located due east of the reactor building, directly above the East Sodium gallery (north chamber). This is a small partially buried room; a portion of it below ground level, which contained the gaseous fission product detector and piping. The gaseous FPD monitored the fission product concentration to detect the failure of a fuel element. The FPD received primary argon cover gas samples from the reactor vessel and the No. 1 and No. 3 primary pump tanks. Access to the FPD building is through a manhole in the roof of the building. The building is constructed of steel reinforced concrete.

History:

All of the areas within ESG-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys. All of the structures comprising ESG-01, with the exception of the FPD Building, are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area ESG-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: Poured reinforced concrete and steel.
3. Continued Investigation: Continued investigation will further evaluate both the steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:
   - Removed the FPD vapor trap and associated equipment.
   - Removed part of the piping in the FPD building.
   - Performed asbestos abatement.
   - The secondary sodium piping has been rinsed to remove residual caustic.
   - The secondary sodium piping was cut at the Reactor Building and the sodium gallery ends during the original decommissioning, and plates were welded over both ends.
2. Planned: Planned decommissioning activities for ESG-01 include:
   - Removal of all piping
3. Anticipated End-State Configuration: The end-state configuration for ESG-01 is anticipated to include:
   - Steel lined reinforced concrete structures now present

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities performed and currently planned, Survey Area ESG-01 is designated as a Class 2 area.

West Sodium Gallery (WSG-01)

Description:

The west sodium gallery consists of two chambers (north and south) which held the secondary sodium lines. The west gallery supplied the No. 3 steam generator. Access to the south compartment of the west sodium gallery chamber is via a horizontal steel door just above ground level. Access to the north compartment is via a tunnel from the Reactor Building annulus or a horizontal door which was sealed with a steel plate, concrete and stone fill to prevent water intrusion. The west sodium gallery's walls and base slab are of conventional concrete resting on concrete filled pilasters.

History:

All of the areas within WSG-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys. All of the structures comprising WSG-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area WSG-01 are Co-60, Cs-137, Sr-90, and H-3
2. Media: Poured reinforced concrete and steel.
3. Continued Investigation: Continued investigation will further evaluate both the steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:
   - Asbestos abatement.
   - Removal of material sealing the entrance to the north chamber.
   - Rinsing of secondary sodium piping.
   - Removal of intermediate heat exchanger seal/leak off lines
2. Planned: Planned decommissioning activities for WSG-01 include:
   - Removal of all piping
3. Anticipated End-State Configuration: The end-state configuration for WSG-01 is anticipated to include:
   - Steel lined reinforced concrete structure now present

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities performed and currently planned, Survey Area WSG-01 is designated as a Class 2 area.

<u>Waste Gas Building (WGB-01)</u>

Description:

The Waste Gas Building housed the waste gas disposal system that removed waste gases from the plant by a process which included storage until the gases decayed to a suitable level, dilution below the maximum permissible concentration in air and dispersion into the atmosphere through a stack. Piping, valves, and mechanical equipment were housed in chambers below grade; the holdup tanks were housed above grade in shielded cells of the building. Piping transported the waste gas to the FARB where it exited to the atmosphere via a waste gas stack. The holdup tank chambers are inside the Fermi 1 Controlled Area, while the below grade chamber and the grade level valve operating room are outside the Fermi 1 Controlled Area boundary. Construction of the Waste Gas Building includes reinforced concrete walls 12-18" thick, with the exception of the concrete block walled valve room. The roof over the tank rooms is constructed of reinforced concrete 2 feet thick.

History:

All of the areas within WGB-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys. All of the structures comprising WGB-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area WGB-01 are Co-60, Cs-137, Sr-90, and H-3
2. Media: Poured reinforced concrete, concrete blocks and steel
3. Continued Investigation: Continued investigation will further evaluate both the steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:
   - The majority of original components have been removed from inside the building.
2. Planned: Planned decommissioning activities for WGB-01 include:
   - Removal of remaining piping and components, as required
3. Anticipated End-State Configuration: The end-state configuration for WGB-01 is anticipated to include:
   - Reinforced concrete and block structure now present

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning

activities performed and currently planned, Survey Area WGB-01 is designated as a Class 2 area.

Inert Gas Building (IGB-01)

Description:

The Inert Gas Building housed the compressors, vapor trap, hold-up and vacuum tanks, valves, piping and other associated equipment for the purification and distribution of the argon cover gas system to the primary, secondary, and FARB cover gas systems. The Inert Gas Building has a first story of concrete construction and a second story of concrete block construction located immediately adjacent to the Sodium Building.

History:

All of the areas within IGB-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys. All of the structures comprising IGB-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area IGB-01 are Co-60, Cs-137, Sr-90, and H-3.

2. Media: Poured reinforced concrete, concrete blocks and steel.

3. Continued Investigation: Continued investigation will further evaluate both the steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:

    - The majority of original components have been removed from inside the building.

2. Planned: Planned decommissioning activities for IGB-01 include:

    - Removal of remaining piping and components

3. Anticipated End-State Configuration: The end-state configuration for IGB-01 is anticipated to include:

    - Reinforced concrete and block structure now present

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area IGB-01 is designated as a Class 2 area.

7.2.2.1.2 Open Land Areas

Inside the Controlled Area Open Land Area (NOL)

Description:

NOL-01 consists of an open land area of approximately 2392 square meters in size. The open land area is made up of soils, asphalt, gravel and concrete. The only area of NOL-01 that has plant-related activity present from previously sampling is the West Yard. A below grade tank and piping remain from the Health Physics/Chemistry Building which will be removed prior to FSS. The West Yard exhibited small amounts of Cs-137 in past samples at levels near the environmental limits.

History:

All of the areas within NOL-01 are not expected to be contaminated to levels above the DCGL.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area NOL-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: Soil, asphalt, gravel and concrete.
3. Continued Investigation: Continued investigation will further evaluate the materials present.

Decommissioning/Decontamination Activities:

1. Performed:
    - Removal of the Health Physics/Chemistry Building (a below grade tank and piping remain from the building).
    - Removed asbestos tile from the Health Physics/Chemistry building footprint.
2. Planned: Planned decommissioning activities for NOL-01 include:

- Excavation and removal of underground components in the West Yard associated with the Health Physics/Chemistry building drain system.

3. Anticipated End-State Configuration: The end-state configuration for NOL-01 is anticipated to include:

   - The configuration that the Survey Area is in at present, with FSS performed in the excavations and backfilled.

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area NOL-01 is designated as a Class 2 area acting as a buffer between the Class 1 and Class 3 areas.

7.2.2.2 Buildings, Structures and Open Land Areas outside the Controlled Area

The following designations are used to identify survey areas outside the Controlled Area:

SGB	Steam Generator Building
CTB	Control Building
TBN	Turbine Building
OFB	Office Building
OOL	Open Land Areas Outside the Controlled Area

Summary assessments for individual survey areas are described in Volume II of the HSA. The areas outside the confines of the Controlled Area have been designated as Class 2 and Class 3 areas based on the potential for migration of radionuclides beyond the Controlled Area boundary due to environmental or other translocation vectors.

7.2.2.2.1 Buildings

Steam Generator Building (SGB-01)

Description:

The Steam Generator Building was located south of the Reactor Building and adjacent to the lease line and the Detroit Edison turbine structure. The building housed the steam generators, secondary sodium pumps and piping components of the secondary coolant system. The equipment components were located at the operating floor at elevation 590'-0". The basement of the building housed the storage tanks and miscellaneous piping and equipment components of the Secondary Sodium Services System. The structure and equipment components were supported through a system of structural steel columns to a reinforced concrete base slab resting on bedrock. The basement floor of the building is divided into five sectors. An east-west concrete block firewall was installed the full length of the building extending between the basement floor and the operating floor. The remaining structure is of conventional design, that is, steel and corrugated asbestos walls.

History:

It is not expected that SGB-01 will be contaminated to levels at, or above the DCGL. All of the structures comprising SGB-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area SGB-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: Poured reinforced concrete, concrete blocks, asbestos (transite) siding and steel.
3. Continued Investigation: Continued investigation will further evaluate both the steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:
   - Removal of the sodium storage tanks
   - Removal of the three Steam Generators
   - Removal of the secondary sodium pumps
   - Removal of various supporting piping
   - Removal of portions of interior walls
   - Asbestos abatement
2. Planned: Planned decommissioning activities for SGB-01 include:
   - No further removal operations are planned in SGB-01.
3. Anticipated End-State Configuration: The end-state configuration for SGB-01 is anticipated to include:

- Reinforced concrete, steel and block structure now present
- Piping not impeding FSS

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities performed, Survey Area SGB-01 is designated as a Class 3 area.

Control Building (CTB-01)

Description:

This structure had, as its primary purpose, the protection, from the elements of weather and radioactive streaming, of personnel working inside. In addition, it served as protection for the equipment installed to control the operation of the whole plant. In order for the shielding function to be performed, the walls adjacent to the Reactor Building were 40 inch thick, reinforced concrete, and the roof was designed to eliminate the effect of sky shine on the control room located on the third floor of the building. Due to failure the Control Building roof was covered with a synthetic material.

History:

It is not expected that CTB-01 will be contaminated to levels at a fraction of the DCGL. All of the structures comprising CTB-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area CTB-01 are Co-60, Cs-137, Sr-90, H-3
2. Media: Poured reinforced concrete, concrete blocks, interior transite wall and steel
3. Continued Investigation: Continued investigation will further evaluate the concrete surfaces.

Decommissioning/Decontamination Activities:

1. Performed:
   - Removal of many of the components in the Control Room.
   - Repair of the roof with a synthetic material.

- Removal of the diesel generator, compressor and considerable electrical equipment.

2. Planned: Planned decommissioning activities for CTB-01 include:

   - Removal of any obstructions in the building to allow FSS.

3. Anticipated End-State Configuration: The end-state configuration for CTB-01 is anticipated to include:

   - Reinforced concrete and block structure now present.
   - Equipment not impeding FSS.

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area CTB-01 is designated as a Class 3 area.

Turbine Building (TBN-01)

Description:

Steam produced in the three steam generators located within the Steam Generator Building passed to the adjacent Turbine Building and was used to operate the turbine. The turbine was a tandem-compound, single flow machine. Four stages of feed water heating were used. The turbine and support equipment, feedwater heaters, main condenser and associated piping and pumps are /were located in the Turbine Building. The Turbine Building is a steel frame structure which is tied together with standard riveted or bolted connections. Steel beams support the concrete or grating floors. The exterior walls consist of a 4-foot high apron wall constructed of 8-inch cinder block except in the region behind the transformer and the hydrogen storage platform, where reinforced concrete was used to provide a positive fire barrier. Non-insulated, corrugated, asbestos-cement siding which is fastened to steel channel girts that run the full height of the building is installed above the apron wall. Open web steel joists support the standard ribbed galvanized steel roof deck. A single layer of plastic vapor barrier material is installed over the steel deck. This material will effectively contain the asphalt on the roof surface. The plastic material is covered by a 2-inch thick layer of Foamglas® which is covered with a four-ply tar and slag roofing.

History:

It is not expected that TBN-01 will be contaminated to levels at a fraction of the DCGL. All of the structures comprising TBN-01 are of original plant construction with the exception of the repaired holes in the south wall due to the removal of the boiler house and interconnecting piping and some newer walls.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area TBN-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: asbestos-cement siding, concrete blocks and steel.
3. Continued Investigation: Continued investigation will further evaluate the siding, steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:
    - Removal of asbestos, some portions of the turbine generator system was salvaged for spare parts.
2. Planned: Planned decommissioning activities for TBN-01 include:
    - No planned
3. Anticipated End-State Configuration: The end-state configuration for TBN-01 is anticipated to include:
    - Steel and block structure now present.
    - Piping and components now present in the structure (additional components may be removed if useful elsewhere).

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area TBN-01 is designated as a Class 3 area with the exception of a portion of the 1st and 3rd floors which are Class 2 areas (classified Class 2 as a result of radioactive material storage and transfer). The radioactive material stored on the 1st and 3rd floors was stored in sealed containers.

Office Building (OFB-01)

Description:

The Office Building is located on the west side of the Control Building and is outside the confines of the Controlled Area. This two-story structure housed the offices, conference rooms and dining room for the project. The structure is of reinforced concrete and structural steel design. The outer walls are made of lightweight concrete block and the remainder of corrugated cement asbestos siding backed up by gypsum board and hard board.

History:

It is not expected that OFB-01 will be contaminated to levels at a fraction of the DCGL. All of the structures comprising OFB-01 are of original plant construction.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area OFB-01 are Co-60, Cs-137, Sr-90, and H-3.
2. Media: Poured reinforced concrete, concrete blocks, asbestos (transite) siding and steel.
3. Continued Investigation: Continued investigation will further evaluate both the steel and concrete.

Decommissioning/Decontamination Activities:

1. Performed:
   - Renovations have been performed as room usage changed.
   - Some asbestos abatement has occurred, however some asbestos remains.
   - Roof repairs were made using a synthetic material.
2. Planned: Planned decommissioning activities for OFB-01 include:
   - None anticipated – subject to further evaluation
3. Anticipated End-State Configuration: The end-state configuration for OFB-01 is anticipated to include:
   - Reinforced concrete and block structure now present
   - Piping and components now present in the structure not impeding FSS

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning

activities currently planned, Survey Area OFB-01 is designated as a Class 3 area.

7.2.2.2.2 Open Land Areas

Open Land Area Outside the Controlled Area (OOL)

Description:

OOL-01 consists of an open land area of approximately 7478 square meters in size. The open land area is made up of soils, asphalt, gravel and concrete. An oily waste basin occupies a portion of OOL-01 and will be surveyed as part of that survey area. A radwaste drain pipe lies below the surface in a portion of OOL-01. This drain pipe will be excavated. The excavation will be treated as a Class 1 area, based on the past history of the pipe. The backfilled excavation will be treated as a Class 3 area.

History:

The section of radwaste drain piping running under the survey area was known to leak, therefore the excavation will be treated as a Class 1 area.

Contamination:

1. Radionuclides Potentially Present: The primary nuclides of concern for Survey Area OOL-01 are Co-60, Cs-137, Sr-90, and H-3.

2. Media: Asphalt, soil, gravel and concrete

3. Continued Investigation: Continued investigation will further evaluate the soils.

Decommissioning/Decontamination Activities:

1. Performed:

    - Acid and caustic tanks have been removed from the west side of the facility.
    - The transformer has been removed from the south side. The stack has been removed.
    - Some out buildings shown in Figure 1 have been removed over the life of the site.

2. Planned: Planned decommissioning activities for OOL-01 include:

    - Excavation of the radwaste piping. All excavations will be backfilled.

3. Anticipated End-State Configuration: The end-state configuration for OOL-01 is anticipated to include:

   - Original surface with all excavations backfilled.

   - Structures and components currently occupying the survey area (e.g. oily waste basin, tank supports, etc.)

Classification Statement:

Based on the radiological condition of this survey area as identified in the operating history and as a result of the decommissioning activities currently planned, Survey Area OOL-01 is designated as a Class 3 area, with the exception of the radwaste piping excavation which will be a Class 1 area.

8.0 References

NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual, Revision 1,* August 2000

Possession Only License (POL), No. DPR-9

Chesapeake Nuclear Services, Inc., *Fermi 1 Radiological Characterization Surveys*, March 2005

Enrico Fermi 1 History of Underground Systems, Pipes and Structures

Detroit Edison Company, Drawing No. 6C721W-7 (Issued for construction September 29, 1976): *Soil Borings/Waste Water Treatment Facilities/Enrico Fermi Power Plant – Unit 1.* Displays borehole logs from October 1955 through January 1976 at EF1.

Power Reactor Development Company, *Technical Information and Hazards Summary Report*

C&M Department Maintenance Reports

Fermi 1 Decommissioning Evaluation Report, June 1997

Enrico Fermi Atomic Power Plant, Unit 1, *Fermi 1 Safety Analysis Report*, November 2006

Enrico Fermi Atomic Power Plant, Unit 1, *Fermi 1 Manual*

Golder Associates, Inc., *Report on Groundwater Characterization*, June 2007

Fermi 1 Shift logs, August, 1965 to September 1995

Fermi 1 Operating Reports, August 1963 to December 1975

Michigan Department of Information Technology, Center for Graphic Information, *USGS 7.5 minute quadrangle map Department of Natural Resources Michigan map, Stony Point*, Retrieved from http://www.dnr.state.mi.us/spatialdatalibrary/PDF_maps/topomaps/Stony_Point.pdf, June 2008

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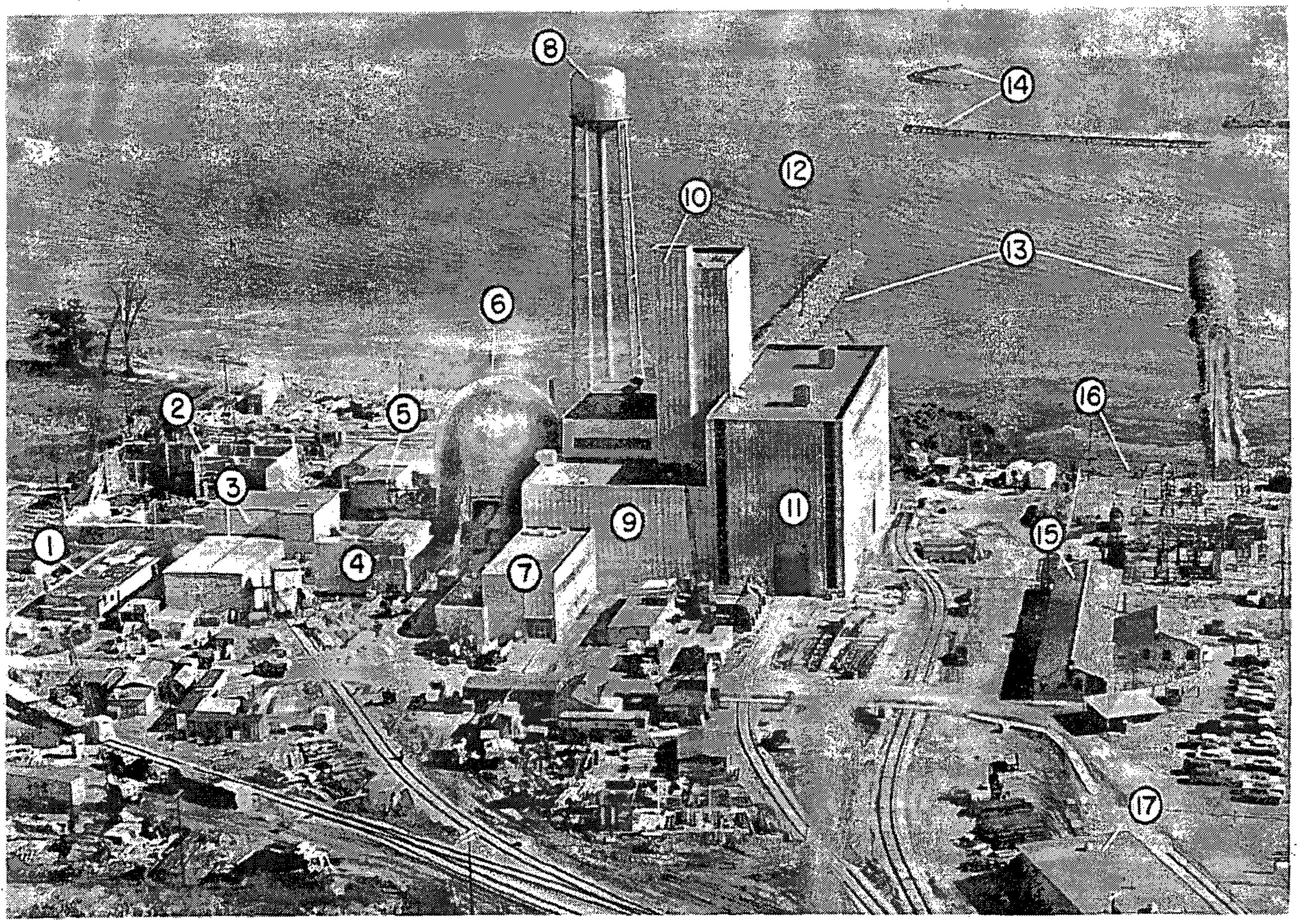
Figure 1
Enrico Fermi Unit 1



ENRICO FERMI ATOMIC POWER PLANT SITE

1. Health Physics Building
2. Fuel Element & Repair Building
3. Sodium Purification & Storage
4. Inert Gas Building
5. Ventilation Building
6. Reactor Containment Building
7. Plant Offices
8. Water Storage Tank
9. Control Center
10. Boiler House
11. Turbine-Generator Building
12. Lake Erie
13. Jetties for Condenser Water Intake
14. Dredging Equipment
15. Construction Offices
16. Electrical Switching Station
17. Atomic Information Center

Figure 2
7.5 Minute Quadrangle Map

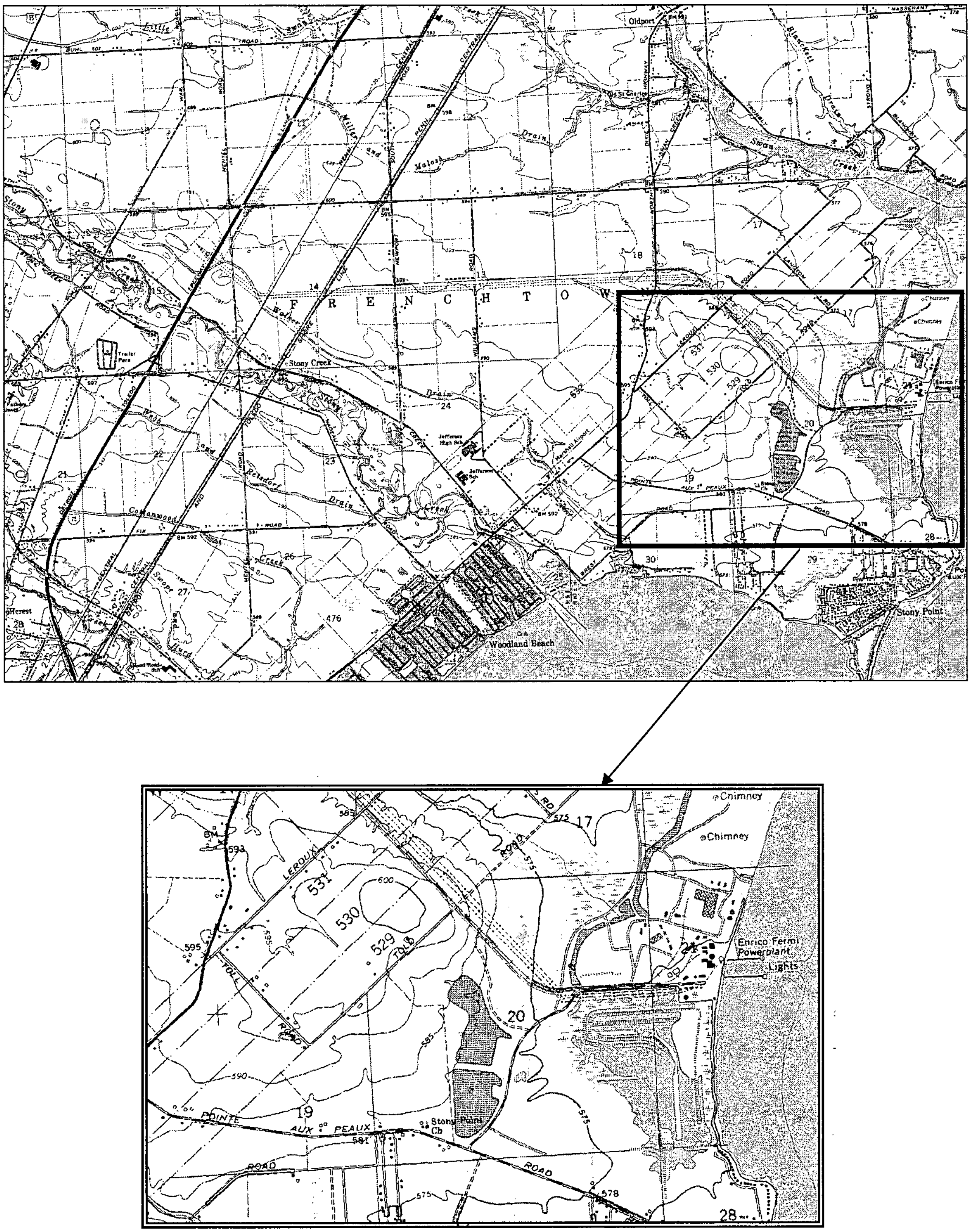


Figure 3
License Boundary

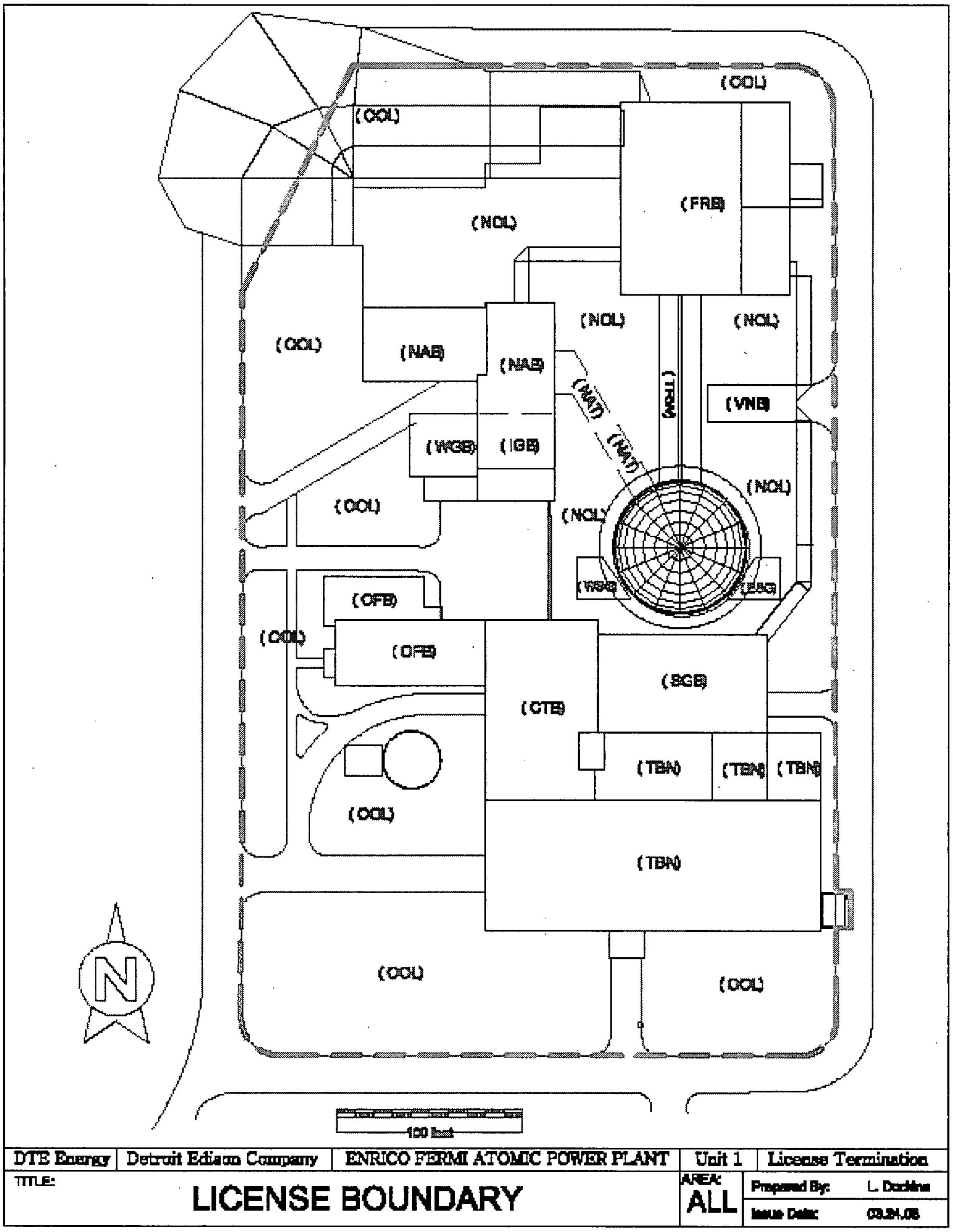


Figure 4
EF1 Survey Areas

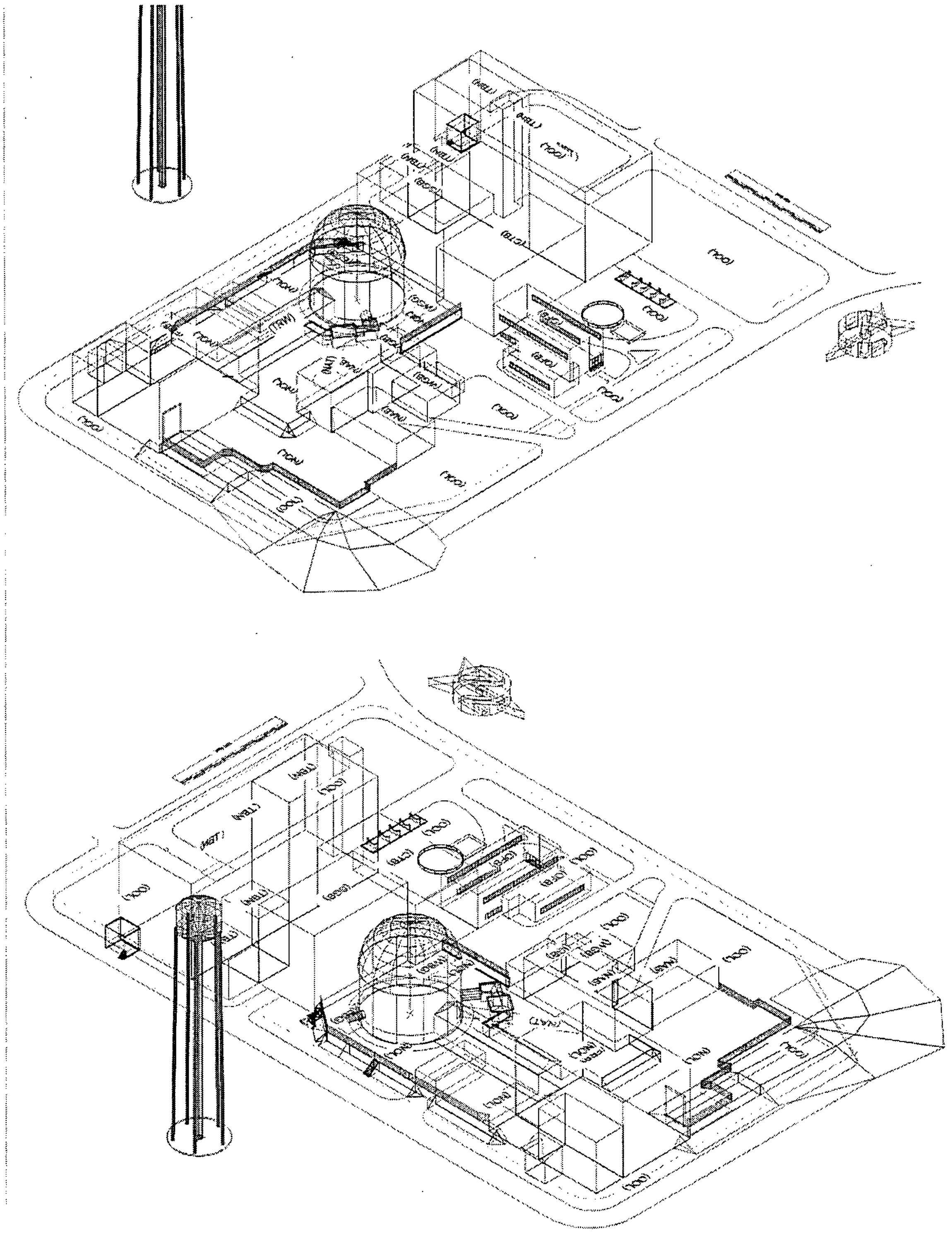
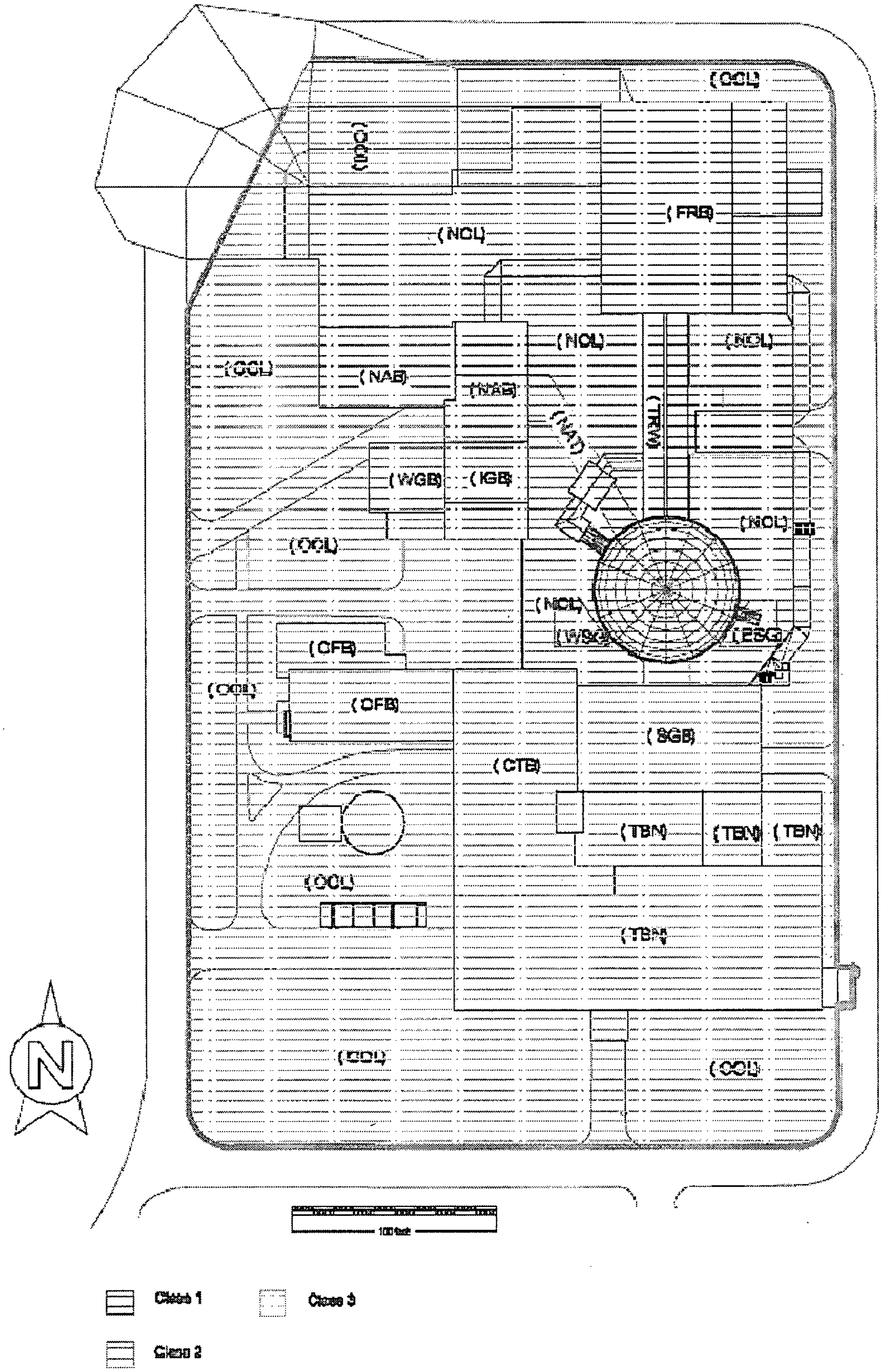


Figure 5
EF1 Classification Areas



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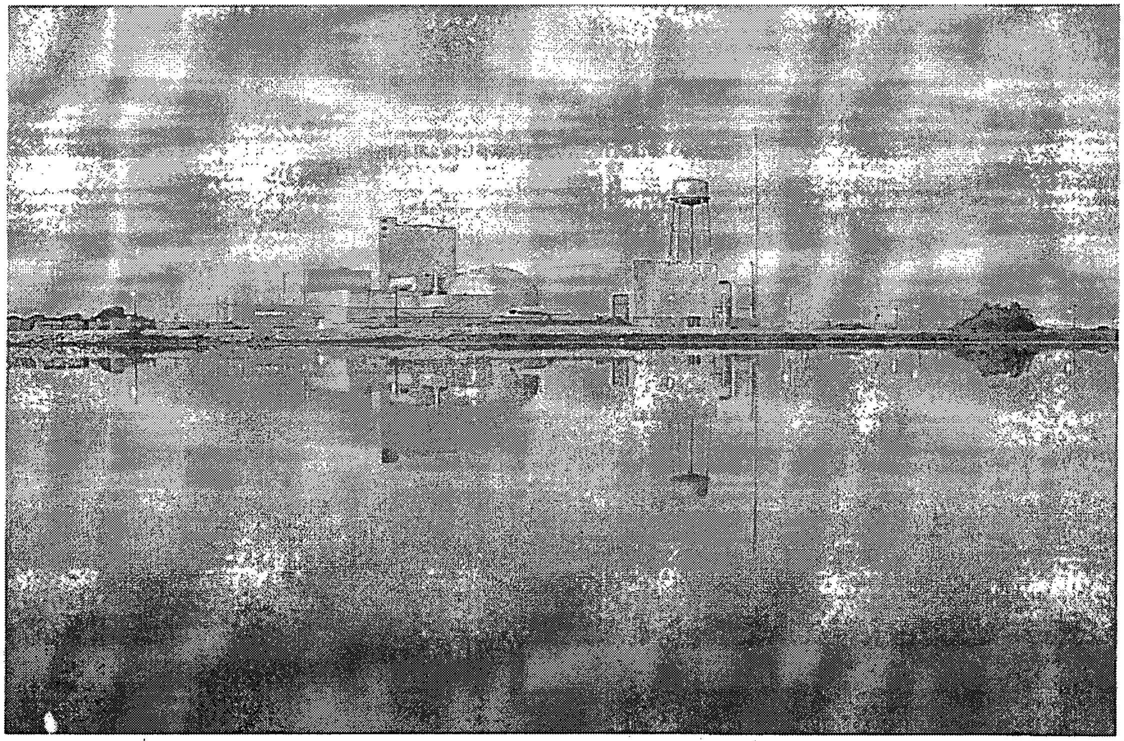
HISTORICAL SITE ASSESSMENT
VOLUME 2



DETROIT EDISON

Historical Site Assessment and Summary

Survey Area Name: Open Land Area Outside the Controlled Area Designator: **OOL-01**

Survey Area Description

Survey Area OOL-01 consists of the open land area outside the EF1 Controlled Area. Survey Area OOL-01 contains about 7478 square meters of surface area made up of soils, asphalt, gravel and concrete. An oily waste basin occupies a portion of OOL-01 and will be included as part of the survey area. A radwaste drain pipe lies below the surface in a portion of OOL-01. This drain pipe will be excavated. The excavation will be treated as a Class 1 area, based on the past history of the pipe. The backfilled excavation will be surveyed as a Class 3 area.

The outer perimeter of OOL-01 is bounded by Perimeter Road. The inner boundaries are NOL-01 and FRB-01 on the north, FRB-01, NOL-01, VNB-01, SGB-01 and TBN-01 on the east, TBN-01 and OFB-01 on the south and TBN-01, OFB-01, CTB-01, NOL-01, WGB-01 and NAB-01 on the west.

Subsurface systems that traverse or connect within OOL-01 include:

- Health Physics Building waste discharge
- Storm sewer systems
- Sanitary sewer system
- Water intake system
- General service water system
- Potable water system
- Fire protection water system
- Electrical duct banks
- FARB liquid discharge line

Items of note located within or adjacent to OOL-01 include:

- A portion of the onsite railroad spurs
- Oily waste collection basin and pump enclosure
- Concrete pad and walkway adjacent to the Turbine Building
- Asphalt driveways to the Turbine Building and the west yard
- Water treatment acid and caustic tank concrete pedestals

Survey Area Name: Open Land Area Outside the Controlled Area Designator: **OOL-01**

Survey Area History

Survey Area OOL-01 encompasses the primary travel path for personnel and equipment entering and leaving EF1.

Systems present in Survey Area OOL-01 that may contain residual radioactivity are the Health Physics/Chemistry Building waste discharge and the FARB liquid discharge line.

Survey area OOL-01 was not used for storing radioactive material or processing radioactive waste.

Contamination of survey area OOL-01 may have resulted from run-off of low levels of radioactive contamination present on the Controlled Area yard surface or from contaminated personnel, equipment, and material traffic. Contamination may have resulted as well from the failure of the Health Physics/Chemistry Building waste discharge line. The line was replaced and capped.

Events and activities that may have contaminated survey area OOL-01 include:

- Leak in the Health Physics/Chemistry Building waste discharge line (5/6/68).
- Transport of radwaste through the survey area.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Contaminated material transport within OOL-01 typically involved moving contaminated equipment and tools by vehicle to and from the FARB and west yard.

- Surface water run-off resulting from rain and snowmelt has the potential to transport surface contamination into storm drains and/or into in low areas where it would collect. Thus far, no samples have indicated the likelihood of this happening.

Site modifications performed within survey area OOL-01 include:

- The removal of the acid and caustic tanks.
- The removal of the transformer.
- The removal of the stack.
- Installation of Fermi 2 duct bank pumping controllers.
- Some out buildings have been removed over the life of the site.

Survey Area Name: Open Land Area Outside the Controlled Area Designator: **OOL-01**

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. Few soil samples were taken in this survey area and no samples taken were analyzed for Hard-to-Detect (HTD) radionuclides. Characterization plan EF1-CHAR-OOL-01 was implemented on June 23, 2008. Fifteen samples were collected with two split samples sent to an off-site lab to be analyzed for Hard-to-Detects. Split sample results, from the off-site lab indicate that no plant-related HTD radionuclides were present above the MDA.

Characterization plan EF1-CHAR-OOL-01-02 was implemented on September 30, 2008 at the two sites excavated (within the original OOL-01 footprint) in support of cable vaults. Split sample results, from the off-site lab indicate that no plant-related HTD radionuclides were present above the MDA. This characterization was performed to the rigors of a FSS and was designated CHAR-OOL-01-02 and the results are included in Table 1 below.

Table 1
OOL-01 Characterization Data

Location	Cs-137 (pCi/g)	Location	Cs-137 (pCi/g)
CHAR-OOL-01-001	0.18	CHAR-OOL-01-02-001	ND[1]
CHAR-OOL-01-002	0.45	CHAR-OOL-01-02-002	ND[1]
CHAR-OOL-01-003	ND[1]	CHAR-OOL-01-02-003	ND[1]
CHAR-OOL-01-004	0.38	CHAR-OOL-01-02-004	ND[1]
CHAR-OOL-01-005	0.09	CHAR-OOL-01-02-005	ND[1]
CHAR-OOL-01-006	ND[1]	CHAR-OOL-01-02-006	0.006
CHAR-OOL-01-007	0.13	CHAR-OOL-01-02-007	ND[1]
CHAR-OOL-01-008	0.06	CHAR-OOL-01-02-008	ND[1]
CHAR-OOL-01-009	0.13	CHAR-OOL-01-02-004-RC[2]	ND[1]
CHAR-OOL-01-010	ND[1]	CHAR-OOL-01-02-008-S[3]	ND[1]
CHAR-OOL-01-010-RC[2]	0.06		
CHAR-OOL-01-011	0.17		
CHAR-OOL-01-012	0.10		
CHAR-OOL-01-013	0.06		
CHAR-OOL-01-013-RC[2]	0.08		
CHAR-OOL-01-014	ND[1]		
CHAR-OOL-01-015	ND[1]		
CHAR-OOL-01-005-S[3]	0.14		
CHAR-OOL-01-008-S[3]	0.16		
Ct. Mean	0.16	**Ct. Mean**	0.006
Ct. Median	0.12	**Ct. Median**	0.006
Ct. Std. Dev.	0.13	**Ct. Std. Dev.**	N/A

[1] ND indicates no activity >MDA.
[2] RC indicates a QC recount.
[3] S indicates a Split sample sent to an offsite lab.

Survey Area Name: Open Land Area Outside the Controlled Area Designator: **OOL-01**

Decommissioning

Excavations have been performed inside the footprint of survey area OOL-01 to support cable vaults. These excavations have been sampled in accordance with characterization plan CHAR-OOL-01-02, and backfilled after work was completed.

Planned decommissioning activities for OOL-01 include excavation of the radwaste piping. All excavations will be sampled, remediated (if necessary) and backfilled.

Findings

Survey area OOL-01 is an open land area that is located outside the Controlled Area portion of the site and is shown in Figure 2 as the red hatched area.

Survey area OOL-01 is impacted and likely has radioactivity concentrations that are a very small fraction of the DCGL.

Results of the characterization sampling in OOL-01 indicate Cs-137 as the only plant-related nuclide present at levels 0.06 to 0.48 pCi/g. While there have been no studies in the general area of EF1 as to the Cs-137 levels due to fallout, Big Rock Point (BRP) performed a study in northern Michigan which would be reasonably representative of the levels found at EF1. As a result of the 2000 BRP study, Cs-137 average activity of 0.48 pCi/g to 0.54 pCi/g would be expected in Michigan. Adjusting the reported data for radioactive decay to 2008 results in current background values of 0.39 pCi/g to 0.44 pCi/g. The 0.48 pCi/g value is statistically within the log-normal standard deviation of the 2000 study (0.79 pCi/g).

Gamma scans indicated no elevated readings present in OOL-01.

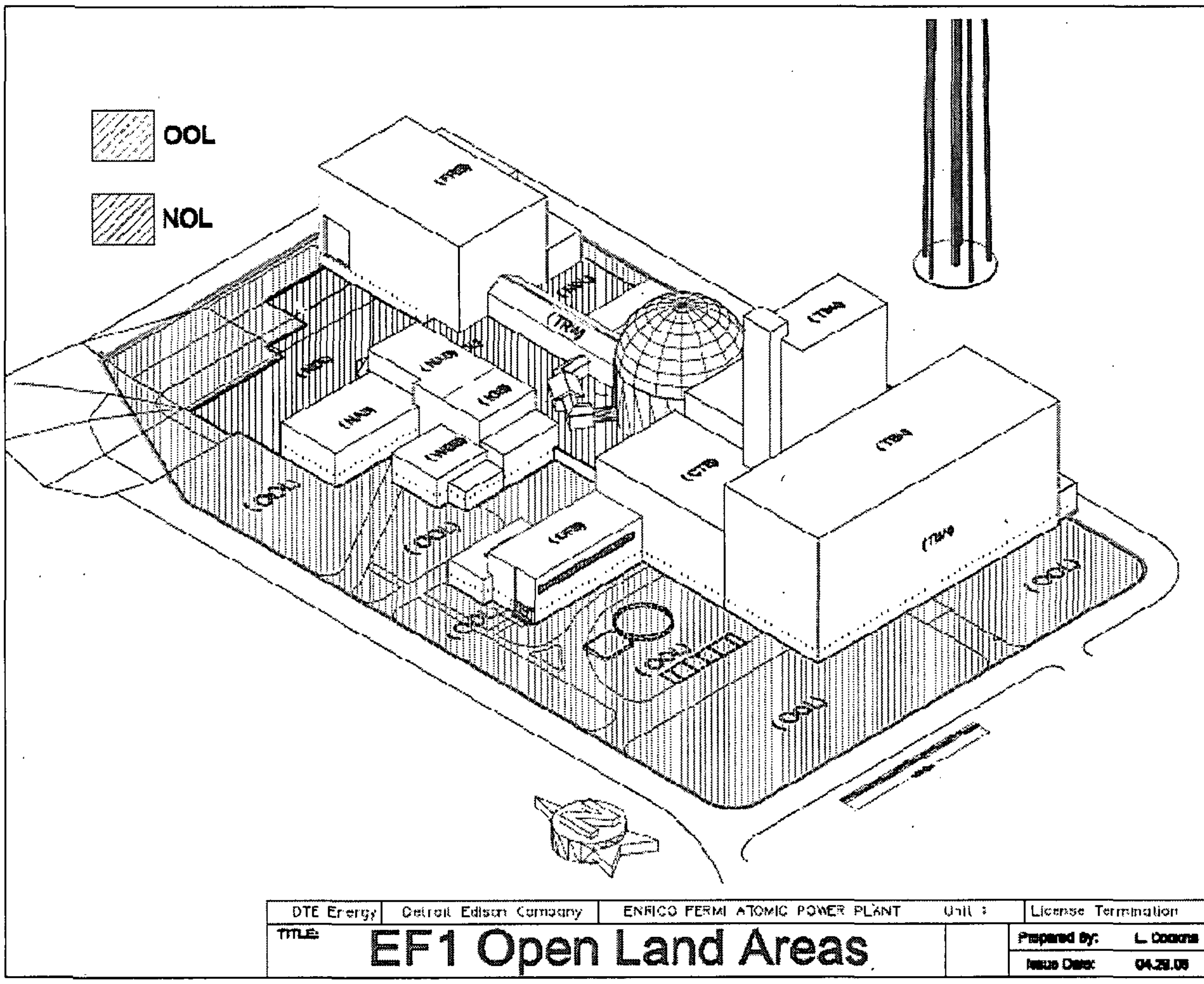
The radionuclide mix likely to be present in OOL-01 includes all radionuclides identified in NSEF -08-0018, "Radionuclide Selection for DCGL Development" (see Enclosure 1). Primary radionuclides of concern for survey area OOL-01 are Co-60, Cs-137, Sr-90 and H-3.

Classification Statement

Based upon the findings of materials reviewed, personnel interviews and of data acquired during characterization, the majority of OOL-01 is classified as a Class 3 area. The area of the excavation where the radwaste piping will be removed will be classified as a Class 1 area prior to backfilling.

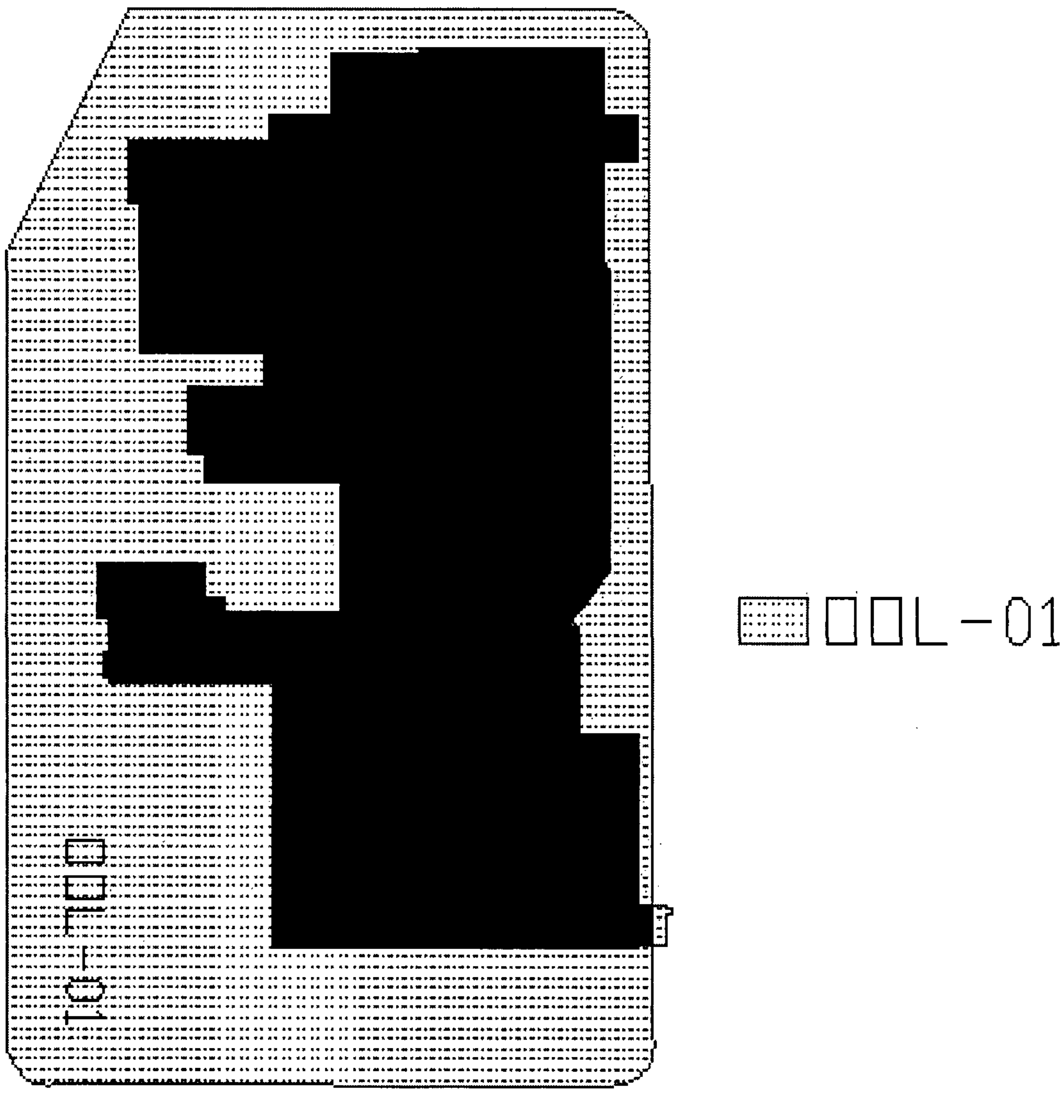
Survey Area Name: Open Land Area Outside the Controlled Area Designator: **OOL-01**

Figure 1
Open Land Areas



Survey Area Name: Open Land Area Outside the Controlled Area Designator: **OOL-01**

Figure 2
OOL-01 Survey Area



Survey Area Name: Open Land Area Inside the Controlled Area Designator: **NOL-01**

Survey Area Description

Survey Area NOL-01 consists of the open land area inside the EF1 Controlled Area. Survey Area NOL-01 contains about 2392 square meters of surface area made up of soils, asphalt, gravel and concrete.

NOL-01 is bounded by the FRB-01 and the Controlled Area fence on the east, the Controlled Area fence and OOL-01 on the northwest and west. FRB-01 forms part of the northern boundary. NAB-01 and IGB-01 form a portion of the western boundary. CTB-01 and SGB-01 forms the southern boundary. NOL-01 lies entirely within the open land Class 3 survey area OOL-01. Survey Area NOL-01 is designated a Class 2 area acting as a buffer between the Class 1 and Class 3 areas.

Subsurface systems that traverse or connect within NOL-01 include:

- Health Physics and Chemistry Building drain system
- Underground vent ducts
- Waste gas lines

Items of note located within or adjacent to NOL-01 include:

- A portion of the onsite railroad spur
- Asphalt driveways to the west yard and FARB
- Health Physics/Chemistry Building slab
- Below grade tank and piping from the Health Physics and Chemistry Building
- The Sodium Tunnel
- The Trestleway

Survey Area History

Survey Area NOL-01 represents the secondary travel path for personnel and equipment entering and leaving EF1.

Systems present in Survey Area NOL-01 that may contain residual radioactivity are the Health Physics/Chemistry building waste discharge and the FARB liquid discharge line.

Contamination of survey area NOL-01 may have resulted from traffic of contaminated personnel, equipment and material.

Events and activities that may have contaminated survey area NOL-01 include:

- Leak in Waste Gas drain line (8/01/67).
- Leak in Waste Gas discharge line (4/30/68).
- Fire in the Reactor Building Basement (5/20/08).

Survey Area Name: Open Land Area Inside the Controlled Area Designator: **NOL-01**

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Contaminated material transport within NOL-01 typically involved moving contaminated equipment and tools by vehicle to and from the FARB and through the west yard.

Site modifications performed within survey area NOL-01 include:

- Demolition of the Health Physics/Chemistry building (1980).
- Removed asbestos tile from the Health Physics/Chemistry building footprint.
- Addition of vestibule to the cold trap room

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. Few soil samples were taken in this survey area and no samples taken were analyzed for Hard-to-Detect radionuclides.

Characterization plan EF1-CHAR-NOL-01 was implemented on June 25, 2008. Seventeen samples were collected with two split samples sent to an off-site lab to be analyzed for Hard-to-Detects. Split sample results, from the off-site lab indicate that no plant-related HTD radionuclides were present above the MDA.

Table 2
NOL-01 Characterization Data

Location	Result (pCi/g)
CHAR-NOL-01-001	0.007
CHAR-NOL-01-002	0.007
CHAR-NOL-01-003	0.008
CHAR-NOL-01-004	ND[1]
CHAR-NOL-01-005	ND[1]
CHAR-NOL-01-006	ND[1]
CHAR-NOL-01-007	0.017
CHAR-NOL-01-008	0.019
CHAR-NOL-01-009	ND[1]
CHAR-NOL-01-010	ND[1]
CHAR-NOL-01-010-RC[2]	ND[1]
CHAR-NOL-01-011	0.014
CHAR-NOL-01-012	0.05
CHAR-NOL-01-013	0.14
CHAR-NOL-01-013-RC[2]	0.13
CHAR-NOL-01-014	ND[1]
CHAR-NOL-01-015	ND[1]

Table 2 (Cont'd)
NOL-01 Characterization Data

Location	Result (pCi/g)
CHAR-NOL-01-016	0.016
CHAR-NOL-01-017	ND[1]
CHAR-NOL-01-005-S[3]	ND[1]
CHAR-NOL-01-008-S[3]	0.24
Ct. Mean	0.06
Ct. Median	0.02
Ct. Std. Dev.	0.08

[1]ND indicates no activity >MDA.
[2] RC indicates a QC recount.
[3] S indicates a Split sample sent to an offsite lab.

Decommissioning

The Health Physics/Chemistry Building was removed – with the exception of a below grade tank and piping from the building drain system. The asbestos tile was removed from the Health Physics/Chemistry building footprint.

Planned decommissioning activities for NOL-01 include excavation and removal of underground components in the West Yard associated with the Health Physics/Chemistry building drain system.

Findings

Survey area NOL-01 is a land area that is located inside of the Controlled Area portion of the site and is shown in Figure 3.

Survey area NOL-01 is impacted and likely has radioactivity concentrations that are a very small fraction of the DCGL.

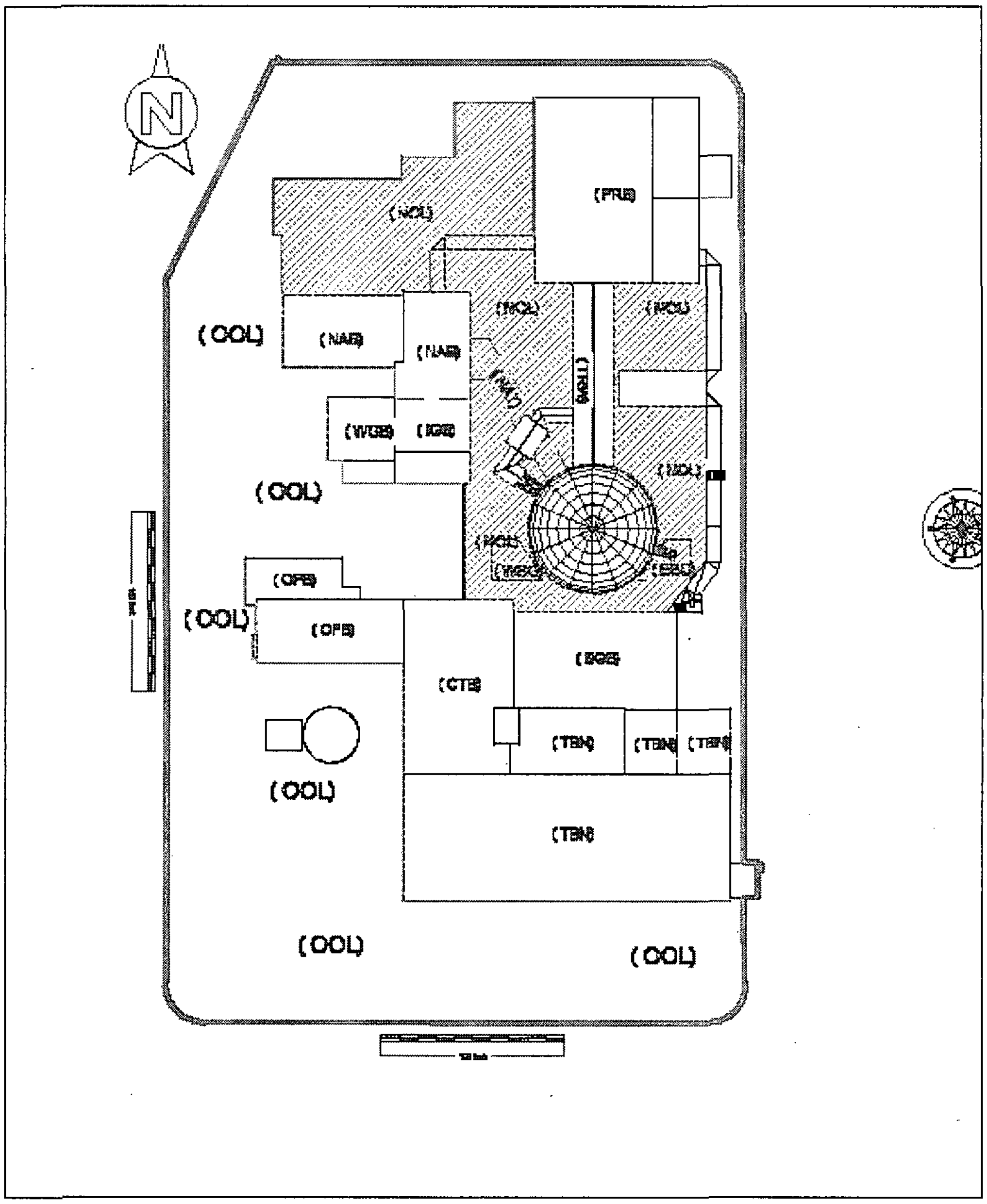
The radionuclide mix likely to be present in NOL-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area NOL-01 are Co-60, Cs-137, Sr-90 and H-3.

Classification Statement

Based upon the findings of materials reviewed, personnel interviews and of data acquired during characterization, the majority of NOL-01 is classified as a Class 2 area. The area of the excavation where the radwaste piping will be removed will be classified as a Class 1 area prior to backfilling.

Survey Area Name: Open Land Area Inside the Controlled Area Designator: **NOL-01**

Figure 3
NOL-01 Survey Area



Survey Area Name: Reactor Building Designator: **RXB-01**

Survey Area Description

Survey Area RXB-01 consists of the Reactor Building is a cylindrical vertical steel vessel, 72 feet in diameter and 120 feet high with the lower 51 feet below finished grade elevation. The inside of the Reactor Building is divided into two regions by a 5-foot thick steel and concrete operating floor. The above floor region is normally accessible to personnel and houses the containment crane. The below floor region housed the reactor vessel and internals, the primary shield tank, the secondary shield, the intermediate heat exchangers, primary sodium pumps, the decay tanks, the primary sodium overflow tank and associated equipment and piping for the primary and secondary sodium coolant systems. The Reactor Building is surrounded by an annulus, approximately 3 foot wide, located below floor level to a depth of about 3 feet below the concrete pedestal on which the steel Reactor Building stands. The annulus contains an access hole to the northwest sodium gallery and four floor drains that empty into a collection tank and sump pump system in the basement of the Steam Generator Building. During operation sealed areas within the reactor building consist of the lower level outside the Secondary Shield Wall and the lower level inside the Secondary Shield Wall. The area outside the Secondary Shield Wall is accessible via a manhole located on the northwest side of the Reactor Building floor near the overflow tank pumps. The area inside the Secondary Shield wall is accessible via a welded manhole cover on the Reactor Building floor, north-northwest of the primary shield tank. RXB-01 has a total floor surface area of 757 m^2.

Survey Area History

All of the areas within RXB-01 are equally likely to be contaminated as a result of work activities performed in the area as well as unplanned events.

The upper section of the Reactor Vessel has been removed of all the graphite blocks, "chinkers" and the Rotating Plug. The Reactor Vessel has undergone processing of the remaining residual sodium. The Reactor Vessel and primary loops have undergone processing of the remaining residual sodium. The primary sodium service system and some of the primary sodium piping have been removed. The fuel handling equipment has been removed. Some cables, cable trays and other electrical equipment have been removed. Asbestos insulation and heat tracing have been removed.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Reactor vessel and associated piping cut-up and removal.
- Transport of radioactive material associated with decommissioning of the Reactor building.
- Sodium fire that occurred on May 20th 2008 in the basement of the Reactor Building.

Survey Area Name: Reactor Building Designator: **RXB-01**

Site modifications performed within survey area RXB-01 include:

- Removal of the graphite blocks, "chinkers" and other pieces from the upper section of the Reactor Vessel.
- The Reactor Vessel and primary loops have undergone processing of the remaining residual sodium.
- The primary sodium service system and some piping have been removed.
- The fuel handling equipment has been removed.
- Some cables, cable trays and other electrical equipment have been removed.
- Asbestos insulation and heat tracing was removed.
- Additional accesses were made into the sealed areas in the lower level.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. Characterization plan EF1-RXB-01-01 was implemented on July 2, 2008. One pulverized concrete sample was collected from the Reactor Building basement on the inner annulus wall to a depth of 6 inches, and sent to an off-site lab for analysis of Easy-to-Detect and Hard-to-Detect radionuclides with the focus on Co-60, Cs-137, Sr-90 and H-3. Additional characterization was performed in September through October, of 2008 to include smears, scans and fixed-point measurements in RXB-01. Table 3 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background. There is much equipment removal to be done in the basement therefore the basement remains a Class 1 area. Characterization measurements will be made for FSS planning once the equipment removal is performed but the survey area will remain a Class 1 area for FSS.

Table 3
RXB-01-01 Characterization Data

Location	Result ($dpm/100cm^2$)	Location	Result ($dpm/100cm^2$)	Location	Result ($dpm/100cm^2$)
590' FLOOR		590' <6' WALLS		590' >6' WALLS	
CHAR-RXB-01-01-001-F-M	1220	CHAR-RXB-01-01-011-F-M	710	CHAR-RXB-01-01-021-F-M	666
CHAR-RXB-01-01-002-F-M	1183	CHAR-RXB-01-01-012-F-M	652	CHAR-RXB-01-01-022-F-M	888
CHAR-RXB-01-01-003-F-M	4081	CHAR-RXB-01-01-013-F-M	681	CHAR-RXB-01-01-023-F-M	779
CHAR-RXB-01-01-004-F-M	1289	CHAR-RXB-01-01-014-F-M	673	CHAR-RXB-01-01-024-F-M	724
CHAR-RXB-01-01-005-F-M	1027	CHAR-RXB-01-01-015-F-M	772	CHAR-RXB-01-01-025-F-M	703
CHAR-RXB-01-01-006-F-M	1776	CHAR-RXB-01-01-016-F-M	739	CHAR-RXB-01-01-026-F-M	848
CHAR-RXB-01-01-007-F-M	1434	CHAR-RXB-01-01-017-F-M	728	CHAR-RXB-01-01-027-F-M	954
CHAR-RXB-01-01-008-F-M	1387	CHAR-RXB-01-01-018-F-M	615	CHAR-RXB-01-01-028-F-M	841
CHAR-RXB-01-01-009-F-M	1249	CHAR-RXB-01-01-019-F-M	648	CHAR-RXB-01-01-029-F-M	863
CHAR-RXB-01-01-010-F-M	1354	CHAR-RXB-01-01-020-F-M	786	CHAR-RXB-01-01-030-F-M	866
				CHAR-RXB-01-01-031-F-M	732

Survey Area Name: Reactor Building Designator: **RXB-01**

Table 3 (Cont'd)
RXB-01-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
				CHAR-RXB-01-01-032-F-M	819
				CHAR-RXB-01-01-033-F-M	772
				CHAR-RXB-01-01-034-F-M	877
				CHAR-RXB-01-01-035-F-M	965
Mean Amb.	1038	**Mean Amb.**	1038	**Mean Amb.**	997
Ct. Mean	1627	**Ct. Mean**	700	**Ct. Mean**	820
Ct. Median	1289	**Ct. Median**	695	**Ct. Median**	841
Ct. Std. Dev.	943	**Ct. Std. Dev.**	56	**Ct. Std. Dev.**	89

F-M = Fixed measurement

Characterization plan EF1-RXB-01-02 was implemented on October 20, 2008 to survey the reactor building 552' elevation annulus. An ambient correction was achieved by taking shielded readings at five locations around the annulus and the Mean of those data was calculated. Table 4 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background.

Table 4
RXB-01-02 Characterization Data

Location	Result (dpm/100cm^2)
ANNULUS	
CHAR-RXB-01-02-001-F-M	1181
CHAR-RXB-01-02-002-F-M	476
CHAR-RXB-01-02-003-F-M	1218
CHAR-RXB-01-02-004-F-M	554
CHAR-RXB-01-02-005-F-M	1536
CHAR-RXB-01-02-006-F-M	1477
CHAR-RXB-01-02-007-F-M	1370
CHAR-RXB-01-02-008-F-M	1325
CHAR-RXB-01-02-009-F-M	631
CHAR-RXB-01-02-010-F-M	1037
CHAR-RXB-01-02-011-F-M	738
CHAR-RXB-01-02-012-F-M	620
CHAR-RXB-01-02-013-F-M	971
CHAR-RXB-01-02-014-F-M	568
CHAR-RXB-01-02-015-F-M	975
Mean Amb.	587

Location	Result (dpm/100cm^2)
Ct. Mean	978
Ct. Median	975
Ct. Std. Dev.	363

F-M = Fixed measurement

Survey Area Name: Reactor Building Designator: **RXB-01**

Decommissioning

Planned decommissioning activities for RXB-01 include:

- Removal of the Reactor Vessel and associated piping.
- Removal of the remainder of large components present in the Reactor Building.
- Removal of obstructions in the building to allow FSS.

Findings

Survey area RXB-01 is a structure located inside of the Radiological Restricted Area (RRA) portion of the site and is shown in Figure 4.

Survey area RXB-01 is impacted and likely has radioactivity concentrations that range from levels at, or above, the DCGL in the basement, floor areas and walls up to a height of six feet on the 590' level, and levels less than the DCGL on the walls above six feet and ceiling on the 590' elevation. The Annulus is not expected to contain levels of radioactivity above a small fraction of the DCGL.

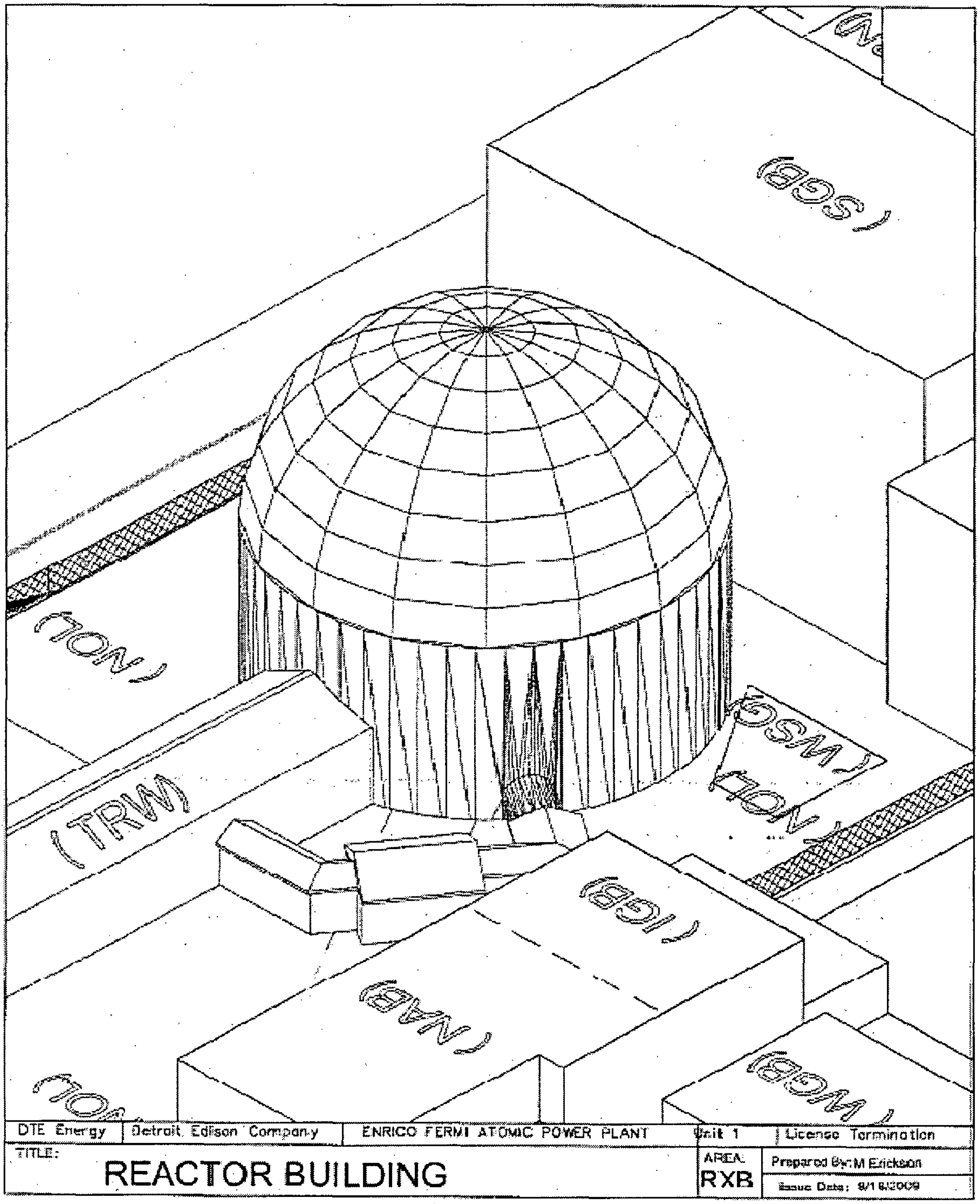
The radionuclide mix likely to be present in RXB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area RXB-01 are Co-60, Cs-137, Sr-90 and H-3.

As a result of historical information, decommissioning activities performed and planned, RXB-01 is classified as follows:

- The basement (including floors, walls and ceiling) is classified as a Class 1 Survey Area.
- The floor and the walls up to a height of six feet are classified as a Class 1 Survey Area.
- The walls above six feet and ceiling of the 590' elevation is classified as a Class 2 Survey Area.
- The Annulus is classified as a Class 3 Survey Area.

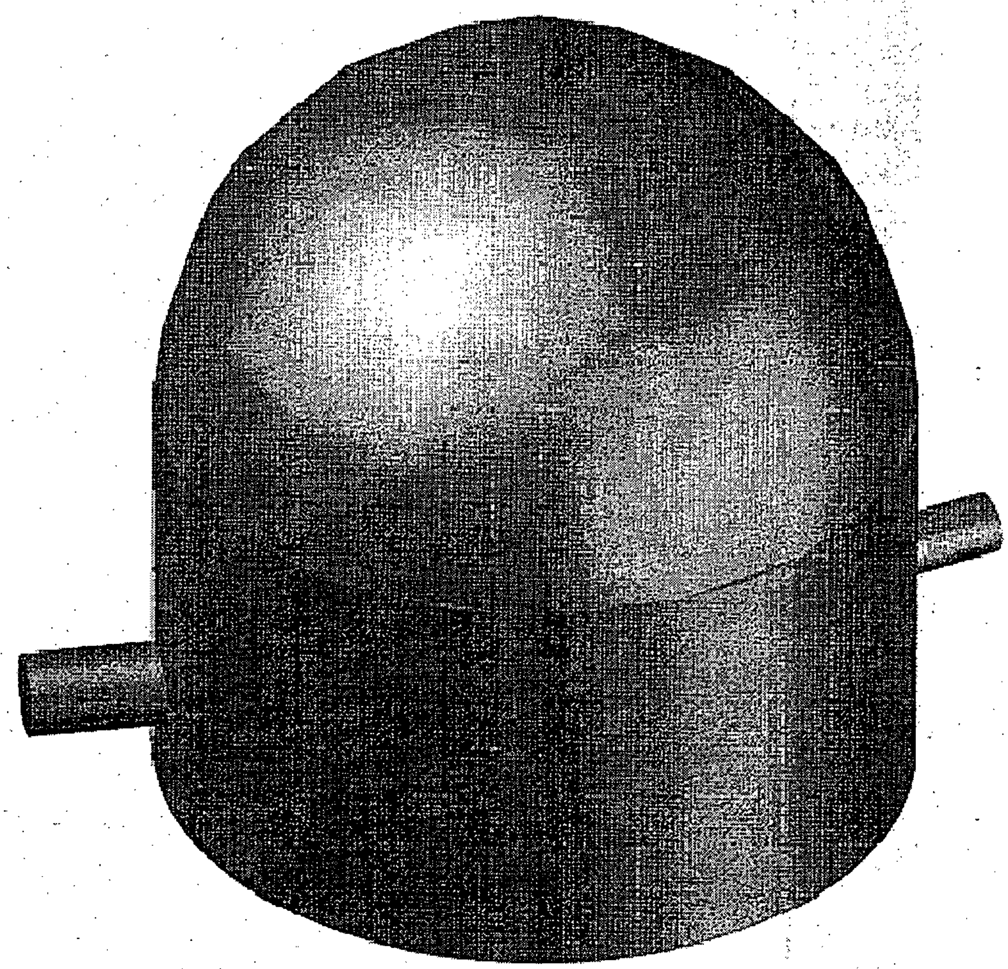
Survey Area Name: Reactor Building Designator: **RXB-01**

Figure 4
Survey Area RXB-01



Survey Area Name: Reactor Building Designator: **RXB-01**

Figure 5
Reactor Building



Survey Area Name: Fuel and Repair Building Designator: **FRB-01**

Survey Area Description

The FARB, located approximately 100 feet north of the Reactor Building, is connected to the Reactor Building by a covered transport car track (trestle). The substructure of the FARB consists of heavy reinforced concrete walls and rests on bedrock. The superstructure consists of two different types of construction. The walls above the operating floor in the new fuel receiving and storage area and the irradiated fuel decay and cut-up pool areas are reinforced concrete. All other superstructure walls consist of structural steel with corrugated asbestos siding.

The FARB contained process cells, water-filled decay and cut-up pools, a new fuel handling and storage area, a central control room for fuel handling and waste system operations, a 75-ton crane, and a transport car access area for the performance of fuel handling functions. Space was provided for a repair and cleaning facility for maintenance of contaminated equipment. The fuel transport machine, or cask car, unloaded irradiated fuel from the reactor via the transfer rotor, transported the irradiated fuel in finned pots from the Reactor Building to the FARB via the trestle and unloaded the pots into the transfer tank rotor. The pot was transferred to a position under a steam cleaning machine that removed the fuel from the pot and positioned the fuel so that the sodium was cleaned from the subassembly by steaming, followed by a water rinse using an automatically programmed cycle. The subassembly was then placed in a container in the cut-up pool, tested for fission product leakage, and transferred to the decay pool for a decay period of approximately 180 days per design before further processing.

The FARB contained a cold trap system (purification system) for the transfer tank sodium in a separate substructure room diagonally adjacent to the fuel transfer tank room. The sodium lines and equipment were shrouded in a welded carbon steel secondary structure, which was inert with nitrogen. The piping outside the walled areas was in the repair pit area and was contained in a concrete vault with a removable cover slab.

Survey Area History

All of the areas within FRB-01 are equally likely to be contaminated as a result of work activities performed in the area as well as unplanned events.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Transport of radioactive material associated with decommissioning of the FARB and adjacent buildings.
- Sodium fire that occurred on May 20, 2008 in the basement of the Reactor Building.

Site modifications performed within survey area FRB-01 include:

Survey Area Name: Fuel and Repair Building Designator: **FRB-01**

- Removal of the Radwaste Control panels.
- Removal of the Transfer Tank.
- Asbestos insulation abatement.
- Ventilation system equipment removal.
- Removal of fuel storage racks.
- Removal of FARB cold-trap heat exchange equipment.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization effort was performed in September, 2008 to include smears, scans and fixed-point measurements in FRB-01. An ambient correction was achieved by taking shielded readings at five locations on each level and the Mean of those data was calculated. Table 5 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background.

Table 5
FRB-01 Characterization Data

Location	**Result ($dpm/100cm^2$)**	**Location**	**Result ($dpm/100cm^2$)**
MAINTENANCE PIT		590' <6' FLOORS AND WALLS	
CHAR-FRB-01-001-F-M	1242	CHAR-FRB-01-016-F-M	2514
CHAR-FRB-01-002-F-M	5176	CHAR-FRB-01-017-F-M	2092
CHAR-FRB-01-003-F-M	1213	CHAR-FRB-01-018-F-M	2765
CHAR-FRB-01-004-F-M	1922	CHAR-FRB-01-019-F-M	1457
CHAR-FRB-01-005-F-M	1224	CHAR-FRB-01-020-F-M	1738
CHAR-FRB-01-006-F-M	2237	CHAR-FRB-01-021-F-M	1549
CHAR-FRB-01-007-F-M	1250	CHAR-FRB-01-022-F-M	2200
CHAR-FRB-01-008-F-M	2007	CHAR-FRB-01-023-F-M	1604
CHAR-FRB-01-009-F-M	1294	CHAR-FRB-01-024-F-M	1619
CHAR-FRB-01-010-F-M	1575	CHAR-FRB-01-025-F-M	1497
CHAR-FRB-01-011-F-M	1105	CHAR-FRB-01-026-F-M	1227
CHAR-FRB-01-012-F-M	1471	CHAR-FRB-01-027-F-M	1738
CHAR-FRB-01-013-F-M	1131	CHAR-FRB-01-028-F-M	1357
CHAR-FRB-01-014-F-M	1416	CHAR-FRB-01-029-F-M	1815
CHAR-FRB-01-015-F-M	1057	CHAR-FRB-01-030-F-M	4913
Mean Amb.	703	**Mean Amb.**	1942
Ct. Mean	1688	**Ct. Mean**	2006
Ct. Median	1294	**Ct. Median**	1738
Ct. Std. Dev.	1028	**Ct. Std. Dev.**	911

F-M = Fixed measurement

Survey Area Name: Fuel and Repair Building Designator: **FRB-01**

Table 5 (Cont'd)
FRB-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
MEZZANINE		590' >6' WALLS	
CHAR-FRB-01-031-F-M	2240	CHAR-FRB-01-046-F-M	1442
CHAR-FRB-01-032-F-M	2603	CHAR-FRB-01-047-F-M	1475
CHAR-FRB-01-033-F-M	2961	CHAR-FRB-01-048-F-M	2044
CHAR-FRB-01-034-F-M	2366	CHAR-FRB-01-049-F-M	1797
CHAR-FRB-01-035-F-M	2218	CHAR-FRB-01-050-F-M	1564
CHAR-FRB-01-036-F-M	1678	CHAR-FRB-01-051-F-M	1553
CHAR-FRB-01-037-F-M	2129	CHAR-FRB-01-052-F-M	2787
CHAR-FRB-01-038-F-M	2266	CHAR-FRB-01-053-F-M	2407
CHAR-FRB-01-039-F-M	3482	CHAR-FRB-01-054-F-M	4577
CHAR-FRB-01-040-F-M	2152	CHAR-FRB-01-055-F-M	3128
CHAR-FRB-01-041-F-M	3409	CHAR-FRB-01-056-F-M	1220
CHAR-FRB-01-042-F-M	5967	CHAR-FRB-01-057-F-M	1464
CHAR-FRB-01-043-F-M	3538	CHAR-FRB-01-058-F-M	1800
CHAR-FRB-01-044-F-M	2580	CHAR-FRB-01-059-F-M	1349
CHAR-FRB-01-045-F-M	2052	CHAR-FRB-01-060-F-M	1379
Mean Amb.	2247	**Mean Amb.**	1942
Ct. Mean	2828	**Ct. Mean**	1999
Ct. Median	2473	**Ct. Median**	1564
Ct. Std. Dev.	1066	**Ct. Std. Dev.**	905

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for FRB-01 include:

- Removal of the various tanks contained within the building and associated piping.
- Removal of the Decay Pool and Cutup Pool liners.
- Removal of obstructions in the building to allow FSS.

Findings

Survey area FRB-01 is a structure located inside of the Controlled Area and is shown in Figure 6.

Survey area FRB-01 is impacted and likely has radioactivity concentrations that range from levels at, or above, the DCGL on the floor areas and walls up to a height of six feet and levels less than the DCGL on the walls above six feet and ceiling.

Survey Area Name: Fuel and Repair Building Designator: **FRB-01**

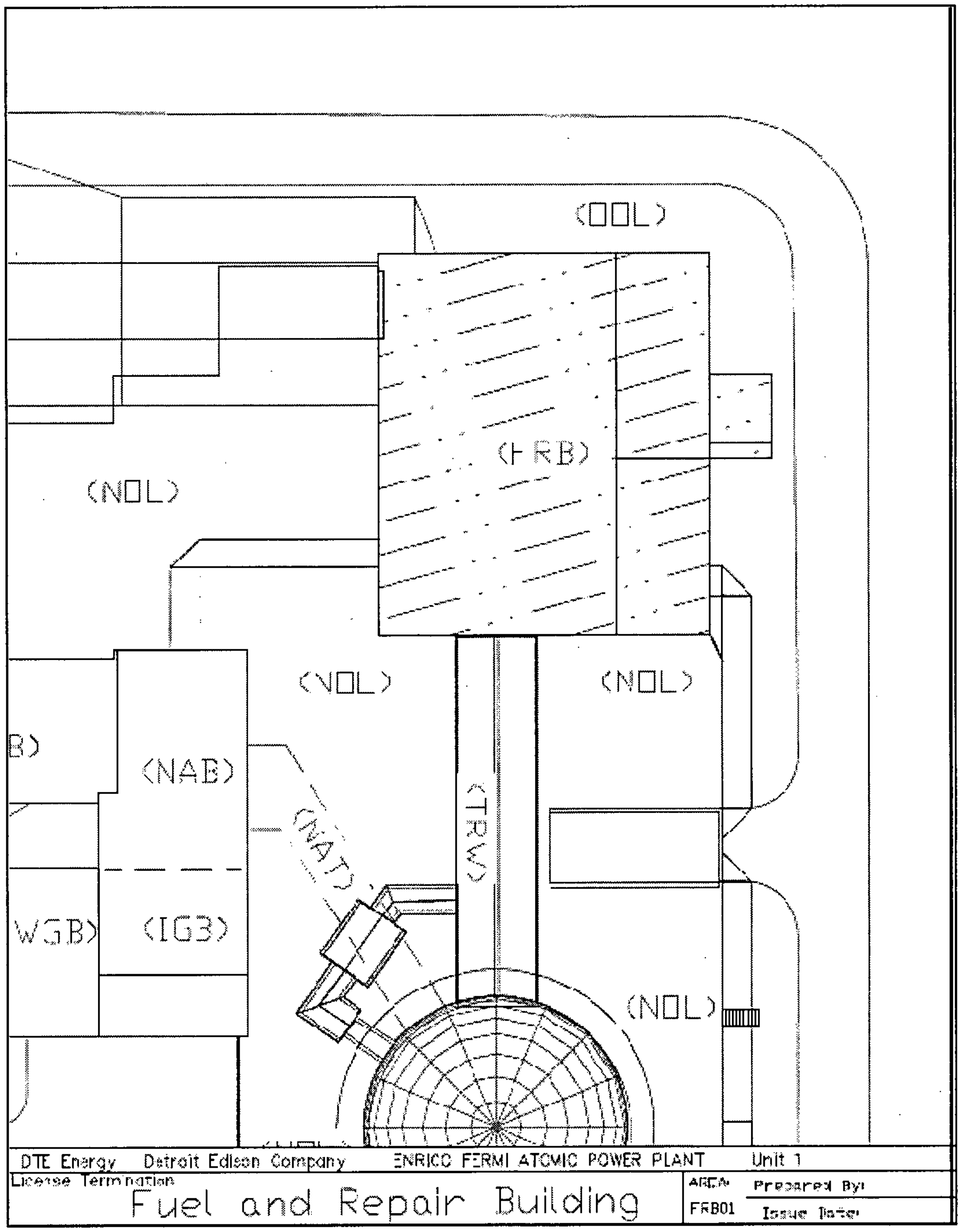
The radionuclide mix likely to be present in FRB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area FRB-01 are Co-60, Cs-137, Sr-90 and H-3.

As a result of historical information, decommissioning activities performed and planned, FRB-01 is classified as follows:

- The floor and the walls up to a height of six feet are classified as a Class 1 Survey Area.
- The walls above six feet and ceiling are classified as a Class 2 Survey Area.
- As obstructions, cut-up and decay pools, etc. are removed, exposed walls will be characterized and classified in accordance with NUREG-1575.

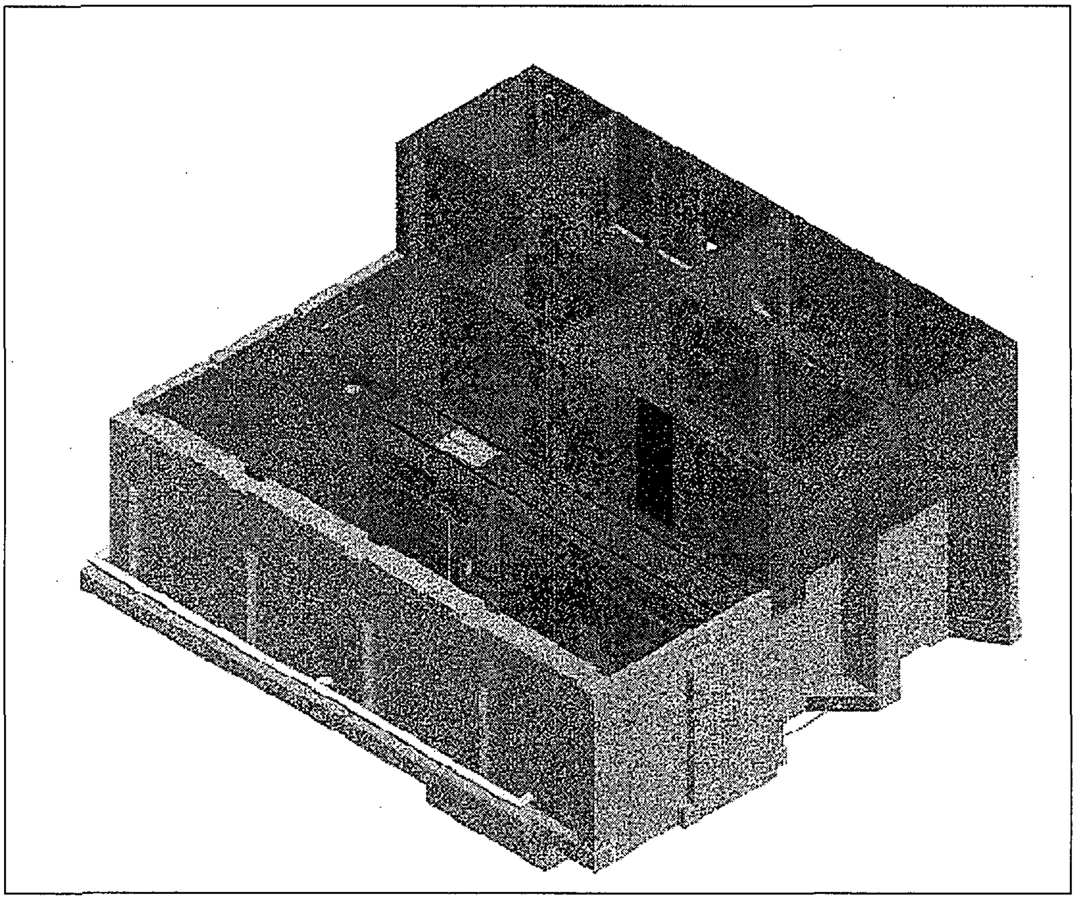
Survey Area Name: Fuel and Repair Building Designator: **FRB-01**

Figure 6
Survey Area FRB-01



Survey Area Name: Fuel and Repair Building Designator: **FRB-01**

Figure 7
Interior of FARB



Survey Area Name: Trestle way Designator: **TRW-01**

Survey Area Description

The trestleway is located to the north and adjacent to the Reactor Building and functioned as a connection between the Reactor Building and the FARB. The substructure consists of reinforced concrete. The superstructure consists of structural steel with corrugated asbestos siding and a corrugated steel roof. The fuel transport machine, or cask car, unloaded irradiated fuel from the reactor via the transfer rotor, transported the irradiated fuel in finned pots from the Reactor Building to the FARB via the trestleway and unloaded the pots into the transfer tank rotor.

Survey Area History

All of the areas within TRW-01 are equally likely to be contaminated as a result of work activities performed in the area as well as unplanned events.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Transport of radioactive material associated with decommissioning of the Trestleway and adjacent buildings.
- Sodium fire that occurred on May 20th 2008 in the basement of the Reactor Building.

Site modifications performed within survey area TRW-01 include:

- A section of the roof was repaired and the addition of wooden doors from the Trestleway into the yard.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization effort was implemented on September 15, 2008 to include smears, scans and fixed-point measurements in TRW-01. An ambient correction was achieved by taking shielded readings at five locations in the Trestleway, and the Mean of those data was calculated. Table 6 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas (with the exception of the FARB side of the trestle way around LSA boxes) as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background. There is a section of the TWR-01 where there is contamination that is painted over. This section will require the paint removed and that area surveyed.

Survey Area Name: Trestle way Designator: **TRW-01**

Table 6
TRW-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
CHAR-TRW-01-001-F-M	2200	CHAR-TRW-01-013-F-M	1704
CHAR-TRW-01-002-F-M	2041	CHAR-TRW-01-014-F-M	1194
CHAR-TRW-01-003-F-M	1686	CHAR-TRW-01-015-F-M	1264
CHAR-TRW-01-004-F-M	2377	CHAR-TRW-01-016-F-M	1198
CHAR-TRW-01-005-F-M	1970	CHAR-TRW-01-017-F-M	1220
CHAR-TRW-01-006-F-M	1985	CHAR-TRW-01-018-F-M	1290
CHAR-TRW-01-007-F-M	1749	CHAR-TRW-01-019-F-M	1420
CHAR-TRW-01-008-F-M	1689	CHAR-TRW-01-020-F-M	1449
CHAR-TRW-01-009-F-M	2092	CHAR-TRW-01-021-F-M	1257
CHAR-TRW-01-010-F-M	1985	CHAR-TRW-01-022-F-M	1542
CHAR-TRW-01-011-F-M	2285	CHAR-TRW-01-023-F-M	2004
CHAR-TRW-01-012-F-M	2540	CHAR-TRW-01-024-F-M	3438
		Mean Amb.	1652
		Ct. Mean	1816
		Ct. Median	1726
		Ct. Std. Dev.	532

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for TRW-01 include:

- Removal of obstructions in the building to allow FSS.
- Decontamination, as necessary.

Findings

Survey area TRW-01 is a structure located inside of the RRA portion of the site and is shown in Figure 8.

Survey area TRW-01 is impacted and likely has radioactivity concentrations that range from levels at, or above, the DCGL in the floor areas and walls up to a height of six feet, and levels less than the DCGL on the walls above six feet and on the ceiling.

The radionuclide mix likely to be present in TRW-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area TRW-01 are Co-60, Cs-137, Sr-90 and H-3.

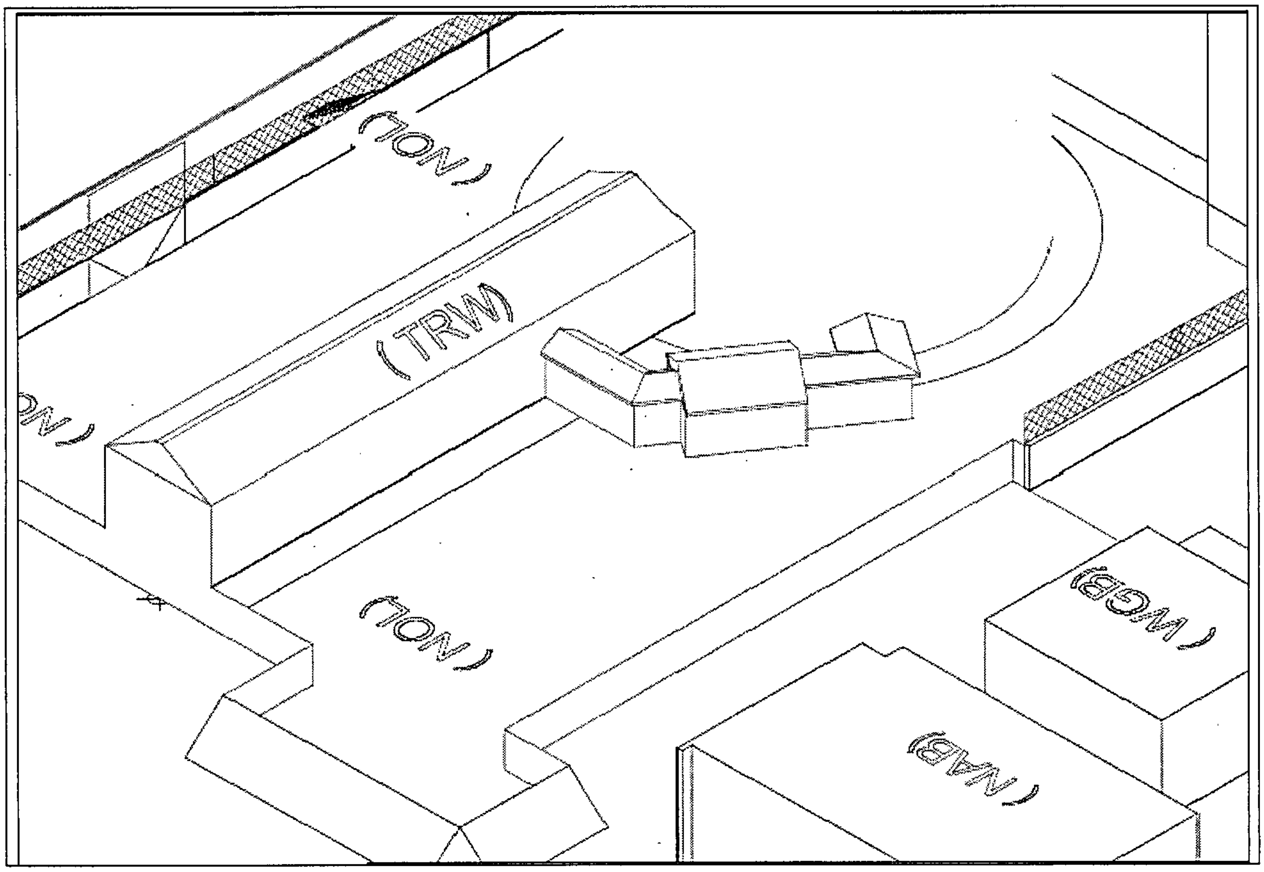
Survey Area Name: Trestleway Designator: **TRW-01**

As a result of historical information, decommissioning activities performed and planned, TRW-01 is classified as follows:

- The floor and the walls up to a height of six feet are classified as a Class 1 Survey Area.
- The walls above six feet and ceiling are classified as a Class 2 Survey Area.

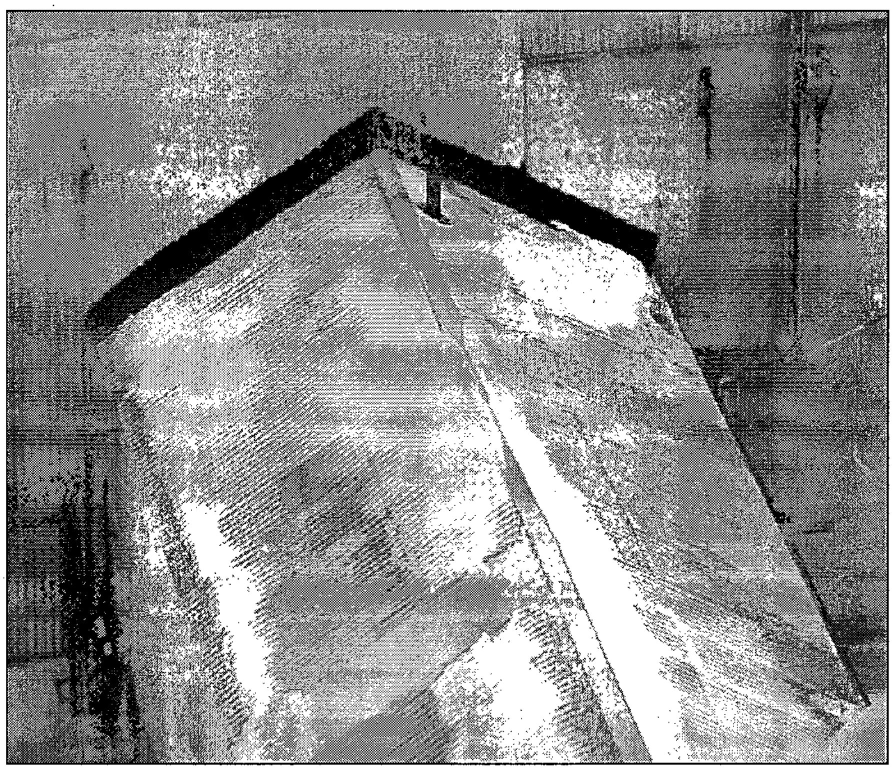
Survey Area Name: Trestleway Designator: **TRW-01**

Figure 8
Survey Area TRW-01



Survey Area Name: Trestleway Designator: **TRW-01**

Figure 9
Roof and Exterior of TRW-01



Survey Area Name: Sodium Building Designator: **NAB-01**

Survey Area Description

The Sodium Building is adjacent to the Reactor Building and is connected by an underground concrete tunnel. The Sodium Building housed the equipment used for storing and purifying the primary sodium. The Sodium Building, Waste Gas Building and the Inert Gas Building form one structural complex. The building is divided into four sections:

1. The primary sodium storage tank room is a concrete structure comprised of 30 inch thick cast concrete walls and a 30 inch thick combination pre-cast and poured concrete roof. The room contains the three 15,000 gallon primary sodium storage tanks.

2. The cold trap room has 6-foot thick external concrete walls as well as a 6-foot thick concrete ceiling. Additionally, the cell has a 4-foot thick internal wall separating it from the storage tank room. This room contained the equipment necessary to determine and maintain the purity of the primary sodium.

3. The sodium-potassium (NaK) room is comprised of reinforced concrete floor, walls and ceiling and access is provided via a steel door located in the west wall of the room and stairway on the east side. The NaK room contained the ventilation equipment and the air-to-NaK heat exchanger equipment for the cold trap.

4. The valve control room occupies the second story region of the Sodium Building and is constructed of concrete block walls and a steel roof deck structure. The valve control room contained the sodium service hand wheels and motors for the valves, electric panels supporting the induction heating for the piping, and the control panel.

Survey Area History

All of the areas within NAB-01 are equally likely to be contaminated as a result of work activities performed in the area. The cold trap room is used to process sodium and is controlled as a contaminated area.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Transport of radioactive material associated with decommissioning of the Sodium Building.
- Processing activities performed in the cold trap room.

Survey Area Name: Sodium Building Designator: **NAB-01**

Site modifications performed within survey area NAB-01 include:

- A sodium processing chamber was installed in the cold trap room.
- A vestibule was installed at the entrance to the cold trap room.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization effort was implemented on September 23, 2008 to include smears, scans and fixed-point measurements in NAB-01. An ambient correction was achieved by taking shielded readings at five locations in each room and the Mean of those data was calculated. Tables 7 and 8 represent the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background.

Because of ambient levels associated with the sodium storage tanks, scan surveys were not performed in the tank room at the time of the characterization survey.

Table 7
NAB-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
TANK ROOM		NaK ROOM		VALVE ROOM	
CHAR-NAB-01-001-F-M	1560	CHAR-NAB-01-021-F-M	2022	CHAR-NAB-01-041-F-M	1878
CHAR-NAB-01-002-F-M	5128	CHAR-NAB-01-022-F-M	3039	CHAR-NAB-01-042-F-M	1642
CHAR-NAB-01-003-F-M	4765	CHAR-NAB-01-023-F-M	1527	CHAR-NAB-01-043-F-M	1806
CHAR-NAB-01-004-F-M	5937	CHAR-NAB-01-024-F-M	1815	CHAR-NAB-01-044-F-M	1787
CHAR-NAB-01-005-F-M	4333	CHAR-NAB-01-025-F-M	1353	CHAR-NAB-01-045-F-M	1744
CHAR-NAB-01-006-F-M	17420	CHAR-NAB-01-026-F-M	1372	CHAR-NAB-01-046-F-M	1649
CHAR-NAB-01-007-F-M	9231	CHAR-NAB-01-027-F-M	2011	CHAR-NAB-01-047-F-M	1613
CHAR-NAB-01-008-F-M	22980	CHAR-NAB-01-028-F-M	2462	CHAR-NAB-01-048-F-M	1791
CHAR-NAB-01-009-F-M	7542	CHAR-NAB-01-029-F-M	1431	CHAR-NAB-01-049-F-M	1715
CHAR-NAB-01-010-F-M	13338	CHAR-NAB-01-030-F-M	1305	CHAR-NAB-01-050-F-M	1791
CHAR-NAB-01-011-F-M	6743	CHAR-NAB-01-031-F-M	1150	CHAR-NAB-01-051-F-M	1835
CHAR-NAB-01-012-F-M	19926	CHAR-NAB-01-032-F-M	1726	CHAR-NAB-01-052-F-M	1671
CHAR-NAB-01-013-F-M	7054	CHAR-NAB-01-033-F-M	1342	CHAR-NAB-01-053-F-M	1249
CHAR-NAB-01-014-F-M	11567	CHAR-NAB-01-034-F-M	1501	CHAR-NAB-01-054-F-M	1376
CHAR-NAB-01-015-F-M	7645	CHAR-NAB-01-035-F-M	1394	CHAR-NAB-01-055-F-M	1383
CHAR-NAB-01-016-F-M	15789	CHAR-NAB-01-036-F-M	1238	CHAR-NAB-01-056-F-M	1220
CHAR-NAB-01-017-F-M	7675	CHAR-NAB-01-037-F-M	1327	CHAR-NAB-01-057-F-M	1260
CHAR-NAB-01-018-F-M	19490	CHAR-NAB-01-038-F-M	1900	CHAR-NAB-01-058-F-M	979

Survey Area Name: Sodium Building Designator: **NAB-01**

Table 7 (Cont'd)
NAB-01 Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
TANK ROOM		NaK ROOM		VALVE ROOM	
CHAR-NAB-01-019-F-M	5634	CHAR-NAB-01-039-F-M	1394	CHAR-NAB-01-059-F-M	1325
CHAR-NAB-01-020-F-M	5590	CHAR-NAB-01-040-F-M	1601	CHAR-NAB-01-060-F-M	1624
Mean Amb.	6266	**Mean Amb.**	1150	**Mean Amb.**	1206
Ct. Mean	9967	**Ct. Mean**	1645	**Ct. Mean**	1567
Ct. Median	7593	**Ct. Median**	1466	**Ct. Median**	1645
Ct. Std. Dev.	6094	**Ct. Std. Dev.**	463	**Ct. Std. Dev.**	256

Table 8
NAB-01 Characterization Data (Mezzanine)

Location	Result (dpm/100cm²)
MEZZANINE	
CHAR-NAB-01-061-F-M	1494
CHAR-NAB-01-062-F-M	1623
CHAR-NAB-01-063-F-M	1512
CHAR-NAB-01-064-F-M	1482
CHAR-NAB-01-065-F-M	1516
CHAR-NAB-01-066-F-M	1538
CHAR-NAB-01-067-F-M	1346
CHAR-NAB-01-068-F-M	1312
CHAR-NAB-01-069-F-M	1438
CHAR-NAB-01-070-F-M	1305
Mean Amb.	972
Ct. Mean	1457
Ct. Median	1488
Ct. Std. Dev.	105

F-M = Fixed measurement

The cold trap room is posted as contaminated. There are still several tasks associated with the equipment removal in this room; therefore the cold trap room remains a Class 1 area. Additional survey data will be taken in this room once the components have been removed and remediation is performed.

Decommissioning

Planned decommissioning activities for NAB-01 include:

- Removal of obstructions in the building to allow FSS.
- Remediation of contaminated portions of concrete.
- Removal of piping.

Survey Area Name: Sodium Building Designator: **NAB-01**

- Removal of storage tanks.
- Removal of the Reaction Chamber and associated piping.

Findings

Survey area NAB-01 is a structure located inside of the Controlled Area and is shown in Figure 10. Survey area NAB-01 is impacted and likely has radioactivity concentrations that range from levels at, or above, the DCGL in the cold trap room and levels below the DCGL in the other rooms.

The radionuclide mix likely to be present in NAB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area NAB-01 are Co-60, Cs-137, Sr-90 and H-3.

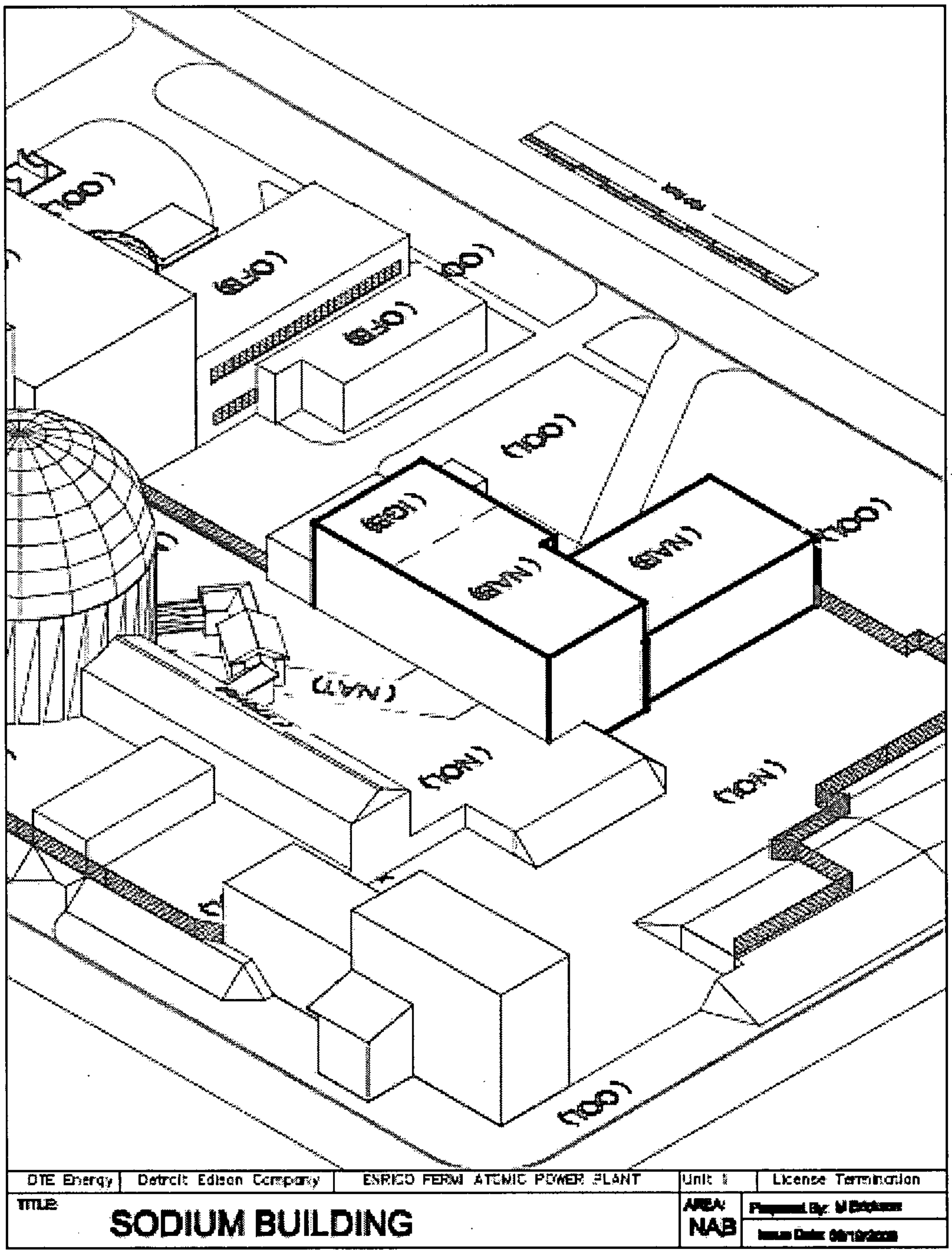
As a result of historical information, decommissioning activities performed and planned, NAB-01 is classified as follows:

- Cold trap room is a Class 1 Survey Area including the floor and up to six feet on the walls.
- All other areas are classified as Class 2 areas.

Survey Area Name: Sodium Building Designator: **NAB-01**

Figure 10

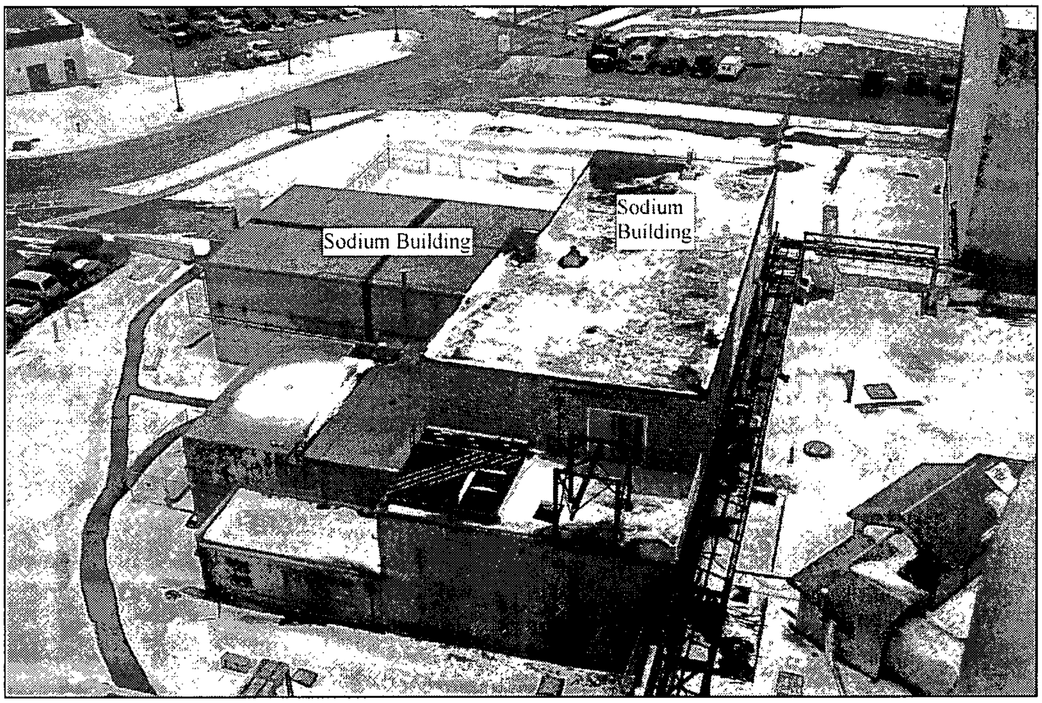
Survey Area NAB-01

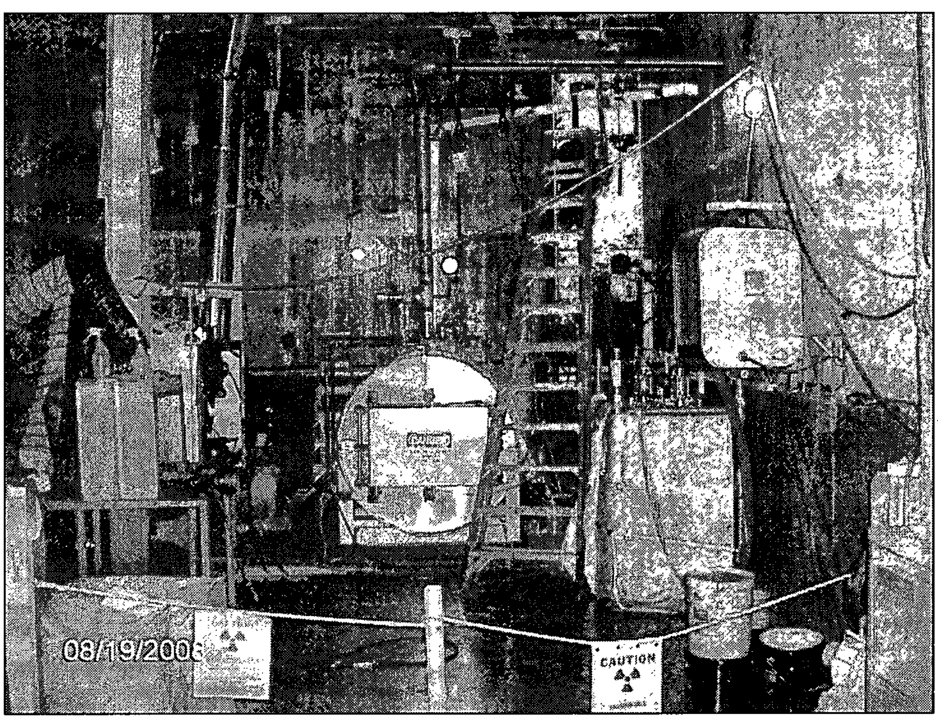


Survey Area Name: Sodium Building Designator: **NAB-01**

Figure 11

Exterior of NAB-01 and Reaction Chamber





Survey Area Name: Ventilation Building Designator: **VNB-01**

Survey Area Description

The Ventilation Building consists of a steel reinforced concrete floor with concrete block walls. The roof consists of a structural steel framework covered by corrugated steel. The Ventilation Building housed equipment for the Reactor Building Ventilation System including the supply and exhaust blowers, valves for water supply to the under floor cooling heat exchangers, a control panel, Freon refrigeration equipment for above floor cooling, and space for future equipment additions, such as dehumidifiers. The restricted area fence has been modified to extend past the east doors of the building.

Survey Area History

During plant operation the building was not used for handling of radioactive materials, therefore no shielding was provided for the structure. Subsequent demolition activities resulted in the removal of all equipment and piping as well as the plugging of the floor drains. The building is currently used for the storage of miscellaneous materials and equipment, some of which are internally contaminated.

All of the areas within VNB-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys and events.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Transport of radioactive material associated with decommissioning of the adjoining structures.
- Sodium fire that occurred on May 20, 2008 in the basement of the Reactor Building.

Site modifications performed within survey area VNB-01 include:

- Removal of all the ventilation components contained within the building.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization effort was implemented on September 16, 2008 to include smears, scans and fixed-point measurements in VNB-01. An ambient correction was achieved by taking shielded readings at five locations within the survey area and the Mean of those data was calculated. Table 9 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated greater than background.

Survey Area Name: Ventilation Building Designator: **VNB-01**

Table 9
VNB-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
CHAR-VNB-01-001-F-M	1471	CHAR-VNB-01-011-F-M	1142
CHAR-VNB-01-002-F-M	1098	CHAR-VNB-01-012-F-M	1431
CHAR-VNB-01-003-F-M	1712	CHAR-VNB-01-013-F-M	1778
CHAR-VNB-01-004-F-M	1357	CHAR-VNB-01-014-F-M	1527
CHAR-VNB-01-005-F-M	1494	CHAR-VNB-01-015-F-M	1187
CHAR-VNB-01-006-F-M	1290	CHAR-VNB-01-016-F-M	1268
CHAR-VNB-01-007-F-M	1235	CHAR-VNB-01-017-F-M	1120
CHAR-VNB-01-008-F-M	1109	CHAR-VNB-01-018-F-M	1616
CHAR-VNB-01-009-F-M	1471	CHAR-VNB-01-019-F-M	1445
CHAR-VNB-01-010-F-M	1165	CHAR-VNB-01-020-F-M	1401
		Mean Amb.	1130
		Ct. Mean	1366
		Ct. Median	1379
		Ct. Std. Dev.	203

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for VNB-01 include:

- Any obstructions within survey area VNB-01 will be removed to allow Final Status Surveys.

Findings

Survey area VNB-01 is a structure located inside of the RRA portion of the site and is shown in Figure 12. Survey area VNB-01 is impacted and likely has radioactivity concentrations that range from levels at, or above, the DCGL in the floor areas and walls up to a height of six feet, and levels less than the DCGL on the walls above six feet and ceiling.

The radionuclide mix likely to be present in VNB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area VNB-01 are Co-60, Cs-137, Sr-90 and H-3.

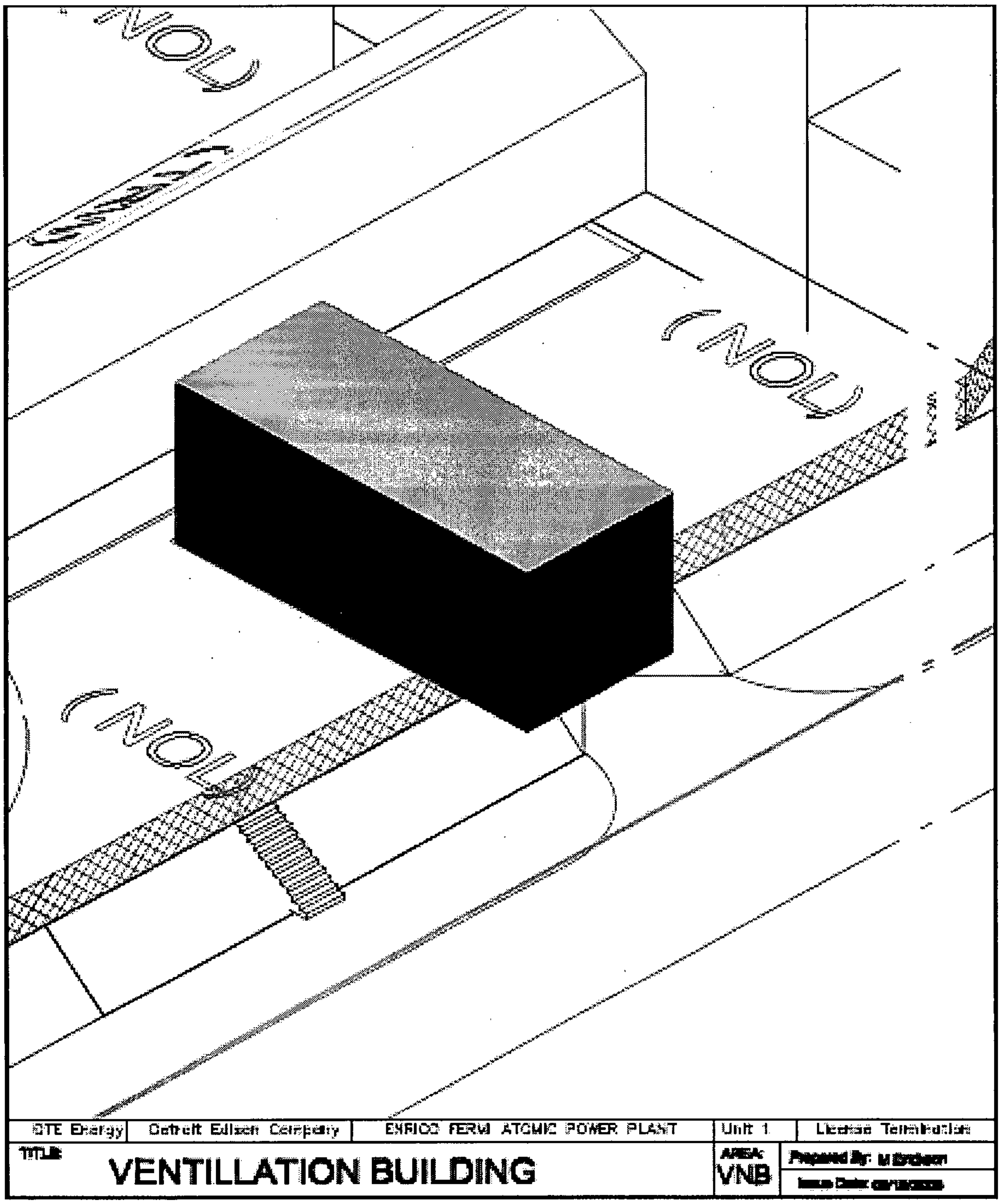
As a result of historical information, decommissioning activities performed and planned, VNB-01 is classified as follows:

- The floor and the walls up to a height of six feet are classified as a Class 1 Survey Area.
- The walls above six feet and ceiling are classified as a Class 2 Survey Area.

Survey Area Name: Ventilation Building Designator: **VNB-01**

Figure 12

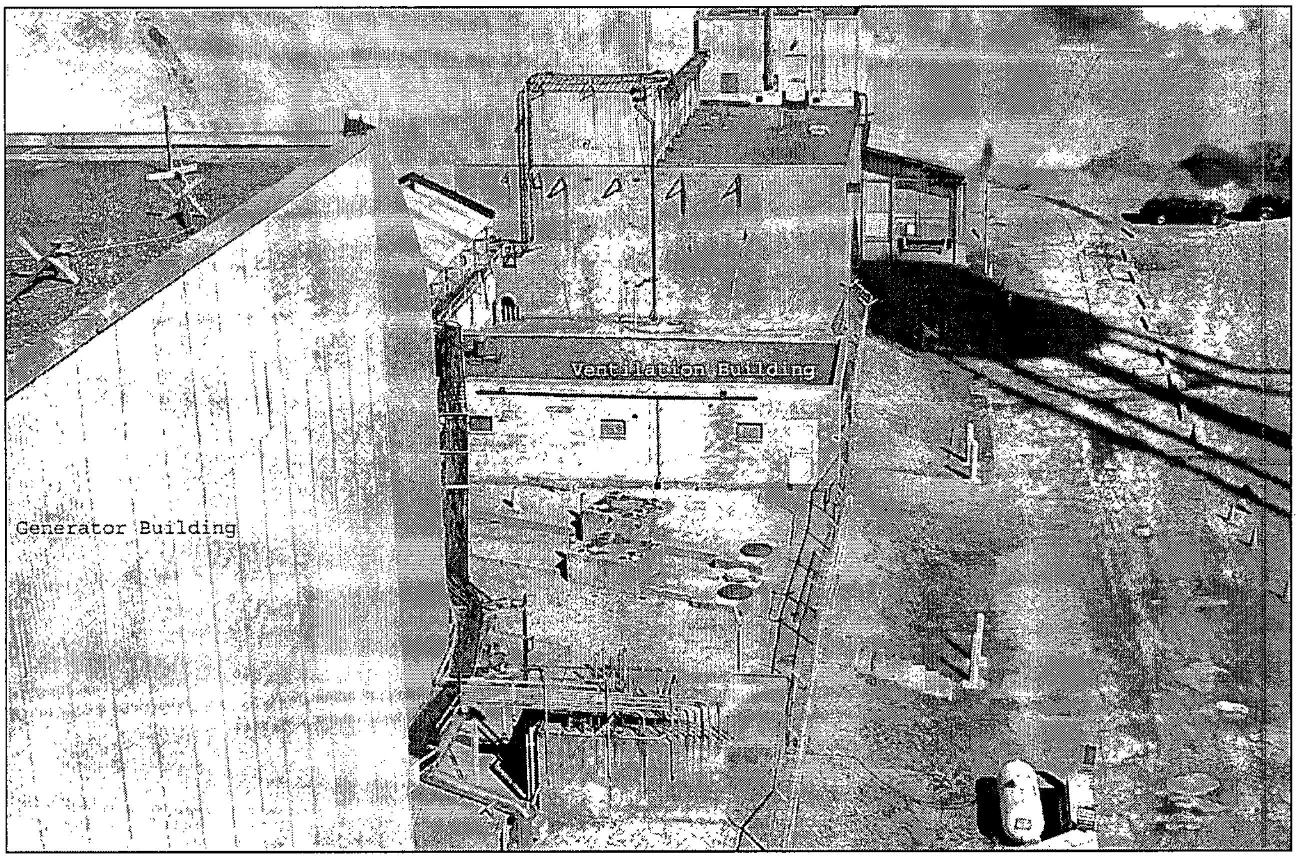
Survey Area VNB-01



Survey Area Name: Ventilation Building Designator: **VNB-01**

Figure 13

Exterior of VNB-01



Survey Area Name: Sodium Tunnel Designator: **NAT-01**

Survey Area Description

The Sodium Tunnel consists of a subsurface reinforced concrete structure lined with a ¼" thick carbon steel plate. The tunnel runs from the northwest corner of the Reactor Building annulus to the Cold Trap Room of the Sodium Building. The structure contained some of the primary sodium service system piping and was heated by a 60 cycle induction heating system replacing heat losses when the piping was at 400 degrees Fahrenheit with a 100 degree Fahrenheit ambient temperature. Access to this tunnel is via one of two manholes located between the Cold Trap Room and the Trestleway.

Survey Area History

All of the areas within NAT-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Any contamination encountered during the removal of piping within NAT-01.

Site modifications performed within survey area NAT-01 include:

- Removed the interior wall.
- Reacted sodium residues in the piping.
- Performed asbestos abatement and removed some of the shield pipe before sodium residue cleaning.
- The installed piping is now used to transfer contaminated liquid between the Reactor Building and the Sodium Building.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization effort was implemented in October 6, 2008 to include smears, scans and fixed-point measurements in NAT-01. An ambient correction was achieved by taking shielded readings at five locations in the sodium tunnel and the Mean of those data was calculated. Table 10 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. No gamma scans were performed during characterization due to obstructions present in the survey area.

Survey Area Name: Sodium Tunnel Designator: **NAT-01**

Table 10
NAT-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
CHAR-NAT-01-001-F-M	2754	CHAR-NAT-01-011-F-M	5423
CHAR-NAT-01-002-F-M	1616	CHAR-NAT-01-012-F-M	4255
CHAR-NAT-01-003-F-M	1641	CHAR-NAT-01-013-F-M	4721
CHAR-NAT-01-004-F-M	1116	CHAR-NAT-01-014-F-M	2030
CHAR-NAT-01-005-F-M	898	CHAR-NAT-01-015-F-M	3508
CHAR-NAT-01-006-F-M	643	CHAR-NAT-01-016-F-M	2033
CHAR-NAT-01-007-F-M	2281	CHAR-NAT-01-017-F-M	3804
CHAR-NAT-01-008-F-M	3619	CHAR-NAT-01-018-F-M	1782
CHAR-NAT-01-009-F-M	2643	CHAR-NAT-01-019-F-M	3538
CHAR-NAT-01-010-F-M	1641	CHAR-NAT-01-020-F-M	1885
		Mean Amb.	3030
		Ct. Mean	2592
		Ct. Median	2157
		Ct. Std. Dev.	1320

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for NAT-01 include:

- The removal of all piping within the sodium tunnel.

Findings

Survey area NAT-01 is a structure located inside the Controlled Area and is shown in Figure 16.

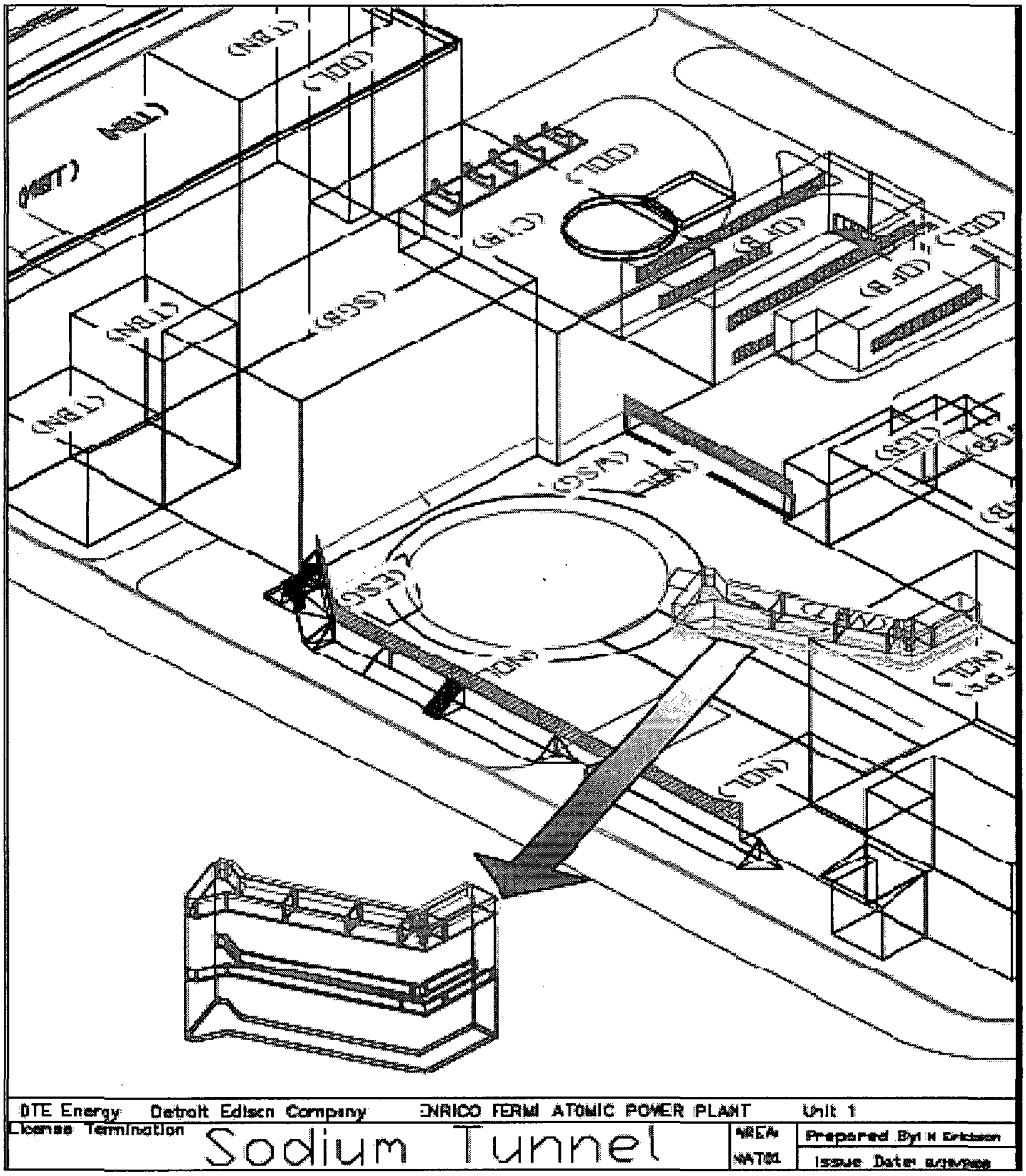
Survey area NAT-01 is impacted and likely has radioactivity concentrations less than the DCGL. The radionuclide mix likely to be present in NAT-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area NAT-01 are Co-60, Cs-137, Sr-90 and H-3.

As a result of historical information, decommissioning activities performed and planned, NAT-01 is classified as a Class 2 Survey Area.

Survey Area Name: Sodium Tunnel Designator: **NAT-01**

Figure 14

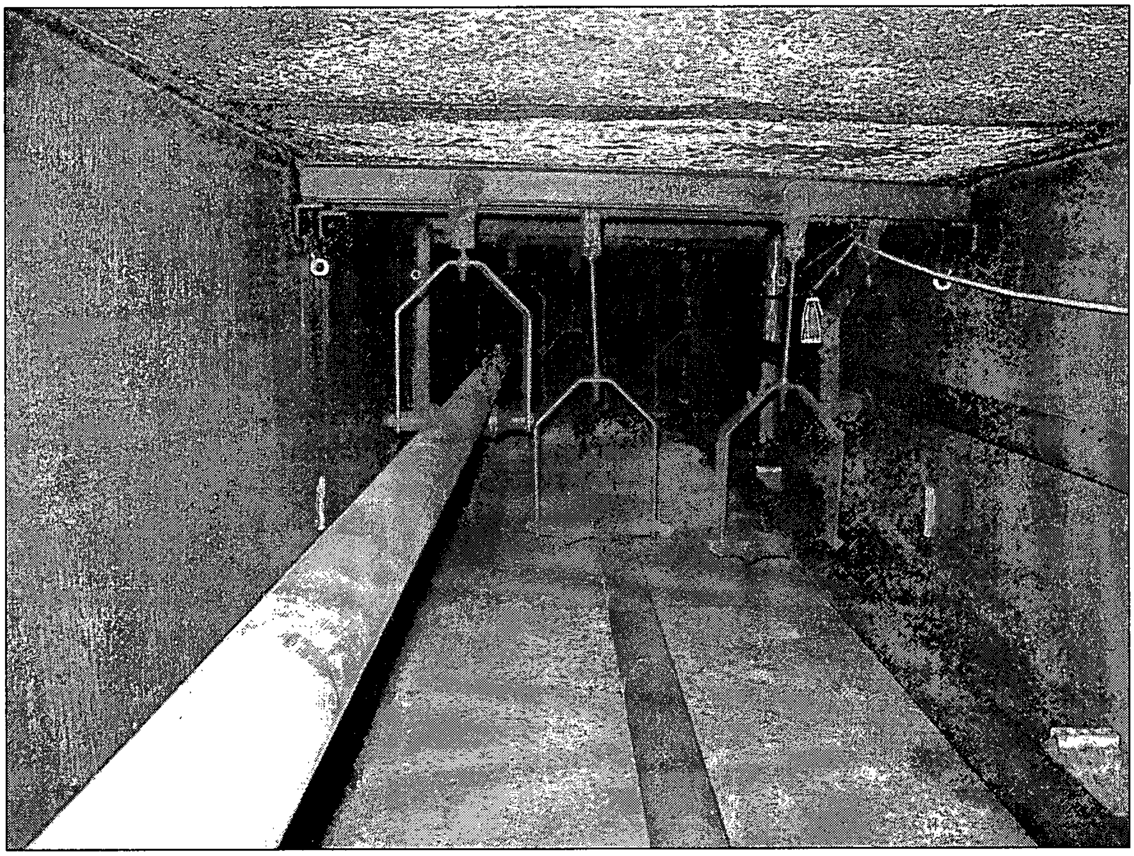
Survey Area NAT-01



Survey Area Name: Sodium Tunnel Designator: **NAT-01**

Figure 15

Sodium Tunnel Interior



Survey Area Name: East Sodium Gallery Designator: **ESG-01**

Survey Area Description

The east sodium gallery consists of three chambers (North, Center and South) which held the secondary sodium lines. Access to the three east sodium gallery chambers is via horizontal steel doors just above ground level. The east sodium gallery's walls and base slab are of conventional reinforced concrete construction resting on concrete filled pilasters. The roof is constructed of an 8 inch thick precast concrete slab covered with a 10 inch thick concrete layer all of which is beneath approximately 5 feet of earth. Included in this area is the Fission Product Detector (FPD) Building. The FPD building is located due east of the reactor building, directly above the East Sodium gallery (north chamber). This is a small partially buried room; a portion of it below ground level, which contained the gaseous fission product detector and piping. Access to the FPD building is through a manhole in the roof of the building. The building is constructed of steel reinforced concrete.

Survey Area History

The east gallery supplied the No. 1 and 2 steam generators. The gaseous FPD monitored the fission product concentration to detect the failure of a fuel element. The FPD received primary argon cover gas samples from the reactor vessel and the No. 1 and No. 3 primary pump tanks. All of the areas within ESG-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Any contamination encountered during the removal of piping within ESG-01.

Site modifications performed within survey area ESG-01 include:

- Removed the FPD vapor trap and associated equipment.
- Removed part of the piping in the FPD building.
- Performed asbestos abatement.
- The secondary sodium piping has been rinsed to remove residual caustic.
- The secondary sodium piping was cut at the Reactor Building and the sodium gallery ends during the original decommissioning, and plates were welded over both ends.
- Portions of the interior walls between the chambers were removed.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization effort was implemented on October 13, 2008 to include smears, scans and fixed-point measurements in ESG-01. An ambient correction was achieved by taking shielded

Survey Area Name: East Sodium Gallery Designator: **ESG-01**

readings at five locations inside the east sodium gallery and the Mean of those data was calculated.

Table 11 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background.

Table 11
ESG-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
EAST SODIUM GALLERY		FISSION PRODUCT DETECTOR (FPD) BLDG.	
CHAR-ESG-01-001-F-M	1124	CHAR-ESG-01-021-F-M	1009
CHAR-ESG-01-002-F-M	1098	CHAR-ESG-01-022-F-M	983
CHAR-ESG-01-003-F-M	1046	CHAR-ESG-01-023-F-M	965
CHAR-ESG-01-004-F-M	1031	CHAR-ESG-01-024-F-M	1113
CHAR-ESG-01-005-F-M	950	CHAR-ESG-01-025-F-M	1020
CHAR-ESG-01-006-F-M	1043	CHAR-ESG-01-026-F-M	987
CHAR-ESG-01-007-F-M	1216	CHAR-ESG-01-027-F-M	773
CHAR-ESG-01-008-F-M	1468	CHAR-ESG-01-028-F-M	1227
CHAR-ESG-01-009-F-M	1338	CHAR-ESG-01-029-F-M	1320
CHAR-ESG-01-010-F-M	1357	CHAR-ESG-01-030-F-M	1486
CHAR-ESG-01-011-F-M	1194		
CHAR-ESG-01-012-F-M	1068		
CHAR-ESG-01-013-F-M	1153		
CHAR-ESG-01-014-F-M	1201		
CHAR-ESG-01-015-F-M	1105		
CHAR-ESG-01-016-F-M	1187		
CHAR-ESG-01-017-F-M	1582		
CHAR-ESG-01-018-F-M	1364		
CHAR-ESG-01-019-F-M	1201		
CHAR-ESG-01-020-F-M	1209		
Mean Amb.	1107	**Mean Amb.**	768
Ct. Mean	1197	**Ct. Mean**	1088
Ct. Median	1190	**Ct. Median**	1015
Ct. Std. Dev.	158	**Ct. Std. Dev.**	205

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for ESG-01 include:

- All obstructions will be removed within ESG-01 to allow the performance of Final Status Surveys.

Survey Area Name: East Sodium Gallery Designator: **ESG-01**

- Removal of all piping.

Findings

Survey area ESG-01 is a structure located inside the Controlled Area and is shown in Figure 16.

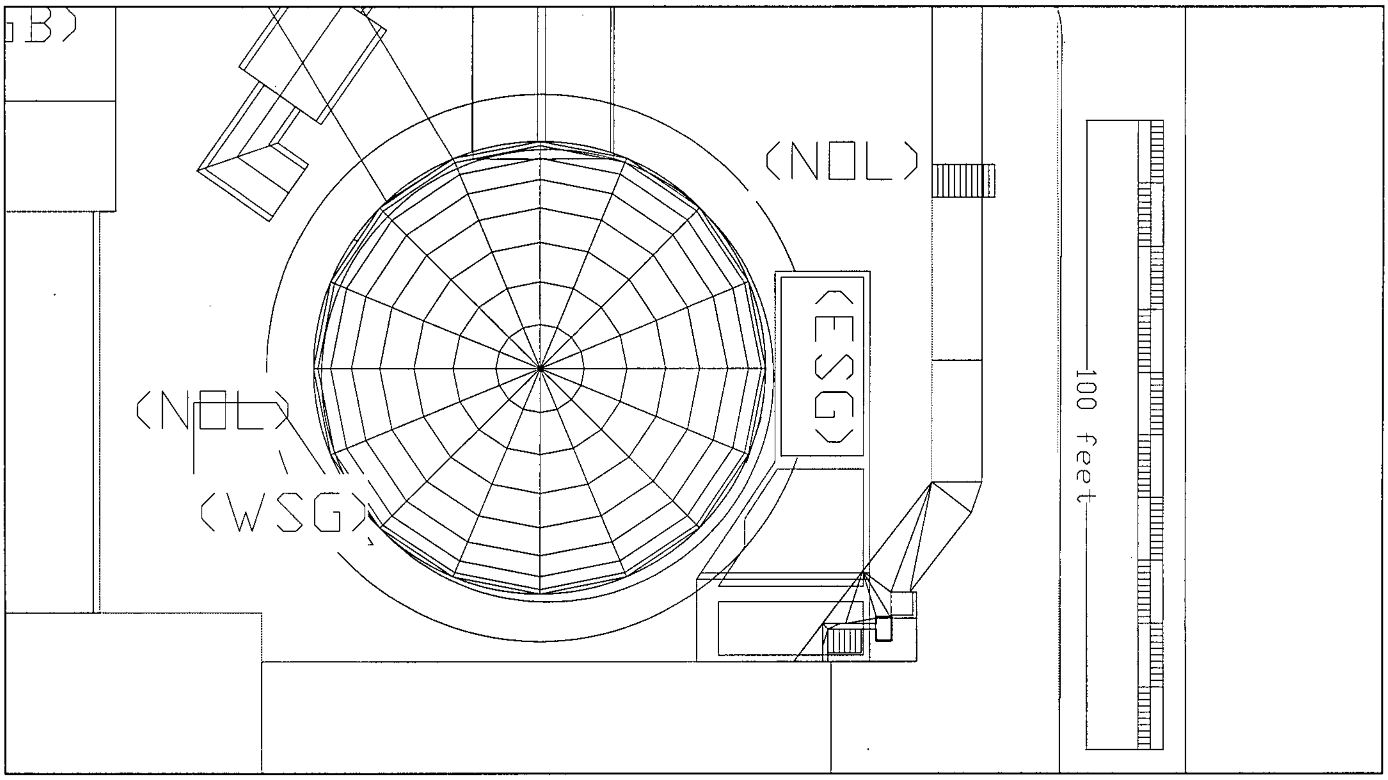
Survey area ESG-01 is impacted and likely has radioactivity concentrations less than the DCGL. The radionuclide mix likely to be present in ESG-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area ESG-01 are Co-60, Cs-137, Sr-90 and H-3.

As a result of historical information, decommissioning activities performed and planned, ESG-01 is classified as a Class 2 Survey Area.

Survey Area Name: East Sodium Gallery Designator: **ESG-01**

Figure 16

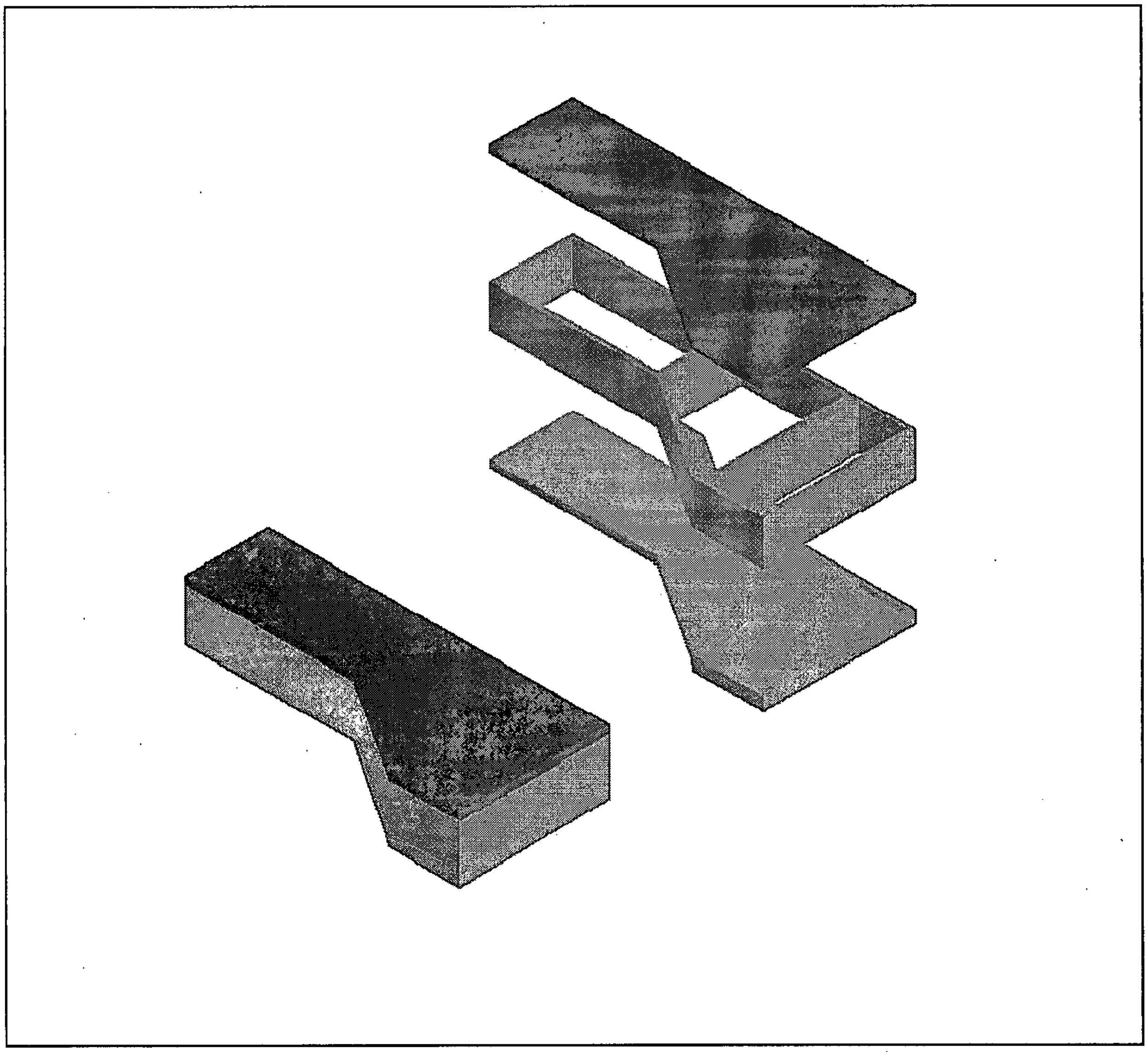
Survey Area ESG-01



Survey Area Name: East Sodium Gallery Designator: **ESG-01**

Figure 17

Exploded view of ESG-01



Survey Area Name: West Sodium Gallery Designator: **WSG-01**

Survey Area Description

The west sodium gallery consists of two chambers (north and south) which held the secondary sodium lines. Access to the south compartment of the west sodium gallery chamber is via a horizontal steel door just above ground level. Access to the north compartment is via a tunnel from the Reactor Building annulus or a horizontal door which was sealed with a steel plate, concrete and stone fill to prevent water intrusion. The west sodium gallery's walls and base slab are of conventional concrete resting on concrete filled pilasters.

Survey Area History

The west gallery supplied the No. 3 steam generator. All of the areas within WSG-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Any contamination encountered during the removal of piping within WSG-01.

Site modifications performed within survey area WSG-01 include:

- Asbestos abatement.
- Removal of material sealing the entrance to the north chamber.
- Rinsing of secondary sodium piping.
- Opening of the sealed entrance
- Removal of various piping

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization effort was implemented on October 16, 2008 to include smears, scans and fixed-point measurements in WSG-01. An ambient correction was achieved by taking shielded readings at five locations inside the west sodium gallery and the Mean of those data was calculated. Table 12 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated results greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background.

Survey Area Name: West Sodium Gallery Designator: **WSG-01**

Table 12
WSG-01 Characterization Data

Location	Result (dpm/100cm^2)	Location	Result (dpm/100cm^2)
CHAR-WSG-01-001-F-M	1172	CHAR-WSG-01-011-F-M	1043
CHAR-WSG-01-002-F-M	1231	CHAR-WSG-01-012-F-M	1046
CHAR-WSG-01-003-F-M	1150	CHAR-WSG-01-013-F-M	1109
CHAR-WSG-01-004-F-M	1190	CHAR-WSG-01-014-F-M	1198
CHAR-WSG-01-005-F-M	1283	CHAR-WSG-01-015-F-M	1264
CHAR-WSG-01-006-F-M	1264	CHAR-WSG-01-016-F-M	909
CHAR-WSG-01-007-F-M	1253	CHAR-WSG-01-017-F-M	1153
CHAR-WSG-01-008-F-M	1238	CHAR-WSG-01-018-F-M	991
CHAR-WSG-01-009-F-M	1102	CHAR-WSG-01-019-F-M	1079
CHAR-WSG-01-010-F-M	1057	CHAR-WSG-01-020-F-M	1179
		Mean Amb.	654
		Ct. Mean	1146
		Ct. Median	1163
		Ct. Std. Dev.	102

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for WSG-01 include:

- Removal of all piping.

Findings

Survey area WSG-01 is a structure located inside the Controlled Area and is shown in Figure 18.

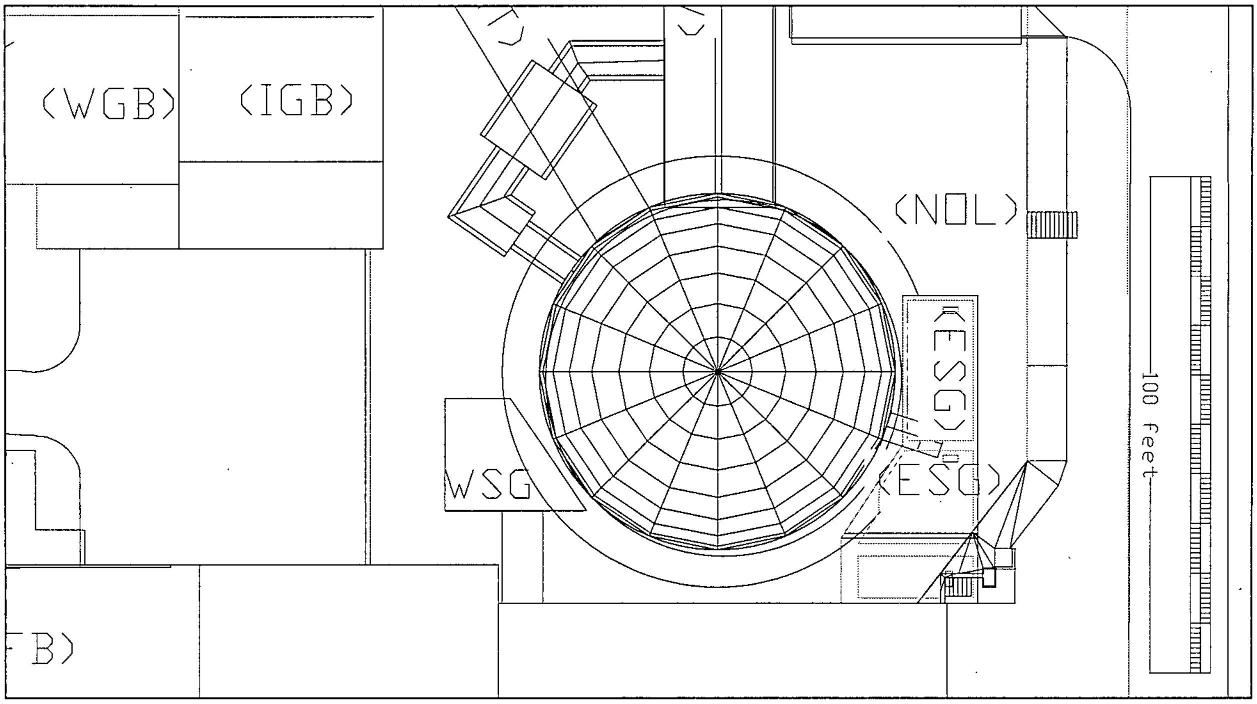
Survey area WSG-01 is impacted and likely has radioactivity concentrations less than the DCGL.

The radionuclide mix likely to be present in WSG-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area WSG-01 are Co-60, Cs-137, Sr-90 and H-3.

As a result of historical information, decommissioning activities performed and planned, WSG-01 is classified as a Class 2 Survey Area.

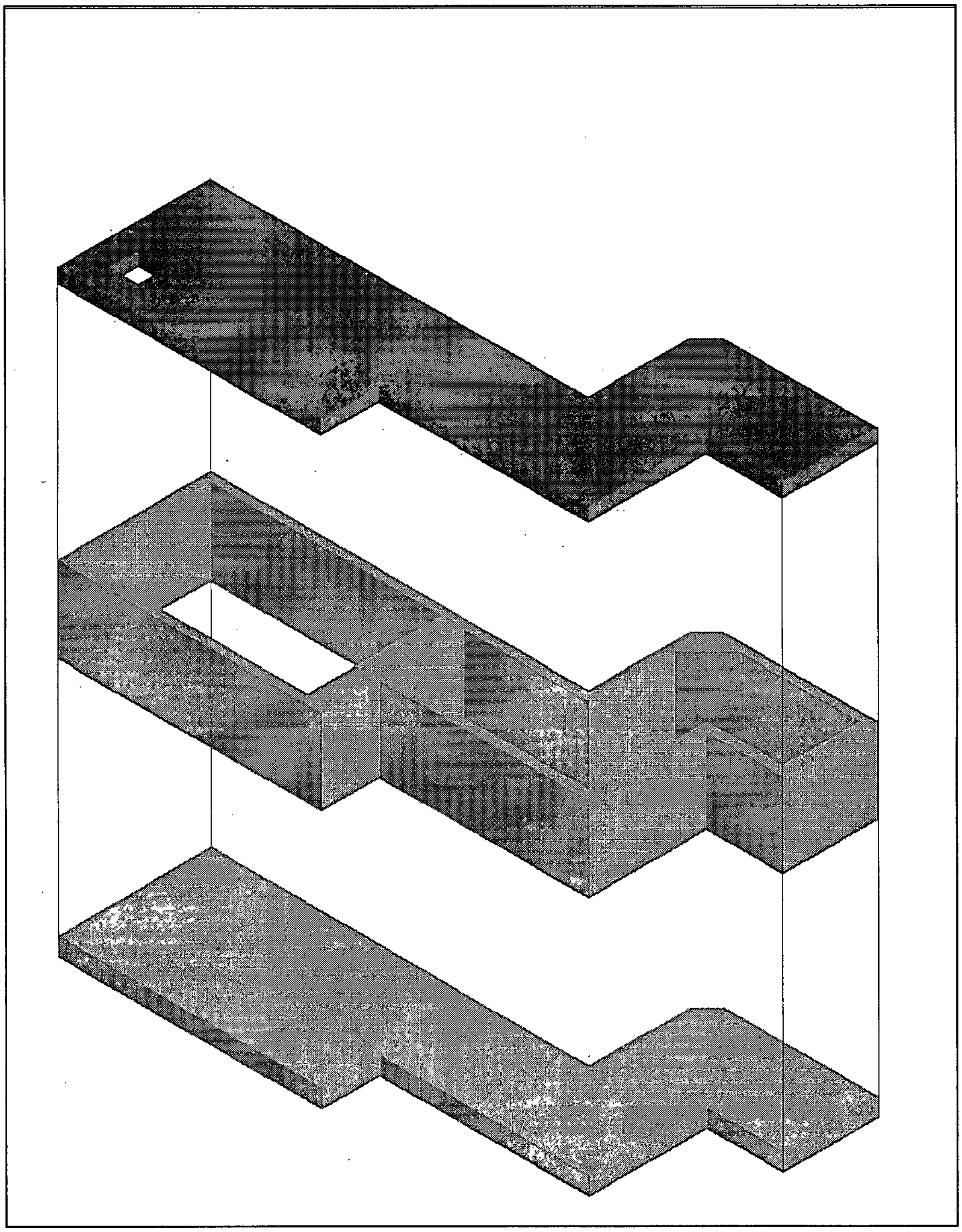
Survey Area Name: West Sodium Gallery Designator: **WSG-01**

Figure 18
Survey Area WSG-01



Survey Area Name: West Sodium Gallery Designator: **WSG-01**

Figure 19
WSG-01 Exploded View



Survey Area Name: Waste Gas Building Designator: **WGB-01**

Survey Area Description

The Waste Gas Building housed the waste gas disposal system that removed waste gases from the plant by a process which included storage until the gases decayed to a suitable level, dilution below the maximum permissible concentration in air and dispersion into the atmosphere through a stack. Piping, valves, and mechanical equipment were housed in chambers below grade; the holdup tanks were housed above grade in shielded cells of the building. Piping transported the waste gas to the FARB where it exited to the atmosphere via a waste gas stack. The holdup tank chambers are inside the Fermi 1 Controlled Area, while the below grade chamber and the grade level valve operating room are outside the Fermi 1 Controlled Area boundary. Construction of the Waste Gas Building includes reinforced concrete walls 12-18 inches thick, with the exception of the concrete block walled valve room. The roof is constructed of reinforced concrete 2 feet thick.

Survey Area History

All of the areas within WGB-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Any contamination encountered during the removal of piping within WGB-01.

Site modifications performed within survey area WGB-01 include:

- The majority of original components have been removed from inside the building.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization was implemented on October 1, 2008 to include smears, scans and fixed-point measurements in WGB-01. An ambient correction was achieved by taking shielded readings at five locations in each room and the Mean of those data was calculated. Tables 13 and 14 represent the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated greater than background.

Survey Area Name: Waste Gas Building Designator: **WGB-01**

Table 13
WGB-01 Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
TANK ROOM 1		TANK ROOM 2		VALVE ROOM	
CHAR-WGB-01-021-F-M	1571	CHAR-WGB-01-031-F-M	1601	CHAR-WGB-01-041-F-M	1360
CHAR-WGB-01-022-F-M	1667	CHAR-WGB-01-032-F-M	1608	CHAR-WGB-01-042-F-M	1564
CHAR-WGB-01-023-F-M	1630	CHAR-WGB-01-033-F-M	1604	CHAR-WGB-01-043-F-M	1287
CHAR-WGB-01-024-F-M	1630	CHAR-WGB-01-034-F-M	1689	CHAR-WGB-01-044-F-M	1409
CHAR-WGB-01-025-F-M	1590	CHAR-WGB-01-035-F-M	1571	CHAR-WGB-01-045-F-M	1231
CHAR-WGB-01-026-F-M	1538	CHAR-WGB-01-036-F-M	1516	CHAR-WGB-01-046-F-M	1120
CHAR-WGB-01-027-F-M	1708	CHAR-WGB-01-037-F-M	1453	CHAR-WGB-01-047-F-M	1213
CHAR-WGB-01-028-F-M	1682	CHAR-WGB-01-038-F-M	1497	CHAR-WGB-01-048-F-M	1287
CHAR-WGB-01-029-F-M	1128	CHAR-WGB-01-039-F-M	1564	CHAR-WGB-01-049-F-M	1231
CHAR-WGB-01-030-F-M	1379	CHAR-WGB-01-040-F-M	1549	CHAR-WGB-01-050-F-M	1227
Mean Amb.	959	**Mean Amb.**	948	**Mean Amb.**	850
Ct. Mean	1552	**Ct. Mean**	1565	**Ct. Mean**	1293
Ct. Median	1610	**Ct. Median**	1567	**Ct. Median**	1259
Ct. Std. Dev.	176	**Ct. Std. Dev.**	67	**Ct. Std. Dev.**	125

F-M = Fixed measurements

Table 14
WGB-01 Lower Level Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
572' ROOM 1		572' ROOM 2	
CHAR-WGB-01-001-F-M	1257	CHAR-WGB-01-011-F-M	1372
CHAR-WGB-01-002-F-M	1294	CHAR-WGB-01-012-F-M	1364
CHAR-WGB-01-003-F-M	1312	CHAR-WGB-01-013-F-M	1390
CHAR-WGB-01-004-F-M	1220	CHAR-WGB-01-014-F-M	1379
CHAR-WGB-01-005-F-M	1242	CHAR-WGB-01-015-F-M	1213
CHAR-WGB-01-006-F-M	1272	CHAR-WGB-01-016-F-M	1353
CHAR-WGB-01-007-F-M	1224	CHAR-WGB-01-017-F-M	1142
CHAR-WGB-01-008-F-M	1002	CHAR-WGB-01-018-F-M	1105
CHAR-WGB-01-009-F-M	1157	CHAR-WGB-01-019-F-M	1349
CHAR-WGB-01-010-F-M	1227	CHAR-WGB-01-020-F-M	1264
Mean Amb.	840	**Mean Amb.**	943
Ct. Mean	1221	**Ct. Mean**	1293
Ct. Median	1235	**Ct. Median**	1351
Ct. Std. Dev.	88	**Ct. Std. Dev.**	105

F-M = Fixed measurements

Survey Area Name: Waste Gas Building Designator: **WGB-01**

Decommissioning

Planned decommissioning activities for WGB-01 include:

- Removal of remaining piping and components, as required.

Findings

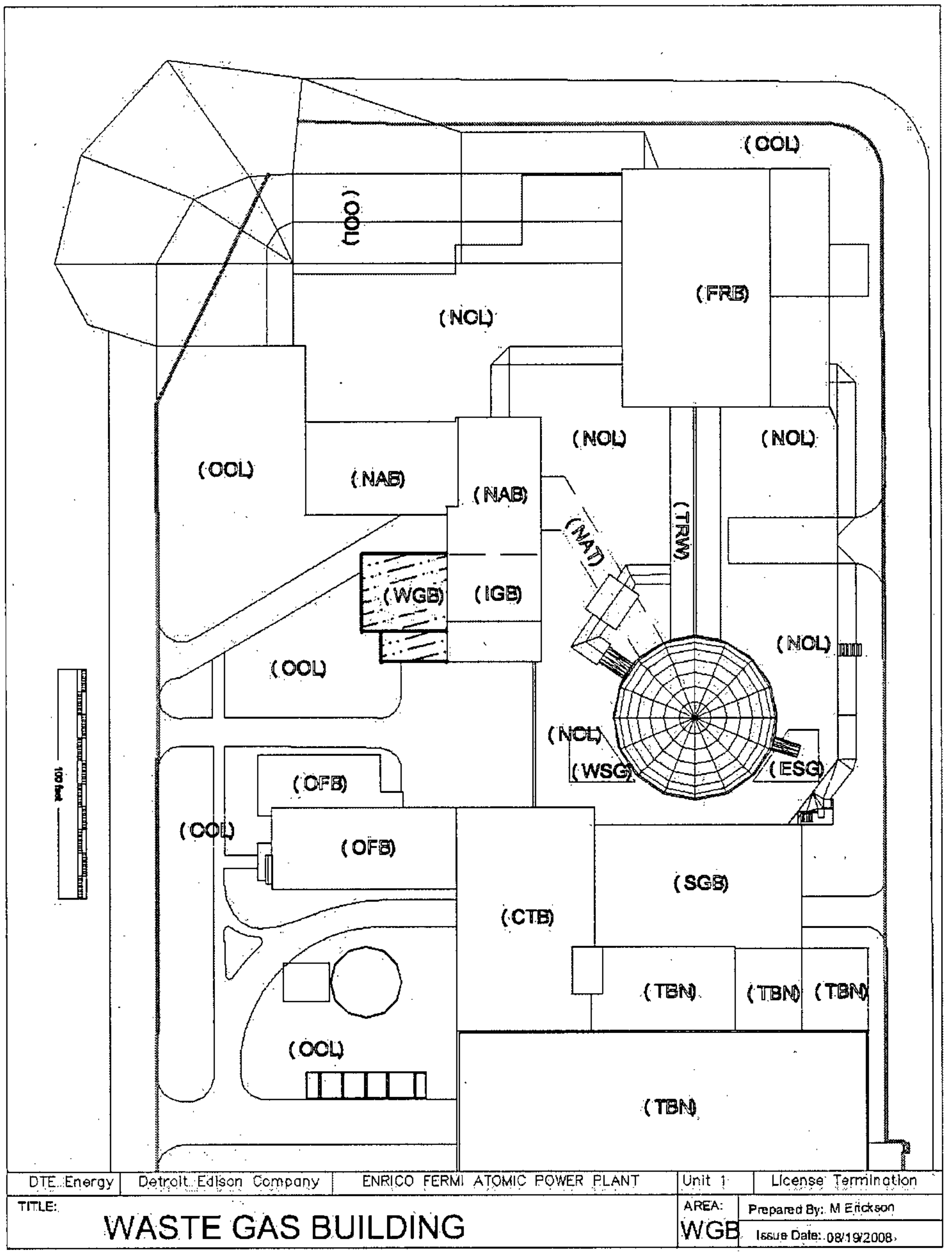
Survey area WGB-01 is a structure located inside the Controlled Area and is shown in Figure 20.

The tank rooms are outside of the Controlled Area. Survey area WGB-01 is impacted and likely has radioactivity concentrations less than the DCGL. The radionuclide mix likely to be present in WGB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area WGB-01 are Co-60, Cs-137, Sr-90 and H-3.

As a result of historical information, decommissioning activities performed and planned, WGB-01 is classified as a Class 2 Survey Area.

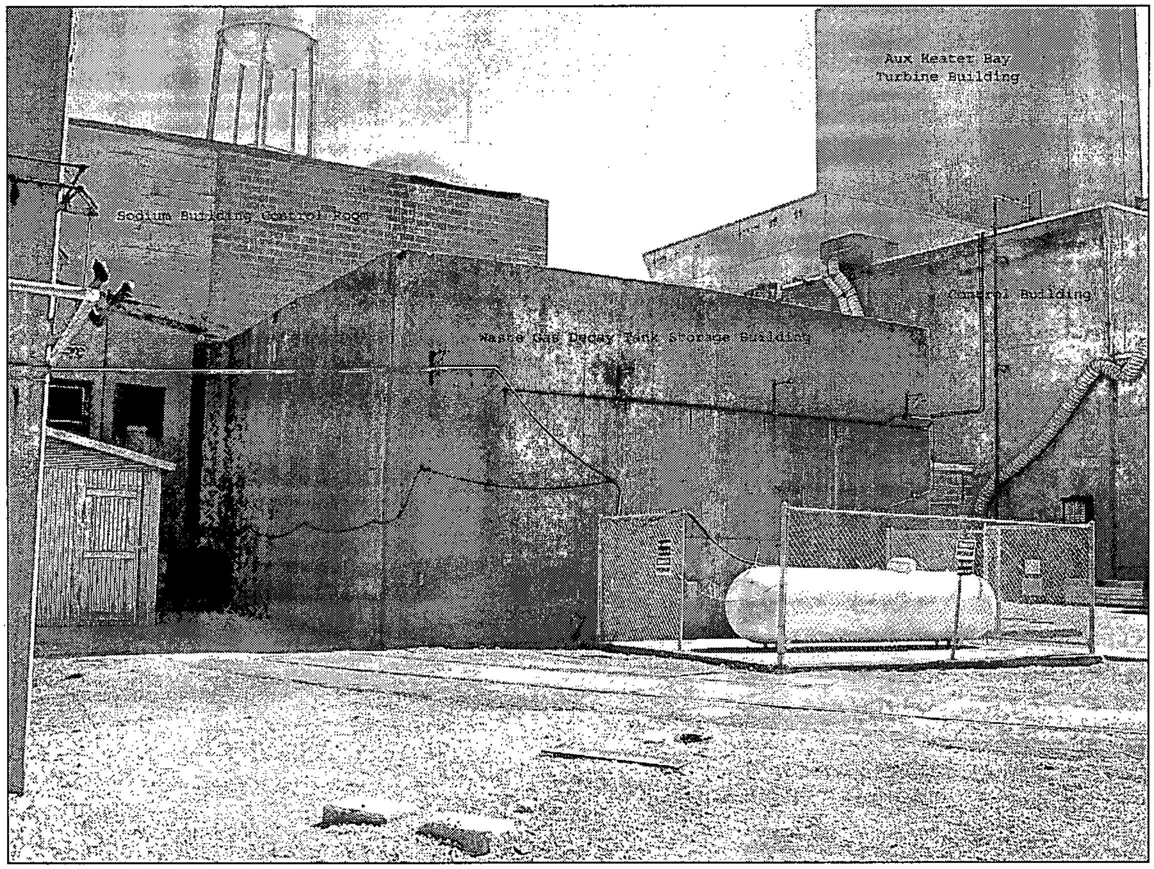
Survey Area Name: Waste Gas Building Designator: **WGB-01**

Figure 20
Survey Area WGB-01



Survey Area Name: Waste Gas Building Designator: **WGB-01**

Figure 21
Exterior of WGB-01



Survey Area Name: Inert Gas Building Designator: **IGB-01**

Survey Area Description

The Inert Gas Building housed the compressors, vapor trap, hold-up and vacuum tanks, valves, piping and other associated equipment for the purification and distribution of the argon cover gas system to the primary, secondary, and FARB cover gas systems. The Inert Gas Building has a first story of concrete construction and a second story of cinder block construction located immediately adjacent to the Sodium Building Valve Room. The Inert Gas Tunnel is part of this Survey Area.

Survey Area History

All of the areas within IGB-01 are equally likely to be contaminated as a result of work activities performed in the area and as indicated by previous surveys.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Any contamination encountered during the removal of piping and components within IGB-01.

Site modifications performed within survey area IGB-01 include:

- The majority of original components have been removed from inside the building.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization was implemented on October 7, 2008 to include smears, scans and fixed-point measurements in IGB-01. An ambient correction was achieved by taking shielded readings at five locations in the tank room and five locations in the tunnel; and the Mean of those data was calculated. Table 15 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas (with the exception of the tunnel areas where gamma scans were inaccessible) as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated greater than background.

Survey Area Name: Inert Gas Building Designator: **IGB-01**

Table 15
IGB-01 Characterization Data

Location	**Result (dpm/100cm^2)**	**Location**	**Result (dpm/100cm^2)**
TANK ROOM		TUNNEL	
CHAR-IGB-01-001-F-M	2052	CHAR-IGB-01-021-F-M	1335
CHAR-IGB-01-002-F-M	1978	CHAR-IGB-01-022-F-M	1187
CHAR-IGB-01-003-F-M	1220	CHAR-IGB-01-023-F-M	1264
CHAR-IGB-01-004-F-M	1209	CHAR-IGB-01-024-F-M	1238
CHAR-IGB-01-005-F-M	1257	CHAR-IGB-01-025-F-M	1309
CHAR-IGB-01-006-F-M	1198	CHAR-IGB-01-026-F-M	1179
CHAR-IGB-01-007-F-M	1449	CHAR-IGB-01-027-F-M	1316
CHAR-IGB-01-008-F-M	1268	CHAR-IGB-01-028-F-M	1250
CHAR-IGB-01-009-F-M	1756	CHAR-IGB-01-029-F-M	1264
CHAR-IGB-01-010-F-M	1889	CHAR-IGB-01-030-F-M	1357
CHAR-IGB-01-011-F-M	1235	CHAR-IGB-01-031-F-M	1205
CHAR-IGB-01-012-F-M	1161	CHAR-IGB-01-032-F-M	1124
CHAR-IGB-01-013-F-M	1238	CHAR-IGB-01-033-F-M	1283
CHAR-IGB-01-014-F-M	1113	CHAR-IGB-01-034-F-M	1157
CHAR-IGB-01-015-F-M	1268	CHAR-IGB-01-035-F-M	1405
CHAR-IGB-01-016-F-M	1287	CHAR-IGB-01-036-F-M	1124
CHAR-IGB-01-017-F-M	1272	CHAR-IGB-01-037-F-M	1482
CHAR-IGB-01-018-F-M	1316	CHAR-IGB-01-038-F-M	1190
CHAR-IGB-01-019-F-M	1183	CHAR-IGB-01-039-F-M	1390
CHAR-IGB-01-020-F-M	1360	CHAR-IGB-01-040-F-M	1201
Mean Amb.	1125	**Mean Amb.**	995
Ct. Mean	1385	**Ct. Mean**	1263
Ct. Median	1268	**Ct. Median**	1257
Ct. Std. Dev.	287	**Ct. Std. Dev.**	97

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for IGB-01 include:

- Removal of remaining piping and components.

Findings

Survey area IGB-01 is a structure located inside the Controlled Area and is shown in Figure 22.

Survey area IGB-01 is impacted and likely has radioactivity concentrations less than the DCGL.

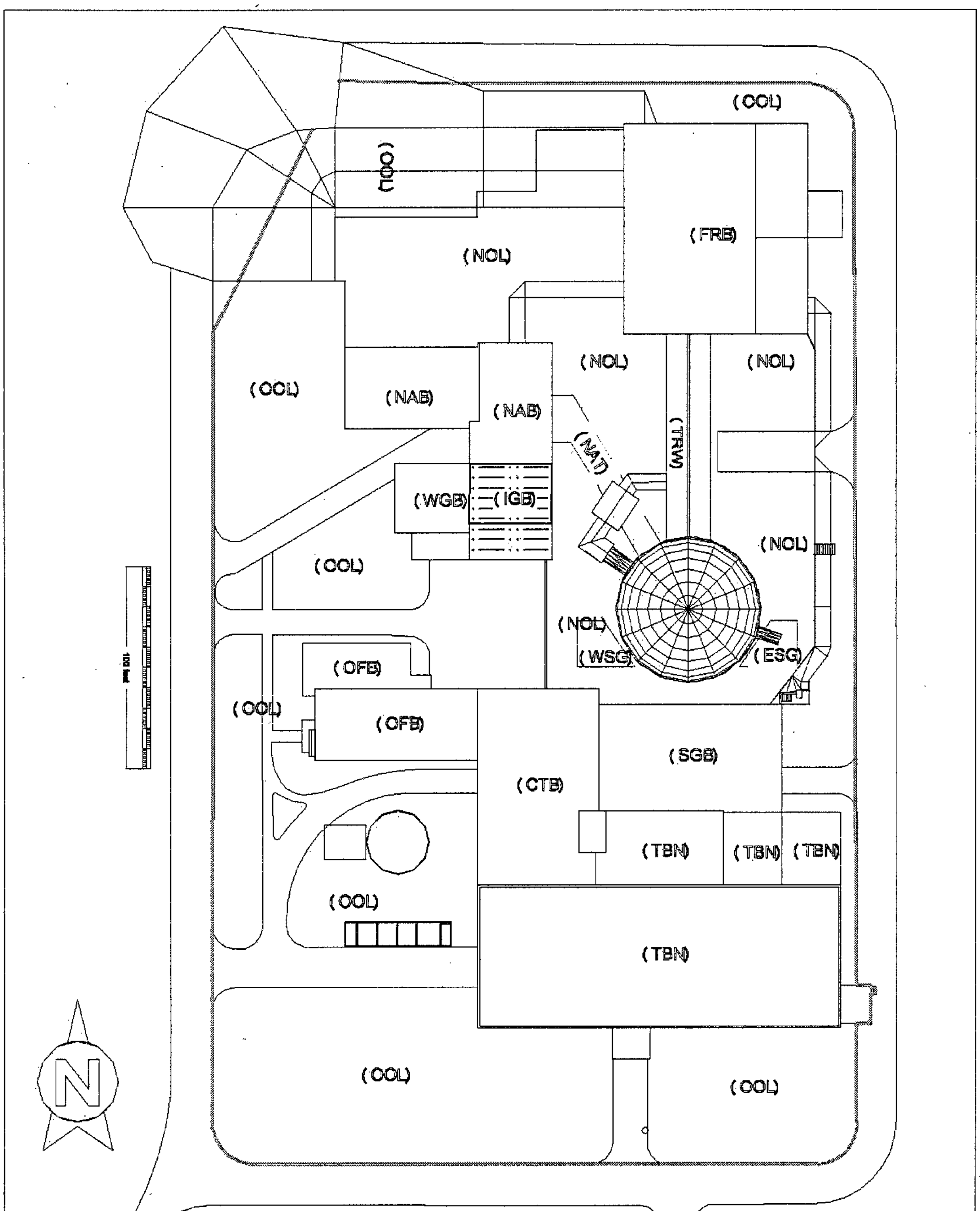
The radionuclide mix likely to be present in IGB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area IGB-01 are Co-60, Cs-137, Sr-90 and H-3.

Survey Area Name: Inert Gas Building Designator: **IGB-01**

As a result of historical information, decommissioning activities performed and planned, IGB-01 is classified as a Class 2 Survey Area.

Survey Area Name: Inert Gas Building Designator: **IGB-01**

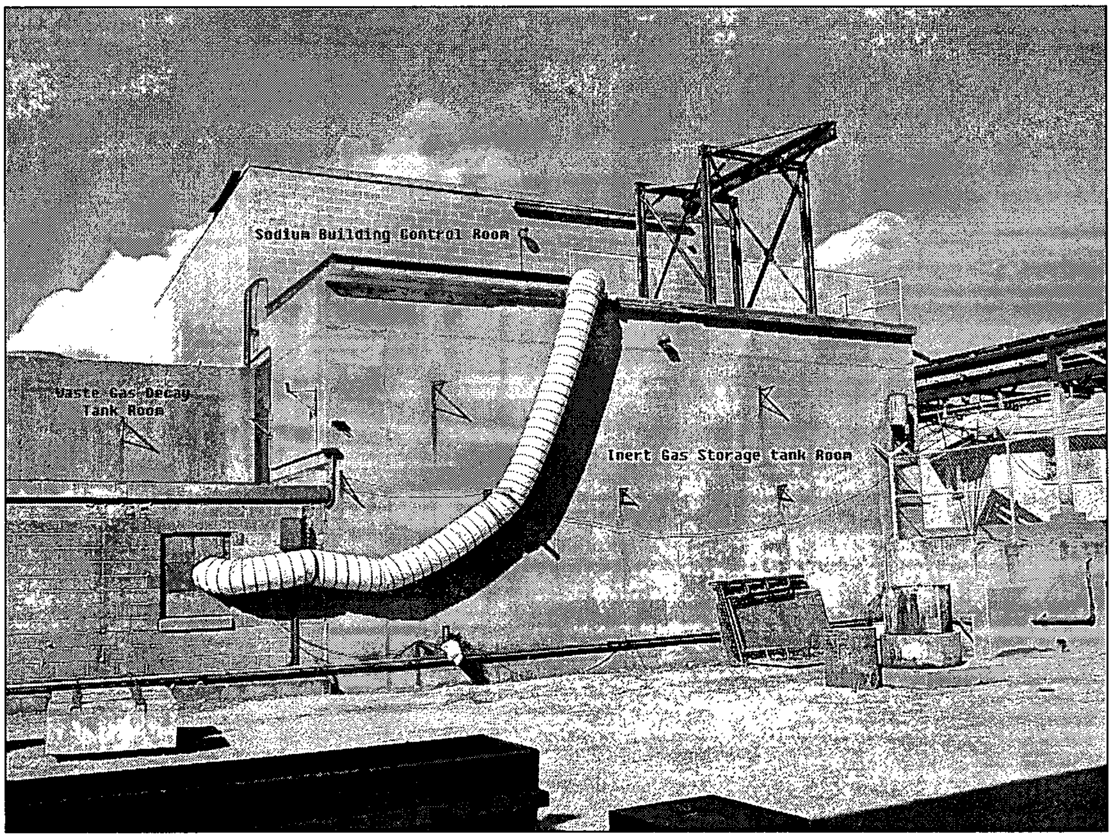
Figure 22
Survey Area IGB-01



DTE Energy	Detroit Edison Company	ENRICO FERMI ATOMIC POWER PLANT	Unit 1	License Termination
TITLE: INERT GAS BUILDING			AREA: IGB	Prepared By: M Erickson Issue Date: 8/19/2008

Survey Area Name: Inert Gas Building Designator: **IGB-01**

Figure 23
Exterior of IGB-01



Survey Area Name: Steam Generator Building Designator: **SGB-01**

Survey Area Description

The Steam Generator Building was located south of the Reactor Building and adjacent to the lease line and the Detroit Edison turbine structure. The building housed the steam generators, secondary sodium pumps and piping components of the secondary coolant system. The equipment components were located at the operating floor at elevation 590'-0". The basement of the building housed the storage tanks and miscellaneous piping and equipment components of the Secondary Sodium Services System. The structure and equipment components were supported through a system of structural steel columns to a reinforced concrete base slab resting on bedrock. The basement floor of the building is divided into five sectors. An east-west concrete block firewall was installed the full length of the building extending between the basement floor and the operating floor. The remaining structure is of conventional design, that is, steel and corrugated asbestos walls.

Survey Area History

All of the areas within SGB-01 are equally likely to be contaminated as a result of work activities performed in the area, however, it is not expected that SGB-01 will be contaminated to levels at, or above the DCGL.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Storage, movement or removal of radioactive material for shipment.
- Tritium contamination from the secondary sodium.

Site modifications performed within survey area SGB-01 include:

- Removal of the sodium storage tanks.
- Removal of the three Steam Generators.
- Removal of the secondary sodium pumps.
- Removal of various supporting piping.
- Removal of portions of interior walls.
- Asbestos abatement.
- Removal of the secondary cold trap.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization was implemented on August 21, 2008 to include smears, scans and fixed-point measurements in SGB-01. An ambient correction was achieved by taking shielded readings at five locations on each level and the Mean of those data was calculated. Table 16 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated greater than background.

Table 16
SGB-01 Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
BASEMENT		1st FLOOR		2nd FLOOR	
CHAR-SGB-01-001-F-M	1377	CHAR-SGB-01-016-F-M	1621	CHAR-SGB-01-031-F-M	2082
CHAR-SGB-01-002-F-M	1458	CHAR-SGB-01-017-F-M	1465	CHAR-SGB-01-032-F-M	1982
CHAR-SGB-01-003-F-M	1465	CHAR-SGB-01-018-F-M	1632	CHAR-SGB-01-033-F-M	1270
CHAR-SGB-01-004-F-M	1580	CHAR-SGB-01-019-F-M	1609	CHAR-SGB-01-034-F-M	1203
CHAR-SGB-01-005-F-M	1443	CHAR-SGB-01-020-F-M	1676	CHAR-SGB-01-035-F-M	1288
CHAR-SGB-01-006-F-M	1403	CHAR-SGB-01-021-F-M	1609	CHAR-SGB-01-036-F-M	1192
CHAR-SGB-01-007-F-M	1366	CHAR-SGB-01-022-F-M	1536	CHAR-SGB-01-037-F-M	1155
CHAR-SGB-01-008-F-M	1325	CHAR-SGB-01-023-F-M	1824	CHAR-SGB-01-038-F-M	1071
CHAR-SGB-01-009-F-M	1543	CHAR-SGB-01-024-F-M	1705	CHAR-SGB-01-039-F-M	1211
CHAR-SGB-01-010-F-M	1473	CHAR-SGB-01-025-F-M	1521	CHAR-SGB-01-040-F-M	1429
CHAR-SGB-01-011-F-M	1491	CHAR-SGB-01-026-F-M	1639	CHAR-SGB-01-041-F-M	1244
CHAR-SGB-01-012-F-M	1469	CHAR-SGB-01-027-F-M	1639	CHAR-SGB-01-042-F-M	1196
CHAR-SGB-01-013-F-M	941	CHAR-SGB-01-028-F-M	1661	CHAR-SGB-01-043-F-M	1436
CHAR-SGB-01-014-F-M	1517	CHAR-SGB-01-029-F-M	1436	CHAR-SGB-01-044-F-M	1735
CHAR-SGB-01-015-F-M	1329	CHAR-SGB-01-030-F-M	1513	CHAR-SGB-01-045-F-M	1465
Mean Amb.	1135	**Mean Amb.**	678	**Mean Amb.**	1065
Ct. Mean	1412	**Ct. Mean**	1606	**Ct. Mean**	1397
Ct. Median	1458	**Ct. Median**	1621	**Ct. Median**	1270
Ct. Std. Dev.	150	**Ct. Std. Dev.**	99	**Ct. Std. Dev.**	305

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for SGB-01 include:

Any obstructions in SGB-01 will be removed to allow Final Status Surveys.

Findings

Survey area SGB-01 is a structure located outside of the Controlled Area portion of the site and is shown in Figure 24.

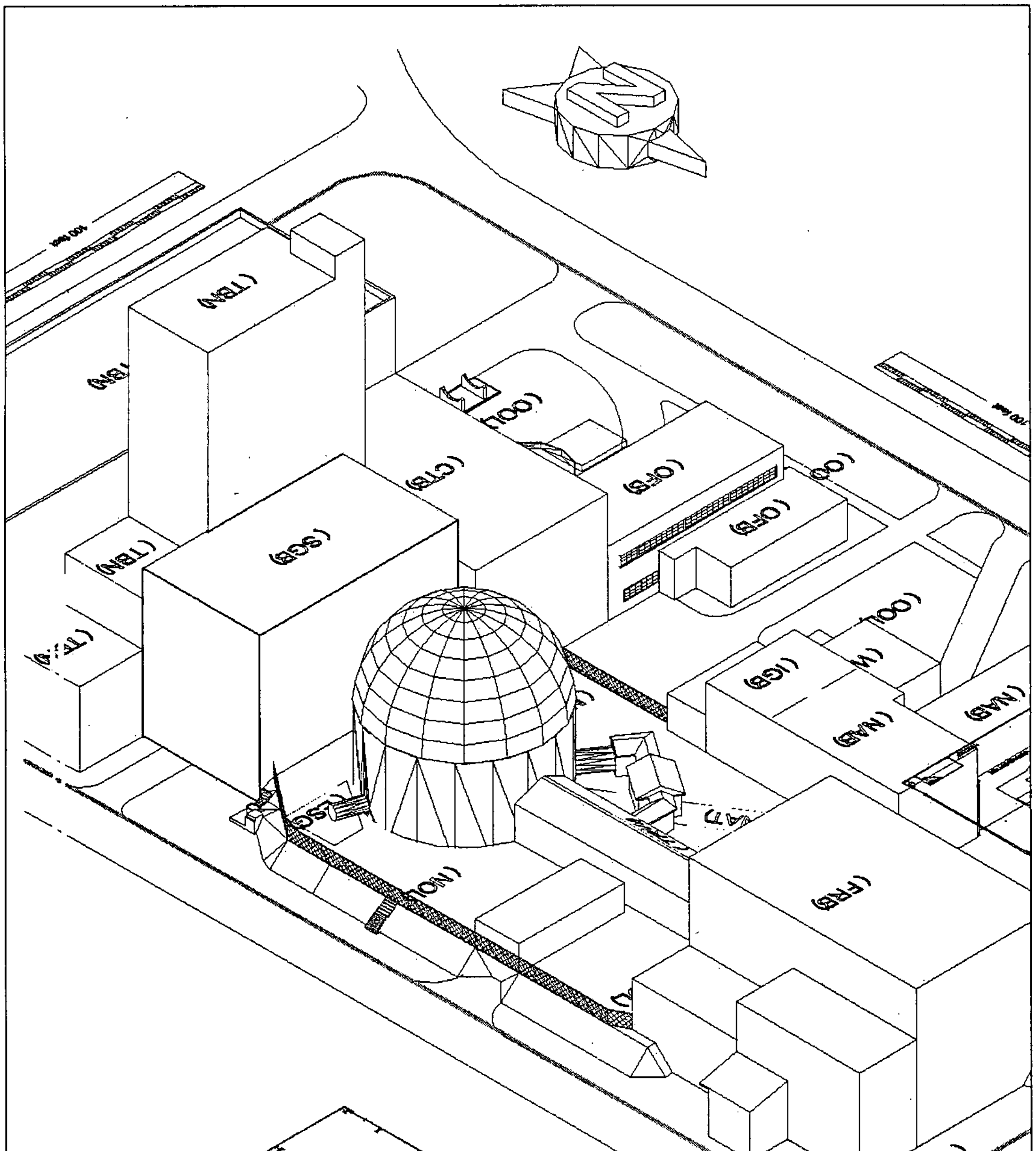
Survey area SGB-01 is impacted and likely has radioactivity concentrations that that are a small fraction of the DCGL. The radionuclide mix likely to be present in SGB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area SGB-01 are Co-60, Cs-137, Sr-90 and H-3.

Survey Area Name: Steam Generator Building Designator: **SGB-01**

As a result of historical information and characterization data gathered, SGB-01 is classified as a Class 3 Survey Area.

Survey Area Name: Steam Generator Building Designator: **SGB-01**

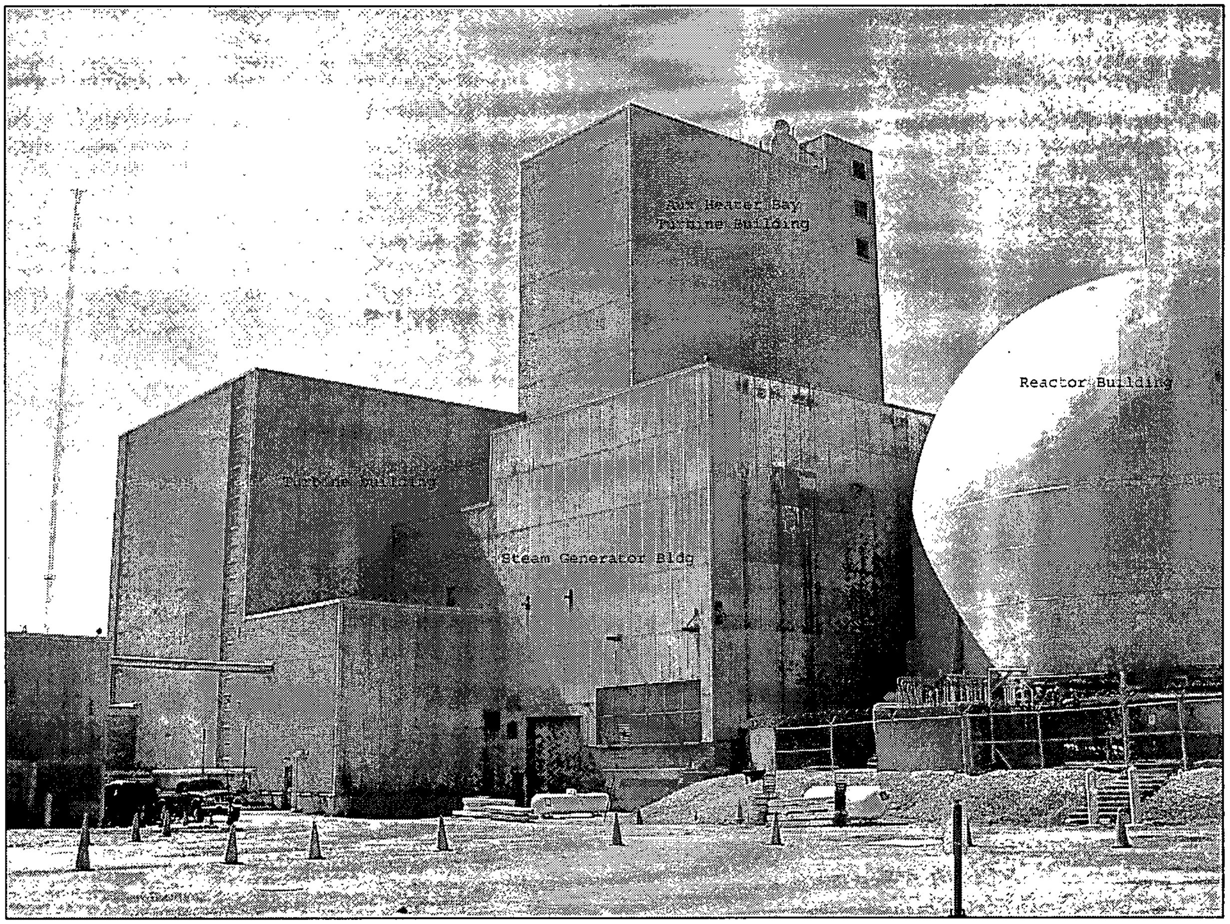
Figure 24
Survey Area SGB-01



DTE Energy	Detroit Edison Company	ENRICO FERMI ATOMIC POWER PLANT	Unit 1	License Termination
TITLE:	STEAM GENERATOR BUILDING		AREA: SGB	Prepared By: M Erickson Issue Date: 8/19/2008

Survey Area Name: Steam Generator Building Designator: **SGB-01**

Figure 25
SGB-01 Exterior



Survey Area Name: Control Building Designator: **CTB-01**

Survey Area Description

This structure had, as its primary purpose, the protection, from the elements of weather and radioactive streaming, of personnel working inside. In addition, it served as protection for the equipment installed to control the operation of the whole plant. In order for the shielding function to be performed, the walls adjacent to the Containment Building were 40 inch thick, reinforced concrete, and the roof was designed to eliminate the effect of sky shine on the control room located on the third floor of the building.

Survey Area History

All of the areas within CTB-01 are equally likely to be contaminated as a result of work activities performed in the area, however, it is not expected that CTB-01 will be contaminated to levels at a fraction of the DCGL.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Migration of contamination from the radwaste storage area on the 3rd level of the Turbine Building to the Control Building.

Site modifications performed within survey area CTB-01 include:

- Removal of many of the components in the Control Room.
- Repair of the roof with a synthetic material.
- Removal of the diesel generator, compressor and considerable electrical equipment.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization was implemented on August 11, 2008 to include smears, scans and fixed-point measurements in CTB-01. An ambient correction was achieved by taking shielded readings at five locations on each floor and the Mean of those data was calculated. Table 17 represents the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated greater than background.

Survey Area Name: Control Building Designator: **CTB-01**

Table 17
CTB-01 Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
1st FLOOR		2nd FLOOR		3rd FLOOR	
CHAR-CTB-01-001-F-M	1372	CHAR-CTB-01-016-F-M	1471	CHAR-CTB-01-031-F-M	1201
CHAR-CTB-01-002-F-M	1379	CHAR-CTB-01-017-F-M	1153	CHAR-CTB-01-032-F-M	994
CHAR-CTB-01-003-F-M	1316	CHAR-CTB-01-018-F-M	1054	CHAR-CTB-01-033-F-M	998
CHAR-CTB-01-004-F-M	976	CHAR-CTB-01-019-F-M	1120	CHAR-CTB-01-034-F-M	987
CHAR-CTB-01-005-F-M	1323	CHAR-CTB-01-020-F-M	1124	CHAR-CTB-01-035-F-M	1054
CHAR-CTB-01-006-F-M	1471	CHAR-CTB-01-021-F-M	1035	CHAR-CTB-01-036-F-M	1290
CHAR-CTB-01-007-F-M	1335	CHAR-CTB-01-022-F-M	1179	CHAR-CTB-01-037-F-M	1113
CHAR-CTB-01-008-F-M	1372	CHAR-CTB-01-023-F-M	1065	CHAR-CTB-01-038-F-M	1035
CHAR-CTB-01-009-F-M	1194	CHAR-CTB-01-024-F-M	1094	CHAR-CTB-01-039-F-M	1216
CHAR-CTB-01-010-F-M	1301	CHAR-CTB-01-025-F-M	1006	CHAR-CTB-01-040-F-M	1083
CHAR-CTB-01-011-F-M	1360	CHAR-CTB-01-026-F-M	1028	CHAR-CTB-01-041-F-M	1116
CHAR-CTB-01-012-F-M	1427	CHAR-CTB-01-027-F-M	736	CHAR-CTB-01-042-F-M	1002
CHAR-CTB-01-013-F-M	1316	CHAR-CTB-01-028-F-M	662	CHAR-CTB-01-043-F-M	1039
CHAR-CTB-01-014-F-M	1405	CHAR-CTB-01-029-F-M	1342	CHAR-CTB-01-044-F-M	906
CHAR-CTB-01-015-F-M	1294	CHAR-CTB-01-030-F-M	1309	CHAR-CTB-01-045-F-M	1124
Mean Amb.	1014	**Mean Amb.**	1006	**Mean Amb.**	986
Ct. Mean	1323	**Ct. Mean**	1092	**Ct. Mean**	1077
Ct. Median	1335	**Ct. Median**	1094	**Ct. Median**	1054
Ct. Std. Dev.	116	**Ct. Std. Dev.**	206	**Ct. Std. Dev.**	102

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for CTB-01 include:

- Removal of any obstructions in the building to allow FSS.

Findings

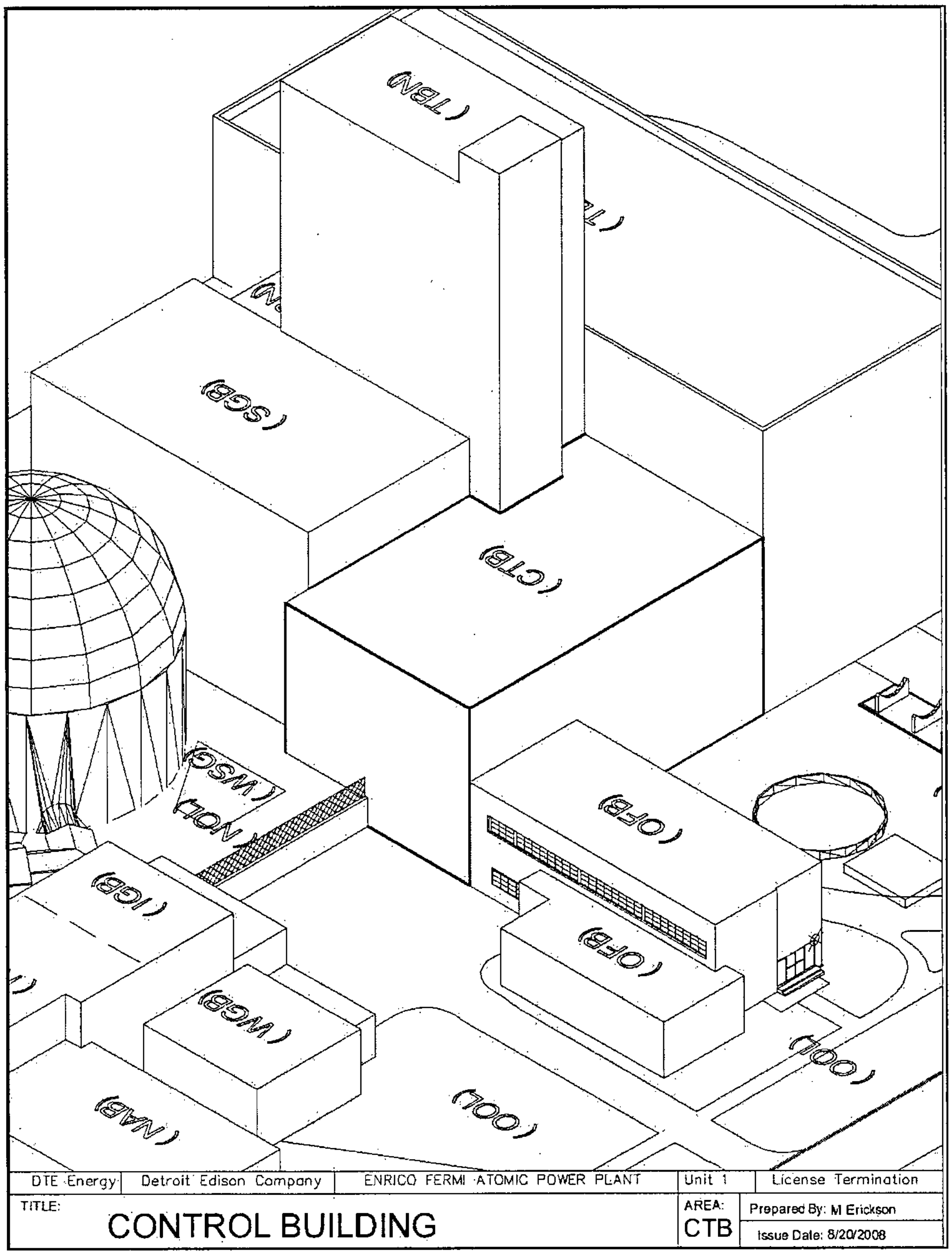
Survey area CTB-01 is a structure located outside of the Controlled Area portion of the site and is shown in Figure 26.

Survey area CTB-01 is impacted and likely has radioactivity concentrations that that are a small fraction of the DCGL. The radionuclide mix likely to be present in CTB-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area CTB-01 are Co-60, Cs-137, Sr-90 and H-3.

As a result of historical information and characterization data gathered, CTB-01 is classified as a Class 3 Survey Area.

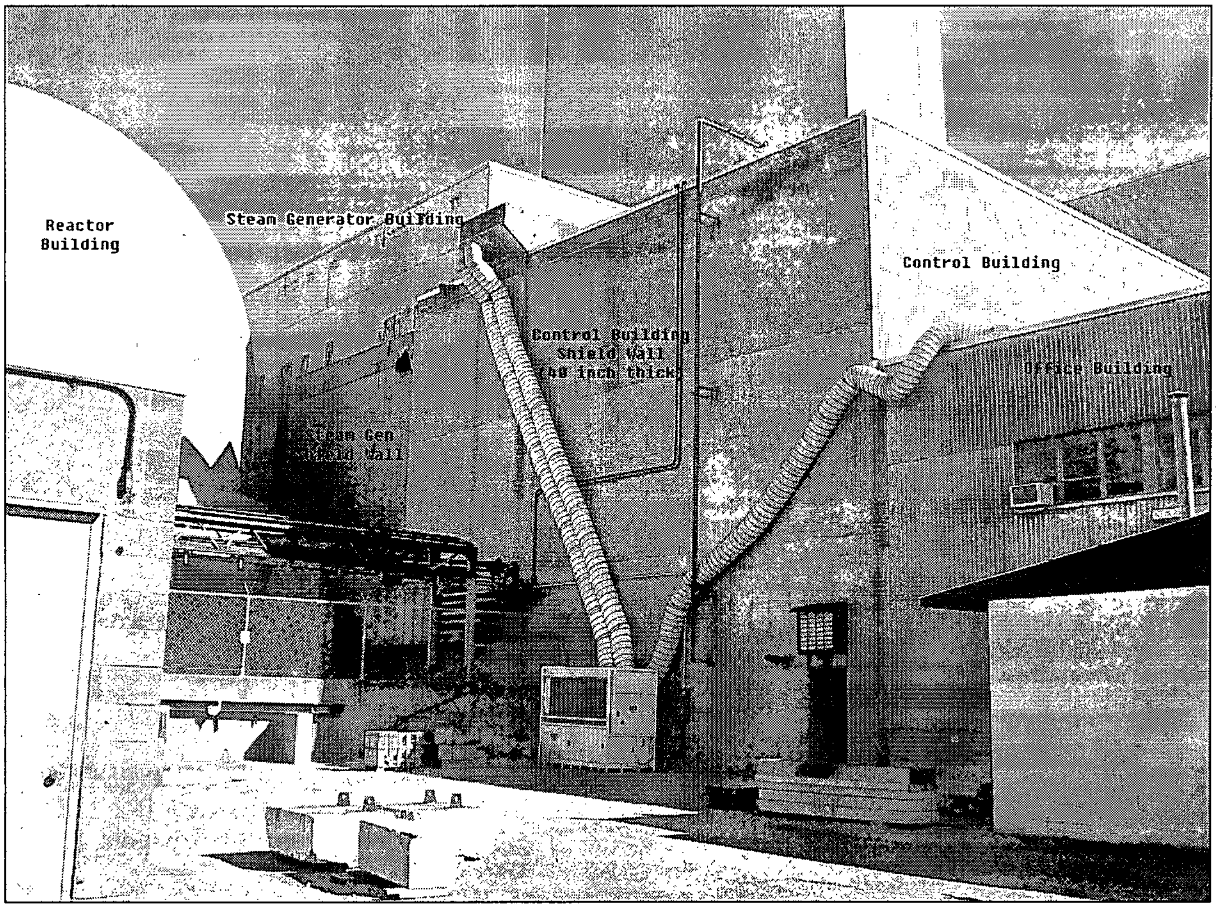
Survey Area Name: Control Building Designator: **CTB-01**

Figure 26
Survey Area CTB-01



Survey Area Name: Control Building Designator: **CTB-01**

Figure 27
Exterior of CTB-01



Survey Area Name: Turbine Building Designator: **TBN-01**

Survey Area Description

Steam produced in the three steam generators located within the Steam Generator Building passed to the adjacent Turbine Building and was used to operate the turbine. The turbine was a tandem-compound, single flow machine. Four stages of feedwater heating were used. The turbine, support equipment, feedwater heaters, main condenser and associated piping and pumps are/were located in the Turbine Building. The Turbine Building is a steel frame structure which is tied together with standard riveted or bolted connections. Steel beams support the concrete or grating floors. The exterior walls consist of a 4-foot high apron wall constructed of 8-inch cinder block except in the region behind the transformer and the hydrogen storage platform, where reinforced concrete is used to provide a positive fire barrier. Non-insulated, corrugated, asbestos-cement siding which is fastened to steel channel girts that run the full height of the building is installed above the apron wall. Open web steel joists support the standard ribbed galvanized steel roof deck. A single layer of plastic vapor barrier material is installed over the steel deck. This material effectively contains the asphalt on the roof surface. The plastic material is covered by a 2-inch thick layer of Foamglas® which is covered with a four-ply tar and slag roofing.

Survey Area History

All of the areas within TBN-01 are equally likely to be contaminated as a result of work activities performed in the area, however, it is not expected that TBN-01 will be contaminated to levels at, or above the DCGL.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- Movement and storage of Radwaste on the 1st and 3rd floors of TBN-01.

Site modifications performed within survey area TBN-01 include:

- Removal of asbestos, some portions of the turbine generator system was salvaged for spare parts.
- Surveyed and characterized ancillary systems.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization was implemented on August 13, 2008 to include smears, scans and fixed-point measurements in TBN-01. An ambient measurement was achieved by taking shielded readings at five locations on each floor and the Mean of those data was calculated. Tables 18 and 19 represent the results of this survey effort. Smears were taken at each fixed-point location.

Survey Area Name: Turbine Building Designator: **TBN-01**

Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated greater than background. Gamma scans were taken in the general areas (with the exception of the Class 2 radioactive material storage areas on the 1st and 3rd floors) as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated greater than background.

Table 18
TBN-01 Characterization Data

Location	**Result (dpm/100cm²)**	**Location**	**Result (dpm/100cm²)**	**Location**	**Result (dpm/100cm²)**
1st FLOOR		2nd FLOOR		3rd FLOOR	
CHAR-TBN-01-001-F-M	1579	CHAR-TBN-01-016-F-M	1242	CHAR-TBN-01-031-F-M	1375
CHAR-TBN-01-002-F-M	1401	CHAR-TBN-01-017-F-M	1390	CHAR-TBN-01-032-F-M	1235
CHAR-TBN-01-003-F-M	1250	CHAR-TBN-01-018-F-M	1689	CHAR-TBN-01-033-F-M	1427
CHAR-TBN-01-004-F-M	1316	CHAR-TBN-01-019-F-M	1582	CHAR-TBN-01-034-F-M	1564
CHAR-TBN-01-005-F-M	1198	CHAR-TBN-01-020-F-M	1238	CHAR-TBN-01-035-F-M	1582
CHAR-TBN-01-006-F-M	1368	CHAR-TBN-01-021-F-M	1375	CHAR-TBN-01-036-F-M	1593
CHAR-TBN-01-007-F-M	1242	CHAR-TBN-01-022-F-M	1390	CHAR-TBN-01-037-F-M	1449
CHAR-TBN-01-008-F-M	1290	CHAR-TBN-01-023-F-M	1457	CHAR-TBN-01-038-F-M	1601
CHAR-TBN-01-009-F-M	1309	CHAR-TBN-01-024-F-M	1213	CHAR-TBN-01-039-F-M	1756
CHAR-TBN-01-010-F-M	1279	CHAR-TBN-01-025-F-M	2085	CHAR-TBN-01-040-F-M	1778
CHAR-TBN-01-011-F-M	1087	CHAR-TBN-01-026-F-M	1900	CHAR-TBN-01-041-F-M	1590
CHAR-TBN-01-012-F-M	1349	CHAR-TBN-01-027-F-M	1649	CHAR-TBN-01-042-F-M	1516
CHAR-TBN-01-013-F-M	1390	CHAR-TBN-01-028-F-M	1689	CHAR-TBN-01-043-F-M	1575
CHAR-TBN-01-014-F-M	1357	CHAR-TBN-01-029-F-M	1020	CHAR-TBN-01-044-F-M	1438
CHAR-TBN-01-015-F-M	1275	CHAR-TBN-01-030-F-M	983	CHAR-TBN-01-045-F-M	1468
Mean Amb.	929	**Mean Amb.**	860	**Mean Amb.**	1248
Ct. Mean	1313	**Ct. Mean**	1460	**Ct. Mean**	1530
Ct. Median	1309	**Ct. Median**	1390	**Ct. Median**	1564
Ct. Std. Dev.	109	**Ct. Std. Dev.**	309	**Ct. Std. Dev.**	139

F-M = Fixed measurement

Survey Area Name: Turbine Building Designator: **TBN-01**

Table 19
TBN-01 Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
4th FLOOR		5th FLOOR		6th FLOOR	
CHAR-TBN-01-046-F-M	1494	CHAR-TBN-01-061-F-M	1738	CHAR-TBN-01-076-F-M	1719
CHAR-TBN-01-047-F-M	1364	CHAR-TBN-01-062-F-M	1715	CHAR-TBN-01-077-F-M	1593
CHAR-TBN-01-048-F-M	1590	CHAR-TBN-01-063-F-M	1689	CHAR-TBN-01-078-F-M	1616
CHAR-TBN-01-049-F-M	1431	CHAR-TBN-01-064-F-M	1616	CHAR-TBN-01-079-F-M	1811
CHAR-TBN-01-050-F-M	1405	CHAR-TBN-01-065-F-M	1878	CHAR-TBN-01-080-F-M	1564
CHAR-TBN-01-051-F-M	1290	CHAR-TBN-01-066-F-M	1878	CHAR-TBN-01-081-F-M	1623
CHAR-TBN-01-052-F-M	1364	CHAR-TBN-01-067-F-M	1800	CHAR-TBN-01-082-F-M	1604
CHAR-TBN-01-053-F-M	1331	CHAR-TBN-01-068-F-M	1730	CHAR-TBN-01-083-F-M	1671
CHAR-TBN-01-054-F-M	1494	CHAR-TBN-01-069-F-M	1630	CHAR-TBN-01-084-F-M	1719
CHAR-TBN-01-055-F-M	1445	CHAR-TBN-01-070-F-M	1848	CHAR-TBN-01-085-F-M	1652
CHAR-TBN-01-056-F-M	1445	CHAR-TBN-01-071-F-M	1819	CHAR-TBN-01-086-F-M	1800
CHAR-TBN-01-057-F-M	1275	CHAR-TBN-01-072-F-M	1645	CHAR-TBN-01-087-F-M	1778
CHAR-TBN-01-058-F-M	1331	CHAR-TBN-01-073-F-M	1738	CHAR-TBN-01-088-F-M	1896
CHAR-TBN-01-059-F-M	1353	CHAR-TBN-01-074-F-M	1804	CHAR-TBN-01-089-F-M	1586
CHAR-TBN-01-060-F-M	1349	CHAR-TBN-01-075-F-M	1612	CHAR-TBN-01-090-F-M	1693
Mean Amb.	996	**Mean Amb.**	1125	**Mean Amb.**	1114
Ct. Mean	1397	**Ct. Mean**	1743	**Ct. Mean**	1688
Ct. Median	1364	**Ct. Median**	1738	**Ct. Median**	1671
Ct. Std. Dev.	86	**Ct. Std. Dev.**	93	**Ct. Std. Dev.**	98

F-M = Fixed measurement

Decommissioning

Planned decommissioning activities for TBN-01 include:

Removal of the stored radioactive material awaiting shipment.

Findings

Survey area TBN-01 is a structure located outside of the Controlled Area portion of the site and is shown in Figure 28.

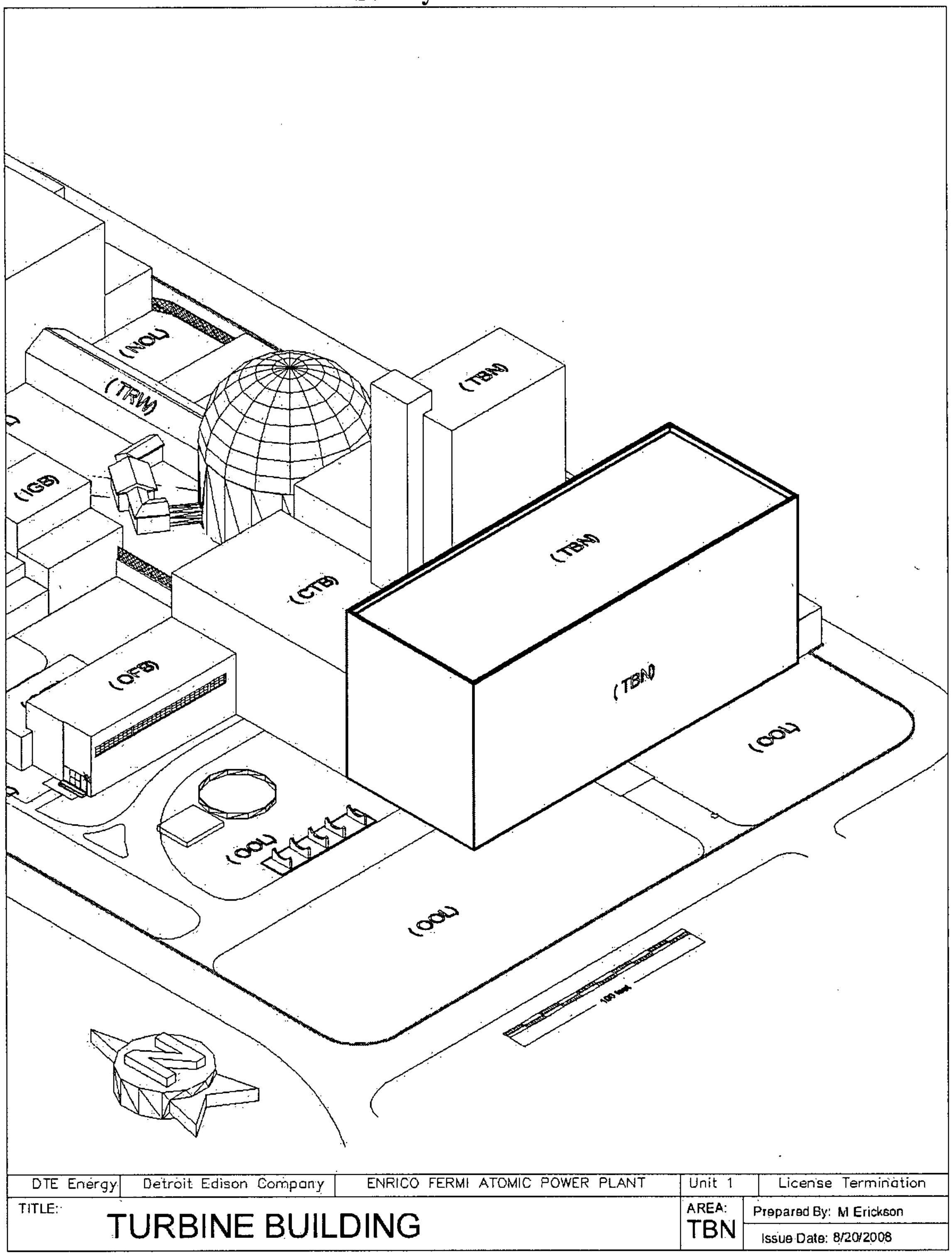
Survey area TBN-01 is impacted and likely has radioactivity concentrations that that are a small fraction of the DCGL.

Survey Area Name: Turbine Building Designator: **TBN-01**

The radionuclide mix likely to be present in TBN-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area TBN-01 are Co-60, Cs-137, Sr-90 and H-3. As a result of historical information and characterization data gathered, TBN-01 is classified as a Class 3 survey area with the exception of a portion of the 1st and 3rd floors which are Class 2 areas (classified Class 2 as a result of radioactive material storage and transfer). The radioactive material on the 1st and 3rd floors was stored in sealed containers.

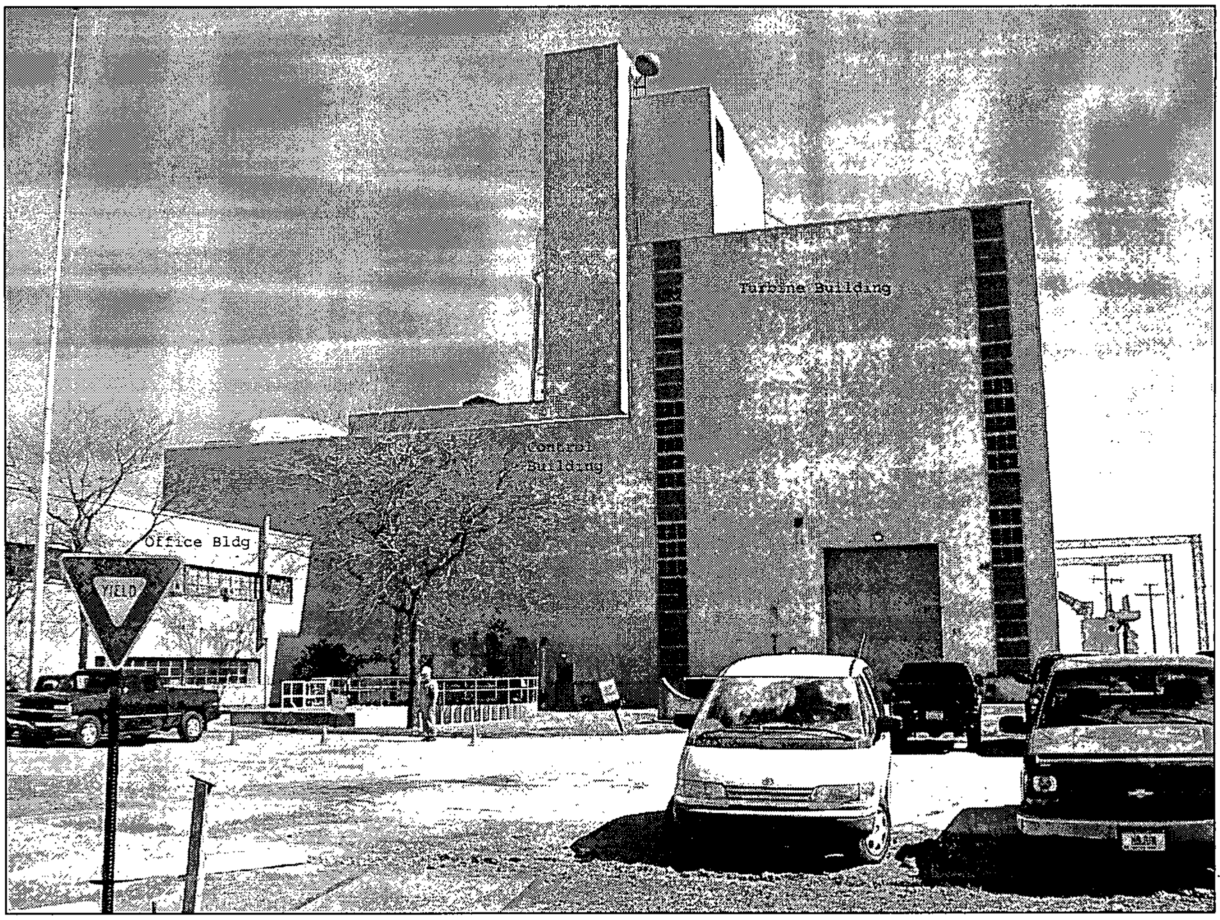
Survey Area Name: Turbine Building Designator: **TBN-01**

Figure 28
Survey Area TBN-01



Survey Area Name: Turbine Building Designator: **TBN-01**

Figure 29
Exterior of TBN-01



Survey Area Name: Office Building Designator: **OFB-01**

Survey Area Description

The Office Building is located on the west side of the Control Building and is outside the confines of the Controlled Area. This structure housed the offices, conference rooms and dining room for the project. The structure is of reinforced concrete and structural steel design. The outer walls are made of lightweight concrete block and the remainder of corrugated asbestos (transite) siding, backed up by gypsum board and hard board.

Survey Area History

All of the areas within OFB-01 are equally likely to be contaminated as a result of work activities performed in the area, however, it is not expected that OFB-01 will be contaminated to levels at a small fraction of the DCGL.

Translocation Pathways

Modes and vectors for transmigration of contaminants include:

- None.

Site modifications performed within survey area OFB-01 include:

- Renovations have been performed as room usage changed.
- Some asbestos abatement has occurred, however some asbestos remains.
- Roof repairs were made using a synthetic material.

Scoping/Characterization

Characterization data from past surveys proved to be insufficient for FSS planning activities. A Characterization was implemented on October 28, 2008 to include smears, scans and fixed-point measurements in OFB-01. An ambient measurement was achieved by taking shielded readings at five locations on each floor and five locations on the roof; and the Mean of those data was calculated. Tables 20 and 21 represent the results of this survey effort. Smears were taken at each fixed-point location. Smear results indicated no smear result greater than MDA. One-square meter beta scans were taken at each fixed-point location. No beta scan indicated results greater than background. Gamma scans were taken in the general areas (with the exception of the OFB-01 roof) as well as locations where cracks and wall-to-floor junctures were present. No gamma scan indicated results greater than background.

Survey Area Name: Office Building Designator: **OFB-01**

Table 20
OFB-01 Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
1st FLOOR		1st FLOOR (Cont'd)	
CHAR-OFB-01-003-F-M	683	CHAR-OFB-01-032-F-M	934
CHAR-OFB-01-004-F-M	742	CHAR-OFB-01-033-F-M	1676
CHAR-OFB-01-005-F-M	1067	CHAR-OFB-01-034-F-M	1030
CHAR-OFB-01-006-F-M	683	CHAR-OFB-01-035-F-M	963
CHAR-OFB-01-007-F-M	890	CHAR-OFB-01-036-F-M	879
CHAR-OFB-01-008-F-M	856	CHAR-OFB-01-037-F-M	915
CHAR-OFB-01-009-F-M	827	CHAR-OFB-01-038-F-M	1259
CHAR-OFB-01-010-F-M	768	CHAR-OFB-01-039-F-M	867
CHAR-OFB-01-011-F-M	978	CHAR-OFB-01-040-F-M	919
CHAR-OFB-01-012-F-M	864	CHAR-OFB-01-041-F-M	1100
CHAR-OFB-01-013-F-M	853	CHAR-OFB-01-042-F-M	808
CHAR-OFB-01-014-F-M	1473	CHAR-OFB-01-043-F-M	1764
CHAR-OFB-01-015-F-M	735	CHAR-OFB-01-044-F-M	1037
CHAR-OFB-01-016-F-M	1259	CHAR-OFB-01-045-F-M	775
CHAR-OFB-01-017-F-M	923	CHAR-OFB-01-046-F-M	1133
CHAR-OFB-01-018-F-M	1082	CHAR-OFB-01-047-F-M	701
CHAR-OFB-01-019-F-M	1082	CHAR-OFB-01-048-F-M	709
CHAR-OFB-01-020-F-M	823	CHAR-OFB-01-049-F-M	912
CHAR-OFB-01-021-F-M	1543	CHAR-OFB-01-050-F-M	886
CHAR-OFB-01-022-F-M	1713	CHAR-OFB-01-051-F-M	860
CHAR-OFB-01-023-F-M	1196	CHAR-OFB-01-052-F-M	1067
CHAR-OFB-01-024-F-M	1351	CHAR-OFB-01-053-F-M	1196
CHAR-OFB-01-025-F-M	1742	CHAR-OFB-01-054-F-M	941
CHAR-OFB-01-026-F-M	1045	CHAR-OFB-01-055-F-M	971
CHAR-OFB-01-027-F-M	1406	CHAR-OFB-01-056-F-M	963
CHAR-OFB-01-028-F-M	1178	CHAR-OFB-01-057-F-M	949
CHAR-OFB-01-029-F-M	945	CHAR-OFB-01-058-F-M	808
CHAR-OFB-01-030-F-M	724	CHAR-OFB-01-059-F-M	864
CHAR-OFB-01-031-F-M	709	CHAR-OFB-01-060-F-M	1082
		Mean Amb.	938
		Ct. Mean	1019
		Ct. Median	943
		Ct. Std. Dev.	275

F-M = Fixed measurement

Survey Area Name: Office Building Designator: **OFB-01**

Table 21
OFB-01 Characterization Data

Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)	Location	Result (dpm/100cm²)
2nd FLOOR		2nd FLOOR (Cont'd)		ROOF	
CHAR-OFB-01-001-F-M	1104	CHAR-OFB-01-018-F-M	1528	CHAR-OFB-01-001-F-M	1292
CHAR-OFB-01-002-F-M	1270	CHAR-OFB-01-019-F-M	1148	CHAR-OFB-01-002-F-M	1517
CHAR-OFB-01-003-F-M	952	CHAR-OFB-01-020-F-M	1111	CHAR-OFB-01-003-F-M	1550
CHAR-OFB-01-004-F-M	816	CHAR-OFB-01-021-F-M	875	CHAR-OFB-01-004-F-M	1318
CHAR-OFB-01-005-F-M	1170	CHAR-OFB-01-022-F-M	997	CHAR-OFB-01-005-F-M	1728
CHAR-OFB-01-006-F-M	1133	CHAR-OFB-01-023-F-M	997	CHAR-OFB-01-006-F-M	2019
CHAR-OFB-01-007-F-M	1325	CHAR-OFB-01-024-F-M	963	CHAR-OFB-01-007-F-M	1709
CHAR-OFB-01-008-F-M	1067	CHAR-OFB-01-025-F-M	716	CHAR-OFB-01-008-F-M	1569
CHAR-OFB-01-009-F-M	1277	CHAR-OFB-01-026-F-M	1074	CHAR-OFB-01-009-F-M	1757
CHAR-OFB-01-010-F-M	842	CHAR-OFB-01-027-F-M	1406	CHAR-OFB-01-010-F-M	1650
CHAR-OFB-01-011-F-M	915	CHAR-OFB-01-028-F-M	1030		
CHAR-OFB-01-012-F-M	934	CHAR-OFB-01-029-F-M	1059		
CHAR-OFB-01-013-F-M	1473	CHAR-OFB-01-030-F-M	890		
CHAR-OFB-01-014-F-M	1229	CHAR-OFB-01-031-F-M	1056		
CHAR-OFB-01-015-F-M	1251	CHAR-OFB-01-032-F-M	1011		
CHAR-OFB-01-016-F-M	963	CHAR-OFB-01-033-F-M	1425		
CHAR-OFB-01-017-F-M	993				
		Mean Amb.	1200	**Mean Amb.**	1361
		Ct. Mean	1091	**Ct. Mean**	1611
		Ct. Median	1059	**Ct. Median**	1609
		Ct. Std. Dev.	195	**Ct. Std. Dev.**	215

F-M = Fixed measurement

Findings

Survey area OFB-01 is a structure located outside of the Controlled Area portion of the site and is shown in Figure 30.

Survey area OFB-01 is impacted and likely has radioactivity concentrations that that are a small fraction of the DCGL.

The radionuclide mix likely to be present in TBN-01 includes all radionuclides identified in the radioactive systems of the plant. The primary radionuclides of concern for survey area TBN-01 are Co-60, Cs-137, Sr-90 and H-3. As a result of historical information and characterization data gathered, TBN-01 is classified as a Class 3 survey area

Decommissioning

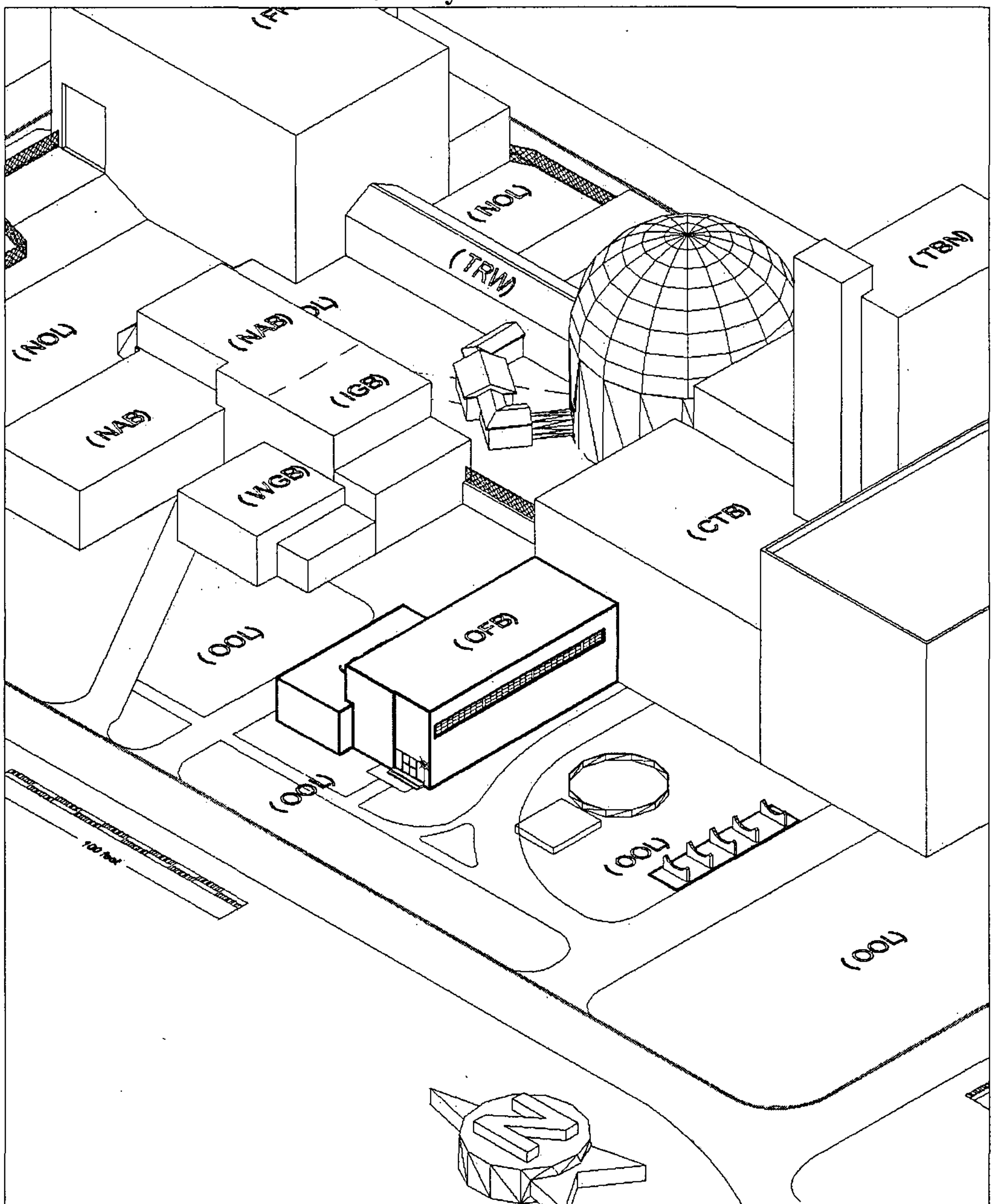
Planned decommissioning activities for OFB-01 include:

Survey Area Name: Office Building Designator: **OFB-01**

- None anticipated – subject to further evaluation.

Survey Area Name: Office Building Designator: **OFB-01**

Figure 30
Survey Area OFB-01



DTE Energy	Detroit Edison Company	ENRICO FERMI ATOMIC POWER PLANT	Unit 1	License Termination
TITLE: OFFICE BUILDING			AREA: OFB	Prepared By: M Erickson Issue Date: 8/20/2008

Survey Area Name: Office Building Designator: **OFB-01**

Figure 31

Exterior of OFB-01

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Technical Based Document, (TBD) NESF-08-0018, *Radionuclide Selection for DCGL Development*

ENCLOSURE 1

Radionuclide Selection for DCGL Development

The following table presents the radionuclides identified in Technical Based Document NESF-08-0018, "Radionuclide Selection for DCGL Development."

Table 18
EF1 Site-Specific Radionuclide Profile

H-3	Sb-125
C-14	Cs-134
Na-22	Cs-137
Fe-55	Eu-152
Ni-59	Eu-154
Co-60	Eu-155
Ni-63	Pu-238
Sr-90	Pu-239/240
Nb-94	Pu-241
Tc-99	Am-241
Ag-108m	Cm-242/243

Technical Based Document NSEF-08-0018

Detroit Edison

Enrico Fermi Unit 1

Radionuclide Selection for DCGL Development

Martin C. Erickson

July 21, 2008

Approved by: ____________ Date: 7-30-08
EF1 Health Physicist

Table of Contents

1.0 Executive Summary

An integral part in the development of the site-specific Derived Concentration Guideline Levels (DCGLs) for Enrico Fermi Unit 1 (EF1) is the identification of potential radionuclides present, at the time of Final Status Survey (FSS), which will contribute to the dose based assessment of the radiological status of the site. Radionuclide selection is a systematic approach to the identification of the potential nuclides and a deselecting of those nuclides which would not be present or would be present in insignificant concentrations.

The initial step in this process is to develop a theoretical suite of radionuclides that would be present in a reactor at shutdown. Comparisons of the materials present in EF1 were compared to those in a typical Pressurized Water Reactor (PWR) so as to identify possible anomalies in the activation analysis. Additional nuclides were added to the list based on previous analyses and documentation. Radionuclides with half-lives of two years or less were omitted from the list since these nuclides would have decayed at least eighteen half-lives since shutdown.

The next step was to determine which individual nuclides on the list would contribute 0.1 percent or less to the total activity present, providing the total activity from all discounted nuclides did not exceed one percent of the total activity. The total activity of all discounted nuclides equaled approximately 0.005 percent. Several nuclides met the criteria of contributing less than 0.1 percent to the total activity but could not be discounted because they have other methods of production in addition to activation of reactor components and/or have been observed in 10 CFR Part 61 waste stream analyses or site characterization samples.

In order to evaluate compliance with the dose criteria for discounted radionuclides, doses for both residential and occupancy scenarios for those nuclides supported by the DandD code were generated. The calculated total dose from discounted NUREG/CR-3473 radionuclides represents only 0.51 percent of the total calculated dose for the residential scenario. The calculated total dose from discounted NUREG/CR-3473 radionuclides represents only 0.02 percent for the occupancy scenario. The activity represented by the radionuclides not supported by the DandD code resulted in a calculated total dose contribution of $2.83E^{-02}$ percent for inhalation exposure-to-dose conversion factors (DCFs) and $4.05E^{-03}$ percent for ingestion DCFs.

As a result of the analysis, an EF1 suite of nuclides was developed from the theoretical set of nuclides and the deletion of the remaining nuclides was justified.

2.0 Introduction

EF1 was a fast breeder reactor power plant cooled by sodium and operated at essentially atmospheric pressure. The reactor plant was designed for a maximum capability of 430 Mwt; however, the maximum reactor power with the first core loading (Core A) was 200 Mwt. The primary system was filled with sodium in December of 1960 and criticality was achieved in August 1963. The reactor was tested at low power in its first couple years of operation. Power ascension testing above 1 Mwt commenced in December 1965, immediately following receipt of the high power operating license. In October 1966, during power ascension, zirconium plates at the bottom of the reactor vessel became loose and blocked sodium coolant flow to some fuel subassemblies. Two subassemblies started to melt. Three years and nine months later, the cause had been determined, cleanup completed, fuel replaced, and EF1 was restarted. In 1972, the core was approaching the burnup limit. In November, 1972, Power Reactor Development Company (PRDC) made the decision to decommission EF1.

Subsequent management decision determined that EF1 should be fully decommissioned up to, and including, the termination of the SAFSTOR license.

As a part of the source-term abstraction process at EF1, a site-specific suite of radionuclides potentially present in the site environs, or present as contamination on structural surfaces, at the time of FSS, must be identified. The purpose of this Technical Based Document is to provide the identification of those radionuclides and methodology behind the selection process.

3.0 Technical Position

Few documents address sodium cooled breeder reactors; therefore, it is necessary to conservatively apply a "best-fit" model for the determination of radionuclides present in EF1.

The theoretical suite of radionuclides that could potentially still be present at EF1 (based upon the guidance contained in NUREG/CR-3474) is provided in Table 1 along with their half-lives and mode of decay. All gamma spectrometry analyses that are performed onsite for characterization or FSS surveys should include the detectable gamma emitters listed in Table 1 in the gamma spectrometry libraries for analysis. Characterization or FSS samples sent to an offsite laboratory for analysis shall be analyzed for the narrowed suite of radionuclides listed in Table 8.

4.0 Limitations

The suite of radionuclides listed in Table 1 is a theoretical list based on NUREG/CR-3474 and should not be used as a site-specific suite for developing DCGLs. The suite of radionuclides listed in Table 8 is an EF1 site-specific suite of radionuclides for developing site-specific DCGLs.

5.0 Technical Bases

5.1 Reactor Vessel Construction

EF1 reactor vessel wall construction is of 304L stainless steel, whereas typical PWR vessel construction is of carbon steel. The activation patterns for carbon steel are similar to that of stainless steel with, however, a lessened importance with regard to Co and Ni. Typical PWR vessel internals are constructed of 304L stainless steel which differs slightly from the vessel internals composition of EF1. EF1 vessel internals located within the flux region of the reactor include:

- Holddown Mechanism (304L and 347L stainless)
- Offset Handling Mechanism (304L stainless)
- Sweep Mechanism (304L stainless)
- Support Plates (347L stainless)

Note: 347L stainless steel is essentially 304L stainless stabilized with niobium (Coates & Jenkinson, 2007) resulting in minor neutronic differences, other than the increased presence of Nb-94, therefore exhibiting similar activation patterns as the 304L stainless.

The total mass of the EF1 components is comparable to the mass of the typical PWR internals (45, 182 kg. vs. 49,508 kg.). The total mass of EF1 vessel (including the Rotating Shield Plug) is somewhat less than the total mass of the typical PWR vessel (161,182 kg. vs. 245,582 kg.) rendering a more conservative result in the radionuclide inventory.

It is therefore appropriate to compare the activation profile of EF1 to that of a typical PWR with some minor modifications that will be explained later.

5.2 Theoretical Suite of Radionuclides

Development of the suite of radionuclides listed in Table 1 began with NUREG/CR-3474. This NUREG assessed the problems posed to reactor decommissioning by long-lived activation products in reactor construction materials. Samples of stainless steel, vessel steel, concrete and concrete ingredients were analyzed for up to 52 elements in order to develop a database of activated major, minor and trace elements. The list of radionuclides was developed by combining those radionuclides listed in Table 5.13, "Activity Inventory of PWR Internals at Shutdown (Total Ci)," and Table 5.15, "Inventories of PWR and BWR Vessel Walls at Shutdown (Total Ci)". Only radionuclides with half-lives of two or more years were included on the list. Radionuclides with half-lives less than two years would not be expected to be observed since two years or less represents eighteen or more half-lives since final shutdown of the EF1 reactor. It is of note that the Table 1 suite of nuclides was based on the activation of plant materials after 30 Effective Full Power Years (EFPY) of operation. EF1's operating history shows a cumulative operation of approximately 33.5 Effective Full Power Days

(EFPD), considerably less than the NUREG/CR-3474 model. This may be somewhat offset by the higher flux present in a fast breeder reactor in the 10^2 to 10^7 ev neutron energy range (DOE, 1993) and, to a much lesser degree, by the power production in the blanket region of the reactor.

Additionally, U-234, U-235, U-236 and U-238 were added because they were identified in NCRP Report No. 58, Table 16 as being present in power reactor fuel.

Normally, levels of transuranic actinides are very low in commercial reactors; however because of the unknowns present in a Liquid Metal Fast Breeder Reactor (LMFBR), the major actinides Pu-238, Pu-239/240, Pu-241 as well as the minor actinides Am-241 and Cm-242/243 were added to the theoretical suite of nuclides.

Table 1
Theoretical Suite of Radionuclides

Radionuclide	Half Life (Years)	Decay Mode	Radionuclide	Half Life (Years)	Decay Mode
*H-3	$1.23E^{+01}$	β	Ag-108m	$1.27E^{+02}$	γ
*C-14	$5.73E^{+03}$	β	*Cs135	$2.30E^{+06}$	β
Na-22	$2.60E^{+00}$	β^+, γ	Cs-137	$3.02E^{+01}$	γ
*Cl-36	$3.01E^{+05}$	β, γ	Pm-145	$1.77E^{+01}$	γ
*Ar-39	$2.69E^{+02}$	β	*Sm-146	$1.00E^{+08}$	α
K-40	$1.28E^{+09}$	β, γ	*Sm-151	$9.30E^{+01}$	β, γ
*Ca-41	$1.03E^{+05}$	β^+, γ	Eu-152	$1.36E^{+01}$	β, γ
*Mn-53	$3.70E^{+06}$	γ	Eu-154	$8.80E^{+00}$	β, γ
*Fe-55	$2.70E^{+00}$	β	Eu-1 55	$4.96E^{+00}$	β, γ
*Ni-59	$7.50E^{+04}$	β	Tb-158	$1.50E^{+02}$	β
Co-60	$5.27E^{+00}$	β, γ	Ho-166m	$1.20E^{+03}$	β, γ
*Ni-63	$1.00E^{+02}$	β	*Hf-178m	$3.00E^{+01}$	IT, γ
*Se-79	$6.50E^{+04}$	β	*Pb-205	$1.51E^{+07}$	γ
Kr-81	$2.10E^{+05}$	γ	*U-233	$1.59E^{+05}$	α, γ
Kr-85	$1.07E^{+01}$	β, γ	*U-234	$2.45E^{+05}$	α, γ
*Sr-90	$2.86E^{+01}$	β	U-235	$7.04E^{+08}$	α, γ
*Zr-93	$1.53E^{+06}$	β	*U-236	$2.34E^{+07}$	α, γ
*Mo-93	$3.50E^{+00}$	γ	*U-238	$4.47E^{+09}$	α, γ
**Nb-92m	$1.46E^{+01}$	γ	*Pu-238	$8.78E^{+01}$	α, γ
Nb-94	$2.03E^{+04}$	β, γ	*Pu-239	$2.41E^{+04}$	α, γ
*Tc-99	$2.13E^{+05}$	β, γ	*Pu-240	$6.60E^{+03}$	α, γ
*Sn-121 m	$5.00E^{+00}$	β	*Pu-241	$1.44E^{+01}$	α
Sb-125	$2.77E^{+00}$	β, γ	Am-241	$4.32E^{+02}$	α, γ
*I-129	$1.57E^{+07}$	β, γ	Cm-242	$2.85E^{+01}$	α, γ
Ba-133	$1.05E^{+01}$	γ	*Cm-243	$2.91E^{+01}$	α, γ
Cs-134	$2.06E^{+00}$	β, γ			

α -Alpha decay β^+- Positron decay β -Beta decay γ -Gamma decay IT - Isomeric transition
*Hard to Detect Nuclides (HTDN) - radionuclides not readily detected by gamma

spectroscopy requiring offsite, contract laboratory analysis
** Although listed in both Tables in NUREG/CR-3474, the half-life is incorrectly listed as $2.70E^{+07}$ years. The actual half-life of Nb-92m is 10.15 days and is therefore excluded from the theoretical suite of nuclides. No isotopes of Nb have a half-life of $2.70E^{+07}$ years.

5.3 *Discounting Insignificant Radionuclides*

5.3.1 Activation Product Considerations

Since Table 1 includes trace-elements that would not likely be found at EF1due to their low abundance, an evaluation of radionuclides that may be discounted as being of potential importance was performed. The total inventory for each radionuclide was determined from activity inventories provided in Table 5.13 and Table 5.15 of NUREG/CR-3474. From this information, the percentage of total inventory for each radionuclide (decayed to 01/01/08) was calculated. The results of this evaluation are provided in Table 2.

Table 2
NUREG/CR-3474 Evaluation

Nuclide	shroud	core barrel	thermal pads	vessel	total activity	% Total	Less than 0.1%?
H-3	12.90	22.70	2.50	2.35	4.045E+01	2.211E-02	YES*
C-14	231.01	50.78	3.68	0.28	2.858E+02	1.562E-01	
Cl-36	4.70	1.10	0.081	0.017	5.898E+00	3.224E-03	YES
Ar-39	1.28	0.13	2.74E-03	0.034	1.447E+00	7.908E-04	YES
Ca-41	0.043	9.55E-03	6.97E-04	2.20E-04	5.347E-02	2.923E-05	YES
Mn-53	3.00E-02	3.60E-03	8.10E-05	4.06E-04	3.409E-02	1.863E-05	YES
Mn-54	2.52E-08	2.56E-09	6.08E-11	2.53E-11	2.785E-08	1.522E-11	YES
Fe-55	256.94	53.89	3.95E+00	2.46E+00	3.172E+02	1.734E-01	
Ni-59	1.02E+03	324.00	2.43E+01	6.55E-01	1.369E+03	7.483E-01	
Co-60	1.18E+04	2338.21	1.58E+02	1.15E+01	1.431E+04	7.821E+00	
Ni-63	1.32E+05	3.21E+04	2.41E+03	6.24E+01	1.666E+05	9.106E+01	
Zn-65	8.82E-13	1.00E-13	7.08E-15	1.30E-15	9.904E-13	5.414E-16	YES
Se-79	5.70E-03	7.85E-04	3.80E-05	7.90E-07	6.524E-03	3.566E-06	YES
Kr-81	7.10E-03	5.80E-05	2.84E-07	2.80E-08	7.158E-03	3.913E-06	YES
Kr-85	8.20E-01	3.00E-02	7.98E-04	3.10E-03	8.539E-01	4.668E-04	YES
Sr-90	7.97E+00	3.60E-02	9.00E-03	3.56E-04	8.015E+00	4.382E-03	YES*
Zr-93	1.00E-03	6.70E-05	2.00E-06	3.00E-06	1.072E-03	5.860E-07	YES
Mo-93	8.00E-03	6.00E-04	1.60E-05	2.16E-04	8.832E-03	4.828E-06	YES
Nb-94	3.70E+00	4.94E-01	2.40E-02	1.10E-02	4.229E+00	2.312E-03	YES*
Tc-99	1.20E+00	1.40E-01	3.40E-03	5.50E-02	1.398E+00	7.644E-04	YES*
Ag-108m	8.80E-01	1.40E-01	8.40E-03	1.08E-02	1.039E+00	5.681E-04	YES*
Sn-121m	3.35E-04	4.41E-05	1.05E-06	2.97E-06	3.831E-04	2.094E-07	YES
I-129	6.00E-06	2.39E-07	6.40E-09	2.50E-10	6.246E-06	3.414E-09	YES

Nuclide	shroud	core barrel	thermal pads	vessel	total activity	% Total	Less than 0.1%?
Ba-133	2.65E+00	5.00E-01	3.50E-02	9.82E-03	3.195E+00	1.746E-03	YES
Cs-134	4.82E-04	1.26E-04	1.01E-05	2.00E-06	6.201E-04	3.390E-07	YES*
Cs-135	4.00E-04	1.50E-05	4.10E-07	3.60E-08	4.154E-04	2.271E-07	YES
Cs-137	8.44E+00	3.80E-01	1.00E-02	8.89E-04	8.831E+00	4.827E-03	YES*
Pm-145	2.06E-03	6.16E-04	4.59E-05	3.10E-06	2.725E-03	1.490E-06	YES
Sm-146	9.30E-10	2.21E-10	5.50E-12	3.00E-12	1.160E-09	6.338E-13	YES
Sm-151	3.30E-02	5.90E-02	2.00E-02	2.85E-03	1.149E-01	6.278E-05	YES
Eu-152	0.00E+00	3.00E-03	2.30E-01	5.15E-01	7.480E-01	4.089E-04	YES*
Eu-154	3.00E-01	6.00E-01	3.00E-02	5.90E-02	9.890E-01	5.406E-04	YES*
Eu-155	2.30E-02	1.40E-02	2.41E-04	3.63E-05	3.728E-02	2.038E-05	YES*
Tb-158	1.50E-02	2.50E-03	5.86E-04	1.87E-04	1.827E-02	9.989E-06	YES
Ho-166m	1.50E+00	2.21E-01	8.90E-03	2.00E-02	1.750E+00	9.566E-04	YES
Hf-178m	1.80E-01	2.12E-01	1.10E-02	5.10E-03	4.081E-01	2.231E-04	YES
Pb-205	1.70E-05	2.00E-06	1.05E-07	2.00E-06	2.111E-05	1.154E-08	YES
U-233	3.30E-03	1.70E-03	8.90E-05	5.00E-05	5.139E-03	2.809E-06	YES
Pu-239	6.50E-02	3.90E-02	1.00E-03	1.10E-03	1.061E-01	5.800E-05	YES*
				Total	1.829E+05	100	
				Total % of discounted		4.936E-03	

* Radionuclides meet the criteria of contributing less than 0.1 percent of the total activity but cannot be discounted because they have other methods of production in addition to activation of reactor components and/or have been observed in 10 CFR Part 61 waste stream analyses or site characterization samples.

5.3.2 Potential Discounted Dose Considerations

Based on the above evaluation, it was determined that individual radionuclides which contributed less than 0.1 percent of the total activity in Table 2 could be discounted from the list of Table 1 identified radionuclides providing that potential dose contributed by the sum of the radionuclides discounted does not exceed one percent of the total calculated dose. The radionuclides that meet the criteria of contributing less than 0.1 percent-of the total activity include:

CI-36	Ar-39	Ca-41	Mn-53	MN-54	Zn-65	Se-79	Kr-81
Kr-85	Zr-93	Mo-93	Sn-121m	I-129	Ba-133	Cs-135	Pm-145
Sm-146	Sm-151	Tb-158	Ho-166m	Hf-178m	Pb-205	U-233	

Although originally included in the list of theoretical radionuclides, the naturally occurring radionuclides K-40, U-234, U-235, U-236 and U-238 have not been detected in characterization/waste stream samples at concentrations distinguishable from naturally occurring concentrations. Therefore, these radionuclides have been discounted from any further consideration. In order to evaluate compliance with the dose criteria for discounted radionuclides, the NRC developed computer code DandD, Version 2.1.0 was used to calculate doses for both residential and occupancy scenarios for those nuclides supported by the DandD code. The DandD code was used with the

NRC determined default parameters to represent a conservative screening tool. Input concentrations for each radionuclide used in the residential scenario were their percent of total activity input as concentration in pCi/g. Input concentrations-for each radionuclide used in the occupancy scenario were 1,000 times their percent of total activity input as surface contamination in dpm/100 cm^2. Calculated doses for the following nuclides were developed using the DandD code:

Cl-36 Ca-41 Mn-54 Zn-65 Se-79 Zr-93 Mo-93
1-129 Cs-135 Sm-151 Ho-166m U-233 Sn-121m

The calculated total dose from discounted NUREG radionuclides represents only 0.51 percent of the total calculated dose for the residential scenario. The calculated total dose from discounted NUREG radionuclides represents only 0.02 percent for the occupancy scenario. Therefore, it is appropriate to discount these radionuclides. Summary reports for the DandD calculations are included in Attachment A. Summary Results are depicted in Tables 3 and 4.

Table 3
Summary DandD Building Occupancy

Building Occupancy			
	Not Discounted		Discounted
Nuclide	All Pathways Dose	Nuclide	All Pathways Dose
3H	4.87E-06	41Ca	1.37E-07
14C	1.16E-03	54Mn	1.21E-11
55Fe	1.08E-03	79Se	1.20E-07
59Ni	5.00E-03	93Zr	4.48E-07
60Co	2.82E+01	93Mo	3.70E-07
63Ni	1.42E+00	121mSn	7.50E-09
90Sr	1.41E-02	129I	2.63E-09
94Nb	7.26E-03	135Cs	4.33E-09
99Tc	1.65E-05	151Sm	4.49E-06
134Cs	6.69E-07	166mHo	4.05E-03
137Cs	6.41E-04	233U	9.06E-04
152Eu	8.29E-04	36Cl	1.83E-04
154Eu	1.22E-03	65Zn	2.84E-16
155Eu	3.48E-06		
239Pu	5.95E-02	**Total**	5.14E-03
		% Total	0.02
Total	2.97E+01		

Table 4
Summary DandD Residential

Residental			
	Not Discounted		**Discounted**
Nuclide	**All Pathways Dose**	**Nuclide**	**All Pathways Dose**
3H	6.32E-03	41Ca	1.33E-05
14C	1.04E-01	54Mn	2.64E-11
55Fe	4.20E-04	79Se	4.52E-07
59Ni	2.07E-03	93Zr	5.83E-09
60Co	5.26E+01	93Mo	6.26E-07
63Ni	6.88E-01	121mSn	2.86E-09
90Sr	8.13E-02	129I	3.84E-08
94Nb	1.00E-02	135Cs	2.73E-08
99Tc	1.30E-03	151Sm	8.98E-08
134Cs	1.52E-06	166mHo	4.30E-03
137Cs	4.43E-03	233U	3.49E-06
152Eu	1.18E-03	36Cl	2.72E-01
154Eu	1.69E-03	65Zn	1.47E-15
155Eu	1.80E-06		
239Pu	6.64E-04	**Total**	2.76E-01
		% Total	0.52
Total	5.35E+01		

DandD does not support the following radionuclides and could not calculate their dose contribution:

Ar-39 Mn-53 Kr-81 Kr-85 Ba-133
Pm-145 Sm-146 Tb-158 Hf-178m Pb-205

The activity represented by the radionuclides not supported by the DandD code is calculated to be only 4.94E^{-03} percent of the total activity presented in NUREG/CR-3474. Of these radionuclides, Ar-39, Kr-81 and Kr-85 are noble gases and it is highly unlikely that they would still be present in soil and on structural surfaces. Therefore, it is appropriate to discount Ar-39, Kr-81 and Kr-85. Potential dose contribution from the remaining radionuclides not supported by the DandD code was evaluated by comparison of the inhalation and ingestion DCFs contained in Federal Guidance Report No.11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion.* Weighted DCFs were calculated for each discounted radionuclide and summed for both inhalation and ingestion DCFs. These totals were then compared to the sum of the weighted DCFs for the two most abundant radionuclides, Co-60 and Ni-63. This resulted in a total of 2.83E^{-02} percent for inhalation DCFs and 4.05E^{-03} percent for ingestion DCFs. The calculations to demonstrate these results are provided in Table 5.

Table 5
Nuclides not supported by DandD

Radionuclide	Percent Total	Inhalation DCF*	Inhalation Weighted DCF	Inhalation % Total Wt DCF	Ingestion DCF*	Ingestion Weighted DCF	Ingestion % Total Wt DCF
Mn-53	1.86E-05	1.35E-10	2.51E-15	4.66E-07	2.92E-11	5.43E-16	7.64E-07
Ba-133	1.74E-03	2.11E-09	3.67E-12	6.82E-04	9.19E-10	1.60E-12	2.25E-03
Pm-145	1.49E-06	8.23E-09	1.23E-14	2.28E-06	1.28E-10	1.91E-16	2.68E-07
Sm-146	6.34E-13	8.26E-05	5.24E-17	9.72E-09	5.51E-08	3.49E-20	4.91E-11
Tb-158	9.99E-06	6.91E-08	6.90E-13	1.28E-04	1.19E-09	1.19E-14	1.67E-05
Hf-178m	2.23E-04	6.65E-07	1.48E-10	2.75E-02	5.68E-09	1.27E-12	1.78E-03
Pb-205	1.15E-08	1.06E-09	1.22E-17	2.26E-09	4.41E-10	5.07E-18	7.13E-09
			Total	2.83E-02		Total	4.05E-03
Co-60	7.82	5.91E-08	4.62E-07		7.28E-09	5.69E-08	
Ni-63	91.06	8.39E-10	7.64E-08		1.56E-10	1.42E-08	
		Total	5.39E-07		Total	7.11E-08	

*Effective Committed Dose Equivalent per Unit Intake (Sv/Bq)

Additionally the potential external dose contribution from the remaining radionuclides not supported by the DandD code was evaluated by comparing the summed weighted Exposure to Contaminated Ground Surface DCFs contained in Federal Guidance Report No.12, *External Exposure to Radionuclides in Air, Water, and Soil for the comparison of the external dose component* to the most abundant gamma producing radionuclide Co-60. No external dose component contributed greater than $6.12E^{-03}$ percent as shown in Table 6.

Table 6
Weighted external dose comparison

% Total Weighted DCF									
Nuclide	**Gonad**	**Breast**	**Lung**	**R Marrow**	**BSurface**	**Thyroid**	**Remainder**	**Effective**	**Skin**
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	3.89E-03	4.00E-03	3.56E-03	3.39E-03	5.37E-03	3.80E-03	3.51E-03	3.76E-03	4.14E-03
Pm-145	3.08E-07	3.36E-07	2.00E-07	1.39E-07	7.17E-07	2.47E-07	2.03E-07	2.64E-07	3.79E-07
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tb-158	4.23E-05	4.24E-05	4.13E-05	4.06E-05	4.85E-05	4.30E-05	4.10E-05	4.20E-05	5.42E-05
Hf-178m	2.82E-03	2.85E-03	2.76E-03	2.69E-03	3.53E-03	2.89E-03	2.71E-03	2.80E-03	2.98E-03
Pb-205	1.27E-11	2.88E-11	6.67E-14	1.19E-12	5.34E-12	2.00E-12	4.65E-12	9.39E-12	6.50E-10
Total	**6.75E-03**	**6.90E-03**	**6.36E-03**	**6.12E-03**	**8.95E-03**	**6.73E-03**	**6.27E-03**	**6.60E-03**	**7.17E-03**

Therefore, it is appropriate to discount all of the radionuclides not supported by the DandD code.

5.4 Activation Analysis

In 2005 an activation analysis of EF1 was performed to determine the activity and radionuclides present in EF1. The analysis took into consideration the materials present and the power operation history. The following results were noted:

- The total specific activity is quite low everywhere with negligible neutron activation outside the primary shield tank.
- The isotopes with the largest relative contribution for most zones are Co60 and Ni63 and, to a lesser extent, Fe55, in a few selected regions.

The radionuclides in the activation analysis (Table 7) were compared with the nuclide suite after deselection. Ca-41 and Mn-54 had been deselected and comprise a very small fraction in the activation analysis therefore those radionuclides will remain deselected. Cr-51, Fe-59 and Co-58 will remain discounted due to the small fraction and their half-lives less than two years.

Table 7
Activation analysis

Nuclide	Fraction
H-3	.004
C-14	.005
Ca-41	$7.6E^{-07}$
Cr-51	0.00
Mn-54	$1.6E^{-08}$
Fe-55	0.1
Fe-59	0.00
Co-58	0.00
Co-60	0.20
Ni-59	0.02
Ni-63	0.673
Nb-94	$3.06E^{-04}$
Eu-152	$5.59E^{-05}$
Eu-154	$4.45E^{-05}$
Eu-155	$8.11E^{-08}$

5.5 10CFR61 Analysis

A review of liquid waste system water samples and smear analyses performed from 1989 through 1998 identified the following radionuclides:

H-3	Cs-137
C-14	Pu-238
Fe-55	Pu-239/240

Co-60	Am-241
Ni-63	Cm-242/243
Sr-90	

A review of past analyses has indicated the presence of Na-22, which is expected in a LMFBR, and is included in Table 6. Even though the analyses from 1989 through 1998 had not indicated the presence of Pu-241 it is prudent to include this radionuclide in the EF1 site-specific radionuclide profile due to the presence of Am-241.

A composite of smears taken on the reactor vessel internals were sent for analysis in the summer of 2007 with the following radionuclides identified:

Ni-63	C-14
Pu-238	Sr-90
Cs-137	Pu-239/240

Since the above mentioned radionuclides have been identified in previous analyses, they have been included in the EF1 site-specific suite of nuclides even though their dose contribution may be less than 0.1%.

6.0 Conclusion

As a result of the analysis of potential radionuclides present in EF1, at the time of FSS, the suite of nuclides was narrowed down to the ones depicted in Table 8. The radionuclides rejected from the theoretical suite of nuclides were analyzed and found that they would either not be present, or if present, would be at concentrations contributing insignificantly to the total dose.

Table 8
EF1 Site-Specific Radionuclide Profile

H-3	Sb-125
C-14	Cs-134
Na-22	Cs-137
Fe-55	Eu-152
Ni-59	Eu-154
Co-60	Eu-155
Ni-63	Pu-238
Sr-90	Pu-239/240
Nb-94	Pu-241
Tc-99	Am-241
Ag-108m	Cm-242/243

7.0 References

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Attachment A

DandD Calculation Reports

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 6/30/2008 8:05:21 PM
Site Name: EF1
Description: Analysis of potential dose of nuclides not discounted for building occupancy
FileName:C:\Documents and Settings\Marty\My Documents\DnD_Bld2.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 2.21E+01
14C	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 1.56E+02
55Fe	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 1.73E+02
59Ni	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 7.48E+02
60Co	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 7.82E+03

63Ni	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 9.11E+04
90Sr	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 4.38E+00
94Nb	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 2.31E+00
99Tc	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 7.64E-01
134Cs	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 3.39E-04
137Cs	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 4.83E+00
152Eu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 4.09E-01
154Eu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 5.41E-01
155Eu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 2.04E-02
239Pu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 5.80E-02

Chain Data:

Number of chains: **15**

Chain No. 1: **3H**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
3H	1	4.51E+03					1.73E-11	1.73E-11	0.00E+00	0.00E+00

Chain No. 2: **14C**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE	Inhalation CEDE	Surface Dose Rate	15 cm Dose Rate

							Factor (Sv/Bq)	Factor (Sv/Bq)	Factor ((Sv/d)/(Bq/m^2))	Factor ((Sv/d)/(Bq/m^3))
14C	1	2.09E+06					5.64E-10	5.64E-10	1.39E-15	6.22E-18

Chain No. 3: **55Fe**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
55Fe	1	9.86E+02					1.64E-10	7.26E-10	0.00E+00	0.00E+00

Chain No. 4: **60Co**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
60Co	1	1.93E+03					7.28E-09	5.91E-08	2.03E-10	6.26E-12

Chain No. 5: **59Ni**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
59Ni	1	2.74E+07					5.67E-11	7.31E-10	0.00E+00	0.00E+00

Chain No. 6: **63Ni**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
63Ni	1	3.51E+04					1.56E-10	1.70E-09	0.00E+00	0.00E+00

Chain No. 7: **90Sr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))

90Sr	1	1.06E+04					3.85E-08	3.51E-07	2.46E-14	3.21E-16
90Y	2	2.67E+00	1	1	0	0	2.91E-09	2.28E-09	4.60E-13	1.03E-14

Chain No. 8: **94Nb**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
94Nb	1	7.41E+06					1.93E-09	1.12E-07	1.32E-10	3.91E-12

Chain No. 9: **99Tc**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
99Tc	1	7.78E+07					3.95E-10	2.25E-09	6.73E-15	5.79E-17

Chain No. 10: **134Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
134Cs	1	7.53E+02					1.98E-08	1.25E-08	1.31E-10	3.86E-12

Chain No. 11: **137Cs**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
137Cs	1	1.10E+04					1.35E-08	8.63E-09	2.46E-14	3.40E-16
137mBa	Implicit		1	0.946			0.00E+00	0.00E+00	5.06E-11	1.48E-12

Chain No. 12: **152Eu**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))

152Eu	1	4.87E+03					1.75E-09	5.97E-08	9.53E-11	2.78E-12
152Gd	2	3.94E+16	1	0.2792			4.34E-08	1.01E-06	0.00E+00	0.00E+00

Chain No. 13: **154Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
154Eu	1	3.21E+03					2.58E-09	7.73E-08	1.02E-10	3.04E-12

Chain No. 14: **155Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
155Eu	1	1.81E+03					4.13E-10	1.12E-08	5.10E-12	8.42E-14

Chain No. 15: **239Pu**
Nuclides in chain: **14**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
239Pu	1	8.79E+06					9.56E-07	1.16E-04	3.17E-14	1.31E-16
235U	2	2.57E+11	1	1	0	0	7.19E-08	3.32E-05	1.28E-11	3.24E-13
231Th	3	1.06E+00	2	1	0	0	3.65E-10	2.37E-10	1.60E-12	1.68E-14
231Pa	4	1.20E+07	3	1	0	0	2.86E-06	3.47E-04	3.52E-12	8.30E-14
227Ac	5	7.95E+03	4	1	0	0	3.80E-06	1.81E-03	1.36E-14	2.26E-16
223Fr	Implicit		5	0.0138			2.33E-09	1.68E-09	4.88E-12	8.74E-14
227Th	6	1.87E+01	5	0.9862	0	0	1.03E-08	4.37E-06	8.94E-12	2.29E-13
223Ra	7	1.14E+01	6	1	5	0.0138	1.78E-07	2.12E-06	1.11E-11	2.67E-13
219Rn	Implicit		7	1			0.00E+00	0.00E+00	4.74E-12	1.33E-13
215Po	Implicit		7	1			0.00E+00	0.00E+00	1.51E-14	4.30E-16
211Pb	Implicit		7	1			1.42E-10	2.35E-09	4.38E-12	1.26E-13
211Bi	Implicit		7	1			0.00E+00	0.00E+00	3.96E-12	1.10E-13
211Po	Implicit		7	0.0028			0.00E+00	0.00E+00	6.57E-13	1.94E-14
207Tl	Implicit		7	0.9972			0.00E+00	0.00E+00	3.25E-13	8.19E-15

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Nuclide	Surface Concentration (dpm/100 cm**2)
3H	2.21E+01
14C	1.56E+02
55Fe	1.73E+02
59Ni	7.48E+02
60Co	7.82E+03
63Ni	9.11E+04
90Sr	4.38E+00
90Y	0.00E+00
94Nb	2.31E+00
99Tc	7.64E-01
134Cs	3.39E-04
137Cs	4.83E+00
137mBa	4.57E+00
152Eu	4.09E-01
152Gd	0.00E+00
154Eu	5.41E-01
155Eu	2.04E-02
239Pu	5.80E-02
235U	0.00E+00
231Th	0.00E+00
231Pa	0.00E+00
227Ac	0.00E+00
223Fr	0.00E+00
227Th	0.00E+00
223Ra	0.00E+00
219Rn	0.00E+00
215Po	0.00E+00
211Pb	0.00E+00
211Bi	0.00E+00
211Po	0.00E+00
207Tl	0.00E+00

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
To:Time In Building	The time in the building during the occupancy period	CONSTANT(hr/week)
Default value used		Value 4.50E+01
Tto:Occupancy Period	The duration of the occupancy exposure period	CONSTANT(days)
Default value used		Value 3.65E+02
Vo:Breathing Rate	The average volumetric breathing rate during building occupancy for an 8-hour work day	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	DERIVED(1/m)
Default value used		
GO*:Ingestion Rate	Effective secondary ingestion transfer rate of removable surface activity from building surfaces to the mouth during building occupancy = GO * Fl	DERIVED(m**2/hr)
Default value used		
Tstart:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
Tend:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+02
dt:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
Pstep:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
AOExt:External Exposure Area	Minimum surface area to which occupant is exposed via external radiation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOInh:Inhalation Exposure Area	Minimum surface area to which occupant is exposed via inhalation during occupancy period	CONSTANT(m**2)

Default value used		Value 1.00E+01
AOIng:Secondary Ingestion Exposure Area	Minimum surface area to which occupant is exposed via secondary ingestion during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AO:Exposure Area	Minimum surface area to which occupant is exposed during the occupancy period	DERIVED(m**2)
Default value used		
Fl:Loose Fraction	Fraction of surface contamination available for resuspension and ingestion	CONSTANT(none)
Default value used		Value 1.00E-01
Rfo:Loose Resuspension Factor	Resuspension factor for loose contamination	CONTINUOUS LOGARITHMIC(1/m)
Default value used		Value / Probability 9.12E-06 / 0.00E+00 1.10E-04 / 7.67E-01 1.46E-04 / 9.09E-01 1.62E-04 / 9.50E-01 1.85E-04 / 9.90E-01 1.90E-04 / 1.00E+00
GO:Loose Ingestion Rate	The secondary ingestion transfer rate of loose removable surface activity from building surfaces to the mouth during building occupancy	CONSTANT(m**2/hr)
Default value used		Value 1.10E-04

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 2.91E+01 **mrem/year .**
The 95 % **Confidence Interval for the** 0.9 **quantile value of TEDE is** 2.86E+01 **to** 2.97E+01 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Surface Concentration (dpm/100 cm**2)
3H	2.15E+01
14C	1.56E+02
55Fe	1.53E+02
59Ni	7.48E+02
60Co	7.33E+03
63Ni	9.07E+04
90Sr	4.33E+00
90Y	4.28E+00
94Nb	2.31E+00
99Tc	7.64E-01
134Cs	2.88E-04
137Cs	4.77E+00
137mBa	4.51E+00
152Eu	3.98E-01
152Gd	3.61E-16
154Eu	5.20E-01
155Eu	1.90E-02
239Pu	5.80E-02
235U	2.86E-11
231Th	2.83E-11
231Pa	1.98E-16
227Ac	1.56E-18
223Fr	2.16E-20
227Th	1.17E-18
223Ra	9.95E-19
219Rn	9.95E-19
215Po	9.95E-19
211Pb	9.95E-19
211Bi	9.95E-19
211Po	2.79E-21
207Tl	9.93E-19

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	External	Inhalation	Secondary Ingestion
2.97E+01	2.42E+01	5.25E+00	2.92E-01

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
3H	4.87E-06
14C	1.16E-03
55Fe	1.08E-03
59Ni	5.00E-03
60Co	2.82E+01
63Ni	1.42E+00
90Sr	1.41E-02
90Y	1.72E-04
94Nb	7.26E-03
99Tc	1.65E-05
134Cs	6.69E-07
137Cs	6.41E-04
137mBa	3.71E-03
152Eu	8.29E-04
152Gd	3.27E-18
154Eu	1.22E-03
155Eu	3.48E-06
239Pu	5.95E-02
235U	8.36E-12
231Th	8.40E-16
231Pa	6.08E-16
227Ac	2.49E-17
223Fr	2.25E-24
227Th	4.53E-20
223Ra	1.95E-20
219Rn	7.67E-23
215Po	2.44E-25

211Pb	9.20E-23
211Bi	6.41E-23
211Po	2.98E-26
207Tl	5.24E-24
All Nuclides	2.97E+01

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	External	Inhalation	Secondary Ingestion
3H	0.00E+00	3.27E-06	1.60E-06
14C	3.53E-06	7.75E-04	3.78E-04
55Fe	0.00E+00	9.77E-04	1.08E-04
59Ni	0.00E+00	4.81E-03	1.82E-04
60Co	2.42E+01	3.81E+00	2.29E-01
63Ni	0.00E+00	1.36E+00	6.07E-02
90Sr	1.73E-06	1.34E-02	7.15E-04
90Y	3.20E-05	8.60E-05	5.35E-05
94Nb	4.96E-03	2.28E-03	1.91E-05
99Tc	8.36E-08	1.51E-05	1.30E-06
134Cs	6.13E-07	3.17E-08	2.45E-08
137Cs	1.91E-06	3.62E-04	2.76E-04
137mBa	3.71E-03	0.00E+00	0.00E+00
152Eu	6.17E-04	2.09E-04	2.99E-06
152Gd	0.00E+00	3.20E-18	6.71E-20
154Eu	8.62E-04	3.54E-04	5.75E-06
155Eu	1.58E-06	1.87E-06	3.37E-08
239Pu	2.99E-08	5.92E-02	2.38E-04
235U	5.94E-15	8.35E-12	8.81E-15
231Th	7.37E-16	5.91E-17	4.44E-17
231Pa	1.13E-20	6.06E-16	2.43E-18
227Ac	3.45E-25	2.49E-17	2.55E-20
223Fr	1.71E-24	3.19E-25	2.16E-25
227Th	1.70E-22	4.51E-20	5.18E-23
223Ra	1.80E-22	1.86E-20	7.60E-22
219Rn	7.67E-23	0.00E+00	0.00E+00

215Po	2.44E-25	0.00E+00	0.00E+00
211Pb	7.08E-23	2.06E-23	6.06E-25
211Bi	6.41E-23	0.00E+00	0.00E+00
211Po	2.98E-26	0.00E+00	0.00E+00
207Tl	5.24E-24	0.00E+00	0.00E+00

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 6/30/2008 7:25:06 PM
Site Name: EF1
Description: Analysis of potential dose from nuclides not discounted for residential
FileName:C:\Documents and Settings\Marty\My Documents\DnD_Res2.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 109
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 2.21E-02
14C	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 1.56E-01
55Fe	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 1.73E-01
59Ni	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 7.48E-01
60Co	UNLIMITED	CONSTANT(pCi/g)

Justification for concentration: Percent total		Value	7.82E+00
63Ni	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	9.11E+01
90Sr	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	4.38E-03
94Nb	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	2.31E-03
99Tc	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	7.64E-04
134Cs	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	3.39E-07

Chain Data:

Number of chains: **10**

Chain No. 1: **3H**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
3H	1	4.51E+03					1.73E-11	1.73E-11	0.00E+00	0.00E+00

Chain No. 2: **14C**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
14C	1	2.09E+06					5.64E-10	5.64E-10	1.39E-15	6.22E-18

Chain No. 3: **55Fe**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
55Fe	1	9.86E+02					1.64E-10	7.26E-10	0.00E+00	0.00E+00

Chain No. 4: **60Co**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
60Co	1	1.93E+03					7.28E-09	5.91E-08	2.03E-10	6.26E-12

Chain No. 5: **59Ni**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
59Ni	1	2.74E+07					5.67E-11	7.31E-10	0.00E+00	0.00E+00

Chain No. 6: **63Ni**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
63Ni	1	3.51E+04					1.56E-10	1.70E-09	0.00E+00	0.00E+00

Chain No. 7: **90Sr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
90Sr	1	1.06E+04					3.85E-08	3.51E-07	2.46E-14	3.21E-16
90Y	2	2.67E+00	1	1	0	0	2.91E-09	2.28E-09	4.60E-13	1.03E-14

Chain No. 8: **94Nb**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
94Nb	1	7.41E+06					1.93E-09	1.12E-07	1.32E-10	3.91E-12

Chain No. 9: **99Tc**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
99Tc	1	7.78E+07					3.95E-10	2.25E-09	6.73E-15	5.79E-17

Chain No. 10: **134Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
134Cs	1	7.53E+02					1.98E-08	1.25E-08	1.31E-10	3.86E-12

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Nuclide	Soil Concentration (pCi/g)
3H	2.21E-02
14C	1.56E-01
55Fe	1.73E-01
59Ni	7.48E-01
60Co	7.82E+00
63Ni	9.11E+01
90Sr	4.38E-03
90Y	0.00E+00
94Nb	2.31E-03
99Tc	7.64E-04
134Cs	3.39E-07

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
Tv(1):Translocation:Leafy	Translocation factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E+00
Tv(2):Translocation:Root	Translocation factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(3):Translocation:Fruit	Translocation factor for fruit	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(4):Translocation:Grain	Translocation factor for grain	CONSTANT(none)
Default value used		Value 1.00E-01
Tf(1):Translocation:Beef Forage	Translocation factor for forage consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(2):Translocation:Poultry Forage	Translocation factor for forage consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(3):Translocation:Milk Cow	Translocatioin factor for forage consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(4):Translocation:Layer Hen Forage	Translocation factor for forage consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
Tg(1):Translocation:Beef Grain	Translocation factor for stored grain consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(2):Translocation:Poultry Grain	Translocation factor for stored grain consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(3):Translocation:Milk Cow Grain	Translocation factor for stored grain consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(4):Translocation:Layer Hen Grain	Translocation factor for stored grain consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
Th(1):Translocation:Beef Hay	Translocation factor for stored hay consumed by beef cattle	CONSTANT(none)

Default value used		Value 1.00E+00
Th(2):Translocation:Poultry Hay	Translocation factor for stored hay consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Th(3):Translocation:Milk Cow Hay	Translocation factor for stored hay consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Th(4):Translocation:Layer Hen Hay	Translocation factor for stored hay consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
fca(1):Beef Carbon Fraction	Mass fraction of beef cattle that is carbon	CONSTANT(none)
Default value used		Value 3.60E-01
fca(2):Poultry Carbon Fraction	Mass fraction of poultry that is carbon	CONSTANT(none)
Default value used		Value 1.80E-01
fca(3):Milk Carbon Fraction	Mass fraction of milk that is carbon	CONSTANT(none)
Default value used		Value 6.00E-02
fca(4):Eggs Carbon Fraction	Mass fraction of an egg that is carbon	CONSTANT(none)
Default value used		Value 1.60E-01
fcf(1):Beef Forage Carbon Fraction	Mass fraction of wet forage consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(2):Poultry Forage Carbon Fraction	Mass fraction of wet forage consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(3):Milk Cow Forage Carbon Fraction	Mass fraction of wet forage consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(4):Layer Hen Forage Carbon Fraction	Mass fraction of wet forage consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcg(1):Beef Grain Carbon Fraction	Mass fraction of wet stored grain consumed by beef cattle that is carbon	CONSTANT(none)

Default value used		Value 4.00E-01
fcg(2):Poultry Grain Carbon Fraction	Mass fraction of wet stored grain consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(3):Milk Cow Grain Carbon Fraction	Mass fraction of wet stored grain consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(4):Layer Hen Grain Carbon Fraction	Mass fraction of wet stored grain consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fch(1):Beef Hay Carbon Fraction	Mass fraction of wet stored hay consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(2):Poultry Hay Carbon Fraction	Mass fraction of wet stored hay consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(3):Milk Cow Hay Carbon Fraction	Mass fraction of wet stored hay consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(4):Layer Hen Hay Carbon Fraction	Mass fraction of wet stored hay consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fCd:Soil Carbon Fraction	Mass fraction of dry soil that is carbon	CONSTANT(none)
Default value used		Value 3.00E-02
SATac:Animal Product Specific Activity	Specific activity equivalence of animal product and specific activity of animal feed, forage, and soil	CONSTANT(none)
Default value used		Value 1.00E+00
xf(1):Beef Forage Contaminated Fraction	Fraction of forage consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(2):Poultry Forage Contaminated Fraction	Fraction of forage consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(3):Milk Cow Forage	Fraction of forage consumed by milk cows that is contaminated	CONSTANT(none)

Contaminated Fraction		
Default value used		Value 1.00E+00
xf(4):Layer Hen Forage Contaminated Fraction	Fraction of forage consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(1):Beef Grain Contaminated Fraction	Fraction of stored grain consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(2):Poultry Grain Contaminated Fraction	Fraction of stored grain consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(3):Milk Cow Grain Contaminated Fraction	Fraction of stored grain consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(4):Layer Hen Grain Contaminated Fraction	Fraction of stored grain that is consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(1):Beef Hay Contaminated Fraction	Fraction of stored hay consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(2):Poultry Hay Contaminated Fraction	Fraction of stored hay consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(3):Milk Cow Hay Contaminated Fraction	Fraction of stored hay consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(4):Layer Hen Hay Contaminated Fraction	Fraction of stored hay consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(1):Beef Water Contaminated Fraction	Fraction of water that is consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(2):Poultry Water Contaminated Fraction	Fraction of water consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(3):Milk Cow Water Contaminated Fraction	Fraction of water consumed by milk cows that is contaminated	CONSTANT(none)

Default value used		Value 1.00E+00
xw(4):Layer Hen Water Contaminated Fraction	Fraction of water consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
DIET:Garden Diet	Fraction of human diet grown onsite	CONSTANT(none)
Default value used		Value 1.00E+00
Uv(1):Diet - Leafy	Yearly human consumption of leafy vegetables	CONSTANT(kg/y)
Default value used		Value 2.14E+01
Uv(2):Diet - Roots	Yearly human consumption of other vegetables	CONSTANT(kg/y)
Default value used		Value 4.46E+01
Uv(3):Diet - Fruit	Yearly human consumption of fruits	CONSTANT(kg/y)
Default value used		Value 5.28E+01
Uv(4):Diet - Grain	Yearly human consumption of grains	CONSTANT(kg/y)
Default value used		Value 1.44E+01
Ua(1):Diet - Beef	Yearly human consumption of beef	CONSTANT(kg/y)
Default value used		Value 3.98E+01
Ua(2):Diet - Poultry	Yearly human consumption of poultry	CONSTANT(kg/y)
Default value used		Value 2.53E+01
Ua(3):Diet - Milk	Yearly human consumption of milk	CONSTANT(L/y)
Default value used		Value 2.33E+02
Ua(4):Diet - Egg	Yearly human consumption of eggs	CONSTANT(kg/y)
Default value used		Value 1.91E+01
Uf:Diet - Fish	Yearly human consumption of fish produced from an onsite pond	CONSTANT(kg/y)
Default value used		Value 2.06E+01
tf:Consumption Period	Consumption period for fish	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(1):Consumption Period - Leafy	Food consumption period for leafy vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(2):Consumption Period - Roots	Food consumption period for other vegetables	CONSTANT(days)

Default value used		Value 3.65E+02
tcv(3):Consumption Period - Fruit	Food consumption period for fruits	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(4):Consumption Period - Grain	Food consumption period for grains	CONSTANT(days)
Default value used		Value 3.65E+02
tca(1):Consumption Period - Beef	Food consumption period for beef	CONSTANT(days)
Default value used		Value 3.65E+02
tca(2):Consumption Period - Poultry	Food consumption period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
tca(3):Consumption Period - Milk	Food consumption period for milk	CONSTANT(days)
Default value used		Value 3.65E+02
tca(4):Consumption Period - Egg	Food consumption period for eggs	CONSTANT(days)
Default value used		Value 3.65E+02
Nunsat:Number of Unsaturated Layers	Number of model layers used to represent the unsaturated zone	CONSTANT(none)
Default value used		Value 1.00E+01
TstartR:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
TendR:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+05
dtR:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
PstepR:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
TI:Indoor Exposure Period	The time the resident spends indoors	CONSTANT(days/year)
Default value used		Value 2.40E+02
TX:Outdoor Exposure Period	The time the resident spends outdoors	CONSTANT(days/year)

Default value used		Value 4.02E+01
TG:Gardening Period	The time the resident spends gardening	CONSTANT(days/year)
Default value used		Value 2.92E+00
TTR:Total time in period	Total time in the one year exposure period	CONSTANT(days/year)
Default value used		Value 3.65E+02
SFI:Indoor Shielding Factor	Shielding factor for the residence	CONSTANT(none)
Default value used		Value 5.52E-01
SFO:Outdoor Shielding Factor	Shielding factor for the cover soil	CONSTANT(none)
Default value used		Value 1.00E+00
PD:Floor dust loading	Floor dust loading	UNIFORM(g/m**2)
Default value used		Lower Limit 2.00E-02 Upper Limit 3.00E-01
RFR:Indoor Resuspension Factor	Resuspension factor for indoor dust	LOGUNIFORM(1/m)
Default value used		Lower Limit 1.00E-07 Upper Limit 8.00E-05
CDO:Outdoor Dust Loading	Average dust loading outdoors	LOGUNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-07 Upper Limit 1.00E-04
CDI:Indoor Dust Loading	Average dust loading indoors	DERIVED(g/m**3)
Default value used		
PF:Indoor/Outdoor Penetration Factor	Fraction of outdoor dust in indoor air	UNIFORM(none)
Default value used		Lower Limit 2.00E-01 Upper Limit 7.00E-01
CDG:Gardening Dust Loading	Average dust loading while gardening	UNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-04 Upper Limit 7.00E-04
VR:Indoor Breathing Rate	Breathing rate while indoors	CONSTANT(m**3/hr)
Default value used		Value 9.00E-01
VX:Outdoor Breathing Rate	Breathing rate while outdoors	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
VG:Gardening Breathing	Breathing rate while gardening	CONSTANT(m**3/hr)

Rate		
Default value used		Value 1.70E+00
GR:Soil Ingestion Transfer Rate	Average rate of soil ingestion	CONSTANT(g/d)
Default value used		Value 5.00E-02
UW:Diet - Water	Drinking water ingestion rate	CONSTANT(L/d)
Default value used		Value 1.26E+00
H1:Surface Soil Thickness	Thickness of the surface soil layer	CONSTANT(m)
Default value used		Value 1.50E-01
H2:Unsaturated Zone Thickness	Thickness of the unsaturated zone	CONTINUOUS LINEAR(m)
Default value used		

Value	Probability
3.05E-01	0.00E+00
6.68E-01	4.76E-03
8.11E-01	9.52E-03
9.21E-01	1.43E-02
9.94E-01	1.91E-02
1.03E+00	2.38E-02
1.07E+00	2.86E-02
1.14E+00	3.33E-02
1.21E+00	3.81E-02
1.30E+00	4.29E-02
1.31E+00	4.76E-02
1.32E+00	5.24E-02
1.56E+00	5.71E-02
1.58E+00	6.19E-02
1.61E+00	6.67E-02
1.69E+00	7.62E-02
1.78E+00	8.57E-02
1.80E+00	9.05E-02
1.81E+00	9.52E-02
1.84E+00	1.00E-01
1.87E+00	1.05E-01
1.92E+00	1.10E-01
2.04E+00	1.14E-01
2.10E+00	1.19E-01
2.11E+00	1.24E-01
2.32E+00	1.29E-01
2.36E+00	1.33E-01
2.37E+00	1.38E-01
2.39E+00	1.43E-01
2.44E+00	1.48E-01
2.44E+00	1.52E-01
2.45E+00	1.57E-01

	2.59E+00	1.62E-01
	2.63E+00	1.67E-01
	2.69E+00	1.71E-01
	2.79E+00	1.76E-01
	2.81E+00	1.81E-01
	2.90E+00	1.86E-01
	2.95E+00	1.91E-01
	3.07E+00	1.95E-01
	3.18E+00	2.00E-01
	3.22E+00	2.05E-01
	3.30E+00	2.10E-01
	3.34E+00	2.14E-01
	3.37E+00	2.19E-01
	3.44E+00	2.24E-01
	3.58E+00	2.29E-01
	3.62E+00	2.33E-01
	3.66E+00	2.38E-01
	3.74E+00	2.43E-01
	3.86E+00	2.48E-01
	3.88E+00	2.52E-01
	4.17E+00	2.57E-01
	4.26E+00	2.62E-01
	4.44E+00	2.71E-01
	4.63E+00	2.76E-01
	4.87E+00	2.81E-01
	5.13E+00	2.86E-01
	5.18E+00	2.91E-01
	5.54E+00	2.95E-01
	5.83E+00	3.00E-01
	5.86E+00	3.05E-01
	5.86E+00	3.10E-01
	5.90E+00	3.14E-01
	6.06E+00	3.19E-01
	6.13E+00	3.24E-01
	6.17E+00	3.29E-01
	6.22E+00	3.33E-01
	6.31E+00	3.38E-01
	6.36E+00	3.43E-01
	6.40E+00	3.48E-01
	6.46E+00	3.52E-01
	6.51E+00	3.57E-01
	6.55E+00	3.62E-01
	6.60E+00	3.67E-01
	6.86E+00	3.71E-01
	6.93E+00	3.76E-01
	6.95E+00	3.86E-01
	6.97E+00	3.91E-01
	7.09E+00	3.95E-01
	7.18E+00	4.00E-01

	7.35E+00	4.05E-01
	7.36E+00	4.10E-01
	7.40E+00	4.14E-01
	7.43E+00	4.19E-01
	7.46E+00	4.24E-01
	7.59E+00	4.29E-01
	7.60E+00	4.33E-01
	7.64E+00	4.38E-01
	7.87E+00	4.43E-01
	8.10E+00	4.48E-01
	8.28E+00	4.52E-01
	8.35E+00	4.57E-01
	8.71E+00	4.62E-01
	8.71E+00	4.67E-01
	8.73E+00	4.71E-01
	8.79E+00	4.76E-01
	8.80E+00	4.81E-01
	8.82E+00	4.86E-01
	8.85E+00	4.91E-01
	8.89E+00	4.95E-01
	8.90E+00	5.00E-01
	8.99E+00	5.05E-01
	9.00E+00	5.10E-01
	9.13E+00	5.14E-01
	9.14E+00	5.19E-01
	9.21E+00	5.24E-01
	9.31E+00	5.29E-01
	9.55E+00	5.33E-01
	9.60E+00	5.38E-01
	9.63E+00	5.43E-01
	9.86E+00	5.48E-01
	1.05E+01	5.52E-01
	1.07E+01	5.57E-01
	1.13E+01	5.62E-01
	1.15E+01	5.67E-01
	1.17E+01	5.71E-01
	1.20E+01	5.76E-01
	1.26E+01	5.81E-01
	1.26E+01	5.86E-01
	1.28E+01	5.91E-01
	1.32E+01	5.95E-01
	1.32E+01	6.00E-01
	1.34E+01	6.05E-01
	1.34E+01	6.10E-01
	1.36E+01	6.14E-01
	1.37E+01	6.19E-01
	1.38E+01	6.24E-01
	1.41E+01	6.29E-01
	1.45E+01	6.33E-01

1.51E+01	6.38E-01
1.52E+01	6.43E-01
1.61E+01	6.48E-01
1.62E+01	6.52E-01
1.65E+01	6.57E-01
1.66E+01	6.62E-01
1.69E+01	6.67E-01
1.74E+01	6.71E-01
1.82E+01	6.76E-01
1.84E+01	6.81E-01
1.84E+01	6.86E-01
1.87E+01	6.91E-01
1.95E+01	6.95E-01
2.01E+01	7.00E-01
2.07E+01	7.05E-01
2.08E+01	7.10E-01
2.17E+01	7.14E-01
2.24E+01	7.19E-01
2.27E+01	7.24E-01
2.29E+01	7.29E-01
2.29E+01	7.33E-01
2.40E+01	7.38E-01
2.47E+01	7.43E-01
2.60E+01	7.48E-01
2.65E+01	7.52E-01
2.72E+01	7.57E-01
2.73E+01	7.62E-01
2.76E+01	7.67E-01
2.77E+01	7.71E-01
2.78E+01	7.76E-01
2.80E+01	7.81E-01
2.86E+01	7.86E-01
2.94E+01	7.91E-01
3.01E+01	7.95E-01
3.03E+01	8.00E-01
3.06E+01	8.10E-01
3.08E+01	8.14E-01
3.11E+01	8.19E-01
3.17E+01	8.24E-01
3.17E+01	8.29E-01
3.17E+01	8.33E-01
3.22E+01	8.38E-01
3.39E+01	8.43E-01
3.48E+01	8.48E-01
3.54E+01	8.52E-01
3.60E+01	8.57E-01
3.68E+01	8.62E-01
4.03E+01	8.67E-01
4.07E+01	8.71E-01

		4.24E+01 8.76E-01 4.29E+01 8.81E-01 4.42E+01 8.86E-01 4.72E+01 8.91E-01 4.97E+01 8.95E-01 5.12E+01 9.00E-01 6.13E+01 9.05E-01 6.19E+01 9.10E-01 6.23E+01 9.14E-01 6.32E+01 9.19E-01 6.59E+01 9.24E-01 6.73E+01 9.29E-01 7.47E+01 9.33E-01 7.92E+01 9.38E-01 8.12E+01 9.43E-01 8.28E+01 9.48E-01 8.47E+01 9.52E-01 8.96E+01 9.57E-01 9.47E+01 9.62E-01 1.08E+02 9.67E-01 1.13E+02 9.71E-01 1.15E+02 9.76E-01 1.42E+02 9.81E-01 1.77E+02 9.86E-01 1.78E+02 9.91E-01 1.80E+02 9.95E-01 3.16E+02 1.00E+00
N1:Surface Soil Porosity	Porosity of the surface soil layer	DERIVED(none)
Default value used		
N2:Unsaturated Zone Porosity	Porosity of the unsaturated zone	DERIVED(none)
Default value used		
F1:Surface Soil Saturation	Saturation ratio of the surface soil layer	DERIVED(none)
Default value used		
F2:Unsaturated Zone Saturation	Saturation ratio of the unsaturated zone	DERIVED(none)
Default value used		
INFIL:Infiltration Rate	Net rate of infiltration to aquifer	DERIVED(m/y)
Default value used		
SCSST:Soil Classification	SCS soil classification ID	DISCRETE CUMULATIVE(none)
Default value used		Value Probability

		1.00E+00 1.00E-04 2.00E+00 1.34E-03 3.00E+00 1.06E-02 4.00E+00 2.51E-02 5.00E+00 6.17E-02 6.00E+00 1.09E-01 7.00E+00 1.62E-01 8.00E+00 2.12E-01 9.00E+00 2.85E-01 1.00E+01 5.10E-01 1.10E+01 7.58E-01 1.20E+01 1.00E+00
NDEV:Porosity Probability	Relative porosity value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
KSDEV:Permeability Probability	Relative permeability value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
BDEV:Parameter "b" Probability	Relative value of "b" parameter within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
AP:Water Application Rate	Total water application rate on cultivated area	CONTINUOUS LINEAR(m/y)
Default value used		Value Probability 6.07E-01 0.00E+00 6.10E-01 4.62E-01 6.35E-01 4.76E-01 7.62E-01 5.40E-01 8.89E-01 6.29E-01 1.02E+00 7.05E-01 1.14E+00 8.04E-01 1.27E+00 8.79E-01 1.40E+00 9.41E-01 1.52E+00 9.82E-01 1.65E+00 9.98E-01 1.78E+00 1.00E+00
IR:Irrigation Rate	Annual average irrigation rate	CONSTANT(L/m**2-d)
Default value used		Value 1.29E+00
RHO1:Surface Soil Density	Bulk density of soil in the surface soil layer	DERIVED(g/mL)

Default value used		
RHO2:Unsaturated Zone Density	Bulk density of soil in the unsaturated zone	DERIVED(g/mL)
Default value used		
Ksat1:Surface Soil Permeabiliy	Saturated permeability of the surface soil layer	DERIVED(cm/sec)
Default value used		
VDR:Volume of Water Consumed	Volume of water withdrawn for consumptive use	CONSTANT(L)
Default value used		Value 1.18E+05
VSW:Volume of Water in Pond	Volume of water in the pond	CONSTANT(L)
Default value used		Value 1.30E+06
AR:Cultivated Area	Area of land cultivated	DERIVED(m**2)
Default value used		
sh:Soil Moisture Content	Moisture content of soil	DERIVED(none)
Default value used		
TTG:Gardening Period	Total time in gardening period	CONSTANT(days)
Default value used		Value 9.00E+01
TD:Drinking-water consumption period	Drinking-water consumption period	CONSTANT(days)
Default value used		Value 3.65E+02
THV(1):Holdup Period : Leafy	Holdup period for leafy vegetables	CONSTANT(days)
Default value used		Value 1.00E+00
THV(2):Holdup Period : Other vegetables	Holdup period for other vegetables	CONSTANT(days)
Default value used		Value 1.40E+01
THV(3):Holdup Period : Fruits	Holdup period for fruits	CONSTANT(days)
Default value used		Value 1.40E+01
THV(4):Holdup Period : Grains	Holdup period for grains	CONSTANT(days)
Default value used		Value 1.40E+01
THA(1):Holdup Period : Beef	Holdup period for beef	CONSTANT(days)

Default value used		Value 2.00E+01
THA(2):Holdup Period : Poultry	Holdup period for poultry	CONSTANT(days)
Default value used		Value 1.00E+00
THA(3):Holdup Period : Milk	Holdup period for milk	CONSTANT(days)
Default value used		Value 1.00E+00
THA(4):Holdup Period : Eggs	Holdup period for eggs	CONSTANT(days)
Default value used		Value 1.00E+00
TGV(1):Growing Period : Leafy	Minimum growing period for leafy vegetables	CONSTANT(days)
Default value used		Value 4.50E+01
TGV(2):Growing Period : Other vegetables	Minimum growing period for other vegetables	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(3):Growing Period : Fruits	Minimum growing period for fruits	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(4):Growing Period : Grains	Minimum growing period for grains	CONSTANT(days)
Default value used		Value 9.00E+01
TGF(1):Growing Period : Beef Forage	Minimum growing period for forage consumed by beef cattle	CONSTANT(days)
Default value used		Value 3.00E+01
TGF(2):Growing Period : Poultry Forage	Minimum growing period for forage consumed by poultry	DERIVED(days)
Default value used		
TGF(3):Growing Period : Milk Cow Forage	Minimum growing period for forage consumed by milk cows	DERIVED(days)
Default value used		
TGF(4):Growing Period : Layer Hen Forage	Minimum growing period for forage consumed by layer hens	DERIVED(days)
Default value used		
TGG(1):Growing Period : Beef Cow Grain	Minimum growing period for stored grain consumed by beef cattle	CONSTANT(days)
Default value used		Value 9.00E+01

TGG(2):Growing Period : Poultry Grain	Minimum growing period for stored grain consumed by poultry	DERIVED(days)
Default value used		
TGG(3):Growing Period : Milk Cow Grain	Minimum growing period for stored grain consumed by milk cows	DERIVED(days)
Default value used		
TGG(4):Growing Period : Layer Hen Grain	Minimum growing period for stored grain consumed by layer hens	DERIVED(days)
Default value used		
TGH(1):Growing Period : Beef Cow Hay	Minimum growing period for stored hay consumed by beef cattle	CONSTANT(days)
Default value used		Value 4.50E+01
TGH(2):Growing Period : Poultry Hay	Minimum growing period for stored hay consumed by poultry	DERIVED(days)
Default value used		
TGH(3):Growing Period : Milk Cow Hay	Minimum growing period for stored hay consumed by milk cows	DERIVED(days)
Default value used		
TGH(4):Growing Period : Layer Hen Hay	Minimum growing period for stored hay consumed by layer hens	DERIVED(days)
Default value used		
RV(1):Interception Fraction : Leafy	Interception fraction for leafy vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(2):Interception Fraction : Other vegetables	Interception fraction for other vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(3):Interception Fraction : Fruits	Interception fraction for fruits	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(4):Interception Fraction : Grains	Interception fraction for grains	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01

RF(1):Interception Fraction : Beef Forage	Interception fraction for beef cattle forage	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(2):Interception Fraction : Poultry forage	Interception fraction for poultry forage	DERIVED(none)
Default value used		
RF(3):Interception Fraction : Milk Cow Forage	Interception fraction for milk cow forage	DERIVED(none)
Default value used		
RF(4):Interception Fraction : Layer Hen Forage	Interception fraction for layer hen forage	DERIVED(none)
Default value used		
RG(1):Interception Fraction : Beef Cow Grain	Interception fraction for beef cattle grain	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RG(2):Interception Fraction : Poultry Grain	Interception fraction for poultry grain	DERIVED(none)
Default value used		
RG(3):Interception Fraction : Milk Cow Grain	Interception fraction for milk cow grain	DERIVED(none)
Default value used		
RG(4):Interception Fraction : Layer Hen Grain	Interception fraction for layer hen grain	DERIVED(none)
Default value used		
RH(1):Interception Fraction : Beef Cow Hay	Interception fraction for beef cattle hay	DERIVED(none)
Default value used		
RH(2):Interception Fraction : Poultry Hay	Interception fraction for poultry hay	DERIVED(none)
Default value used		
RH(3):Interception Fraction : Milk Cow Hay	Interception fraction for milk cow hay	DERIVED(none)
Default value used		
RH(4):Interception Fraction : Layer Hen Hay	Interception fraction for layer hen hay	DERIVED(none)

Default value used	

YV(1):Crop Yield : Leafy	Crop yield for leafy vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used

Value	Probability
2.70E+00	0.00E+00
2.71E+00	1.60E-03
2.74E+00	6.00E-03
2.76E+00	1.76E-02
2.78E+00	4.36E-02
2.80E+00	8.48E-02
2.82E+00	1.56E-01
2.85E+00	2.57E-01
2.87E+00	3.64E-01
2.89E+00	5.00E-01
2.91E+00	6.39E-01
2.93E+00	7.46E-01
2.96E+00	8.42E-01
2.98E+00	9.09E-01
3.00E+00	9.60E-01
3.02E+00	9.84E-01
3.04E+00	9.94E-01
3.07E+00	9.97E-01
3.09E+00	9.99E-01
3.11E+00	1.00E+00
3.13E+00	1.00E+00
3.15E+00	1.00E+00

YV(2):Crop Yield : Other	Crop yield for other vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used

Value	Probability
2.26E+00	0.00E+00
2.29E+00	8.00E-04
2.30E+00	1.20E-03
2.31E+00	6.40E-03
2.33E+00	1.52E-02
2.34E+00	3.28E-02
2.35E+00	7.44E-02
2.36E+00	1.40E-01
2.38E+00	2.49E-01
2.39E+00	3.80E-01
2.40E+00	5.30E-01
2.42E+00	6.61E-01
2.43E+00	7.88E-01
2.44E+00	8.86E-01
2.45E+00	9.42E-01
2.47E+00	9.75E-01

		2.48E+00 9.88E-01 2.49E+00 9.96E-01 2.51E+00 9.97E-01 2.52E+00 9.99E-01 2.53E+00 1.00E+00 2.54E+00 1.00E+00
YV(3):Crop Yield : Fruits	Crop yield for fruits	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		<u>Value</u> <u>Probability</u> 2.17E+00 0.00E+00 2.20E+00 1.20E-03 2.21E+00 2.40E-03 2.23E+00 6.80E-03 2.25E+00 1.80E-02 2.27E+00 4.36E-02 2.29E+00 7.64E-02 2.31E+00 1.38E-01 2.32E+00 2.14E-01 2.34E+00 3.27E-01 2.36E+00 4.50E-01 2.38E+00 5.76E-01 2.40E+00 6.87E-01 2.42E+00 7.88E-01 2.43E+00 8.68E-01 2.45E+00 9.25E-01 2.47E+00 9.60E-01 2.49E+00 9.81E-01 2.51E+00 9.92E-01 2.53E+00 9.98E-01 2.54E+00 1.00E+00 2.56E+00 1.00E+00
YV(4):Crop Yield : Grains	Crop yield for grains	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		<u>Value</u> <u>Probability</u> 2.85E-01 0.00E+00 2.90E-01 6.00E-04 3.02E-01 2.80E-03 3.14E-01 9.40E-03 3.26E-01 2.14E-02 3.38E-01 5.42E-02 3.50E-01 1.08E-01 3.62E-01 2.02E-01 3.74E-01 3.15E-01 3.86E-01 4.50E-01 3.98E-01 5.92E-01

		4.10E-01 7.20E-01 4.23E-01 8.26E-01 4.35E-01 9.03E-01 4.47E-01 9.51E-01 4.59E-01 9.77E-01 4.71E-01 9.91E-01 4.83E-01 9.96E-01 4.95E-01 9.99E-01 5.07E-01 1.00E+00 5.19E-01 1.00E+00 5.31E-01 1.00E+00
YF(1):Crop Yield : Beef Forage	Crop yield for beef cattle forage	BETA(kg dry wt forage/m**2)
Default value used		Lower Limit 3.70E-01 Upper Limit 5.24E-01 p 2.36E+00 q 1.40E+00
YF(2):Crop Yield : Poultry Forage	Crop yield for poultry forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(3):Crop Yield : Milk Cow Forage	Crop yield for milk cow forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(4):Crop Yield : Layer Hen Forage	Crop yield for layer hen forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YG(1):Crop Yield : Beef Cow Grain	Crop yield for beef cattle grain	NORMAL(kg dry wt grain /m**2)
Default value used		Mean 5.78E-01 Standard Deviation 7.77E-02
YG(2):Crop Yield : Poultry Grain	Crop yield for poultry grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(3):Crop Yield : Milk Cow Grain	Crop yield for milk cow grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(4):Crop Yield : Layer Hen Grain	Crop yield for layer hen grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YH(1):Crop Yield : Beef	Crop yield for beef cattle hay	DERIVED(kg wet wt/m**2)

Cow Hay		
Default value used		
YH(2):Crop Yield : Poultry Hay	Crop yield for poultry hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(3):Crop Yield : Milk Cow Hay	Crop yield for milk cow hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(4):Crop Yield : Layer Hen Hay	Crop yield for layer hen hay	DERIVED(kg wet wt/m**2)
Default value used		
WV(1):Wet/dry : Leafy Vegetables	Wet/dry conversion factor for leafy vegetables	CONTINUOUS LINEAR(none)
Default value used		Value / Probability 3.32E-02 0.00E+00 4.89E-02 3.45E-02 5.47E-02 6.91E-02 5.96E-02 1.04E-01 6.36E-02 1.38E-01 6.70E-02 1.73E-01 7.05E-02 2.07E-01 7.38E-02 2.42E-01 7.48E-02 2.50E-01 7.72E-02 2.76E-01 8.03E-02 3.11E-01 8.34E-02 3.45E-01 8.66E-02 3.80E-01 9.00E-02 4.15E-01 9.36E-02 4.49E-01 9.73E-02 4.84E-01 9.91E-02 4.99E-01 1.01E-01 5.18E-01 1.05E-01 5.53E-01 1.09E-01 5.87E-01 1.13E-01 6.22E-01 1.18E-01 6.56E-01 1.23E-01 6.91E-01 1.29E-01 7.25E-01 1.33E-01 7.50E-01 1.35E-01 7.60E-01 1.42E-01 7.94E-01 1.50E-01 8.29E-01 1.59E-01 8.64E-01

		1.70E-01	8.98E-01
		1.85E-01	9.33E-01
		2.10E-01	9.67E-01
		2.56E-01	9.91E-01
		3.24E-01	1.00E+00
WV(2):Wet/dry : Other Vegetables	Wet/dry conversion factor for other vegetables	CONTINUOUS LINEAR(none)	
Default value used		Value	Probability
		3.58E-02	0.00E+00
		4.87E-02	3.45E-02
		5.46E-02	6.91E-02
		5.90E-02	1.04E-01
		6.29E-02	1.38E-01
		6.69E-02	1.73E-01
		7.02E-02	2.07E-01
		7.34E-02	2.42E-01
		7.41E-02	2.50E-01
		7.65E-02	2.76E-01
		7.99E-02	3.11E-01
		8.32E-02	3.45E-01
		8.66E-02	3.80E-01
		9.05E-02	4.15E-01
		9.41E-02	4.49E-01
		9.82E-02	4.84E-01
		9.98E-02	4.99E-01
		1.02E-01	5.18E-01
		1.06E-01	5.53E-01
		1.09E-01	5.87E-01
		1.14E-01	6.22E-01
		1.19E-01	6.56E-01
		1.24E-01	6.91E-01
		1.29E-01	7.25E-01
		1.33E-01	7.50E-01
		1.35E-01	7.60E-01
		1.42E-01	7.94E-01
		1.50E-01	8.29E-01
		1.59E-01	8.64E-01
		1.70E-01	8.98E-01
		1.87E-01	9.33E-01
		2.12E-01	9.67E-01
		2.62E-01	9.91E-01
		3.13E-01	1.00E+00
WV(3):Wet/dry : Fruit	Wet/dry conversion factor for fruits	CONTINUOUS LINEAR(none)	
Default value used		Value	Probability
		3.66E-02	0.00E+00

		4.87E-02 3.45E-02 5.45E-02 6.91E-02 5.93E-02 1.04E-01 6.31E-02 1.38E-01 6.72E-02 1.73E-01 7.10E-02 2.07E-01 7.44E-02 2.42E-01 7.52E-02 2.50E-01 7.78E-02 2.76E-01 8.13E-02 3.11E-01 8.45E-02 3.45E-01 8.78E-02 3.80E-01 9.11E-02 4.15E-01 9.46E-02 4.49E-01 9.82E-02 4.84E-01 9.97E-02 4.99E-01 1.02E-01 5.18E-01 1.06E-01 5.53E-01 1.10E-01 5.87E-01 1.14E-01 6.22E-01 1.19E-01 6.56E-01 1.24E-01 6.91E-01 1.29E-01 7.25E-01 1.34E-01 7.50E-01 1.35E-01 7.60E-01 1.42E-01 7.94E-01 1.49E-01 8.29E-01 1.58E-01 8.64E-01 1.70E-01 8.98E-01 1.87E-01 9.33E-01 2.14E-01 9.67E-01 2.58E-01 9.91E-01 3.25E-01 1.00E+00
WV(4):Wet/dry : Grain	Wet/dry conversion factor for grains	CONSTANT(none)
Default value used		Value 8.80E-01
WF(1):Wet/dry : Beef Cow Forage	Wet/dry conversion factor for beef cattle forage	BETA(none)
Default value used		Lower Limit 1.83E-01 Upper Limit 3.23E-01 p 1.15E+00 q 1.18E+00
WF(2):Wet/dry : Poultry Forage	Wet/dry conversion factor for poultry forage	DERIVED(none)
Default value used		
WF(3):Wet/dry : Milk Cow	Wet/dry conversion factor for milk	DERIVED(none)

Forage	cow forage	
Default value used		
WF(4):Wet/dry : Layer Hen Forage	Wet/dry conversion factor for layer hen forage	DERIVED(none)
Default value used		
WG(1):Wet/dry : Beef Cow Grain	Wet/dry conversion factor for beef cattle grain	CONSTANT(none)
Default value used		Value 8.80E-01
WG(2):Wet/dry : Poultry Grain	Wet/dry conversion factor for poultry grain	DERIVED(none)
Default value used		
WG(3):Wet/dry : Milk Cow Grain	Wet/dry conversion factor for milk cow grain	DERIVED(none)
Default value used		
WG(4):Wet/dry : Layer Hen Grain	Wet/dry conversion factor for layer hen grain	DERIVED(none)
Default value used		
WH(1):Wet/dry : Beef Cow Hay	Wet/dry conversion factor for beef cattle hay	DERIVED(none)
Default value used		
WH(2):Wet/dry : Poultry Hay	Wet/dry conversion factor for poultry hay	DERIVED(none)
Default value used		
WH(3):Wet/dry : Milk Cow Hay	Wet/dry conversion factor for milk cow hay	DERIVED(none)
Default value used		
WH(4):Wet/dry : Layer Hen Hay	Wet/dry conversion factor for layer hen hay	DERIVED(none)
Default value used		
QF(1):Ingestion Rate : Beef Cow Forage	Ingestion rate for beef cattle forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QF(2):Ingestion Rate : Poultry Forage	Ingestion rate for poultry forage	BETA(kg dry wt forage/d)

Default value used		Lower Limit 3.48E-03 Upper Limit 2.82E-02 p 1.51E+00 q 1.41E+00
QF(3):Ingestion Rate : Milk Cow Forage	Ingestion rate for milk cow forage	CONTINUOUS LINEAR(kg dry wt forage/d)
Default value used		Value / Probability

Value	Probability
6.35E+00	0.00E+00
6.77E+00	3.45E-02
6.96E+00	6.91E-02
7.10E+00	1.04E-01
7.24E+00	1.38E-01
7.35E+00	1.73E-01
7.47E+00	2.07E-01
7.57E+00	2.42E-01
7.60E+00	2.50E-01
7.67E+00	2.76E-01
7.77E+00	3.11E-01
7.87E+00	3.45E-01
7.98E+00	3.80E-01
8.08E+00	4.15E-01
8.18E+00	4.49E-01
8.31E+00	4.84E-01
8.37E+00	4.99E-01
8.42E+00	5.18E-01
8.54E+00	5.53E-01
8.67E+00	5.87E-01
8.81E+00	6.22E-01
8.95E+00	6.56E-01
9.10E+00	6.91E-01
9.26E+00	7.25E-01
9.38E+00	7.50E-01
9.45E+00	7.60E-01
9.68E+00	7.94E-01
9.93E+00	8.29E-01
1.02E+01	8.64E-01
1.06E+01	8.98E-01
1.11E+01	9.33E-01
1.20E+01	9.67E-01
1.33E+01	9.91E-01
1.53E+01	1.00E+00

QF(4):Ingestion Rate : Layer Hen Forage	Ingestion rate for layer hen forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.19E-02 Upper Limit 2.22E-02 p 1.45E+00

		q 7.92E-01
QG(1):Ingestion Rate : Beef Cattle Grain	Ingestion rate for beef cattle grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QG(2):Ingestion Rate : Poultry Grain	Ingestion rate for poultry grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 1.04E-02 Upper Limit 8.45E-02 p 1.51E+00 q 1.41E+00
QG(3):Ingestion Rate : Milk Cow Grain	Ingestion rate for milk cow grain	NORMAL(kg dry wt grain/d)
Default value used		Mean 1.71E+00 Standard Deviation 2.62E-01
QG(4):Ingestion Rate : Layer Hen Grain	Ingestion rate for layer hen grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 3.58E-02 Upper Limit 6.67E-02 p 1.43E+00 q 7.92E-01
QH(1):Ingestion Rate : Beef Cattle Hay	Ingestion rate for beef cattle hay	BETA(kg dry wt hay/d)
Default value used		Lower Limit 3.38E+00 Upper Limit 4.58E+00 p 1.99E+00 q 9.11E-01
QH(2):Ingestion Rate : Poultry Hay	Ingestion rate for poultry hay	CONSTANT(kg dry wt hay/d)
Default value used		Value 0.00E+00
QH(3):Ingestion Rate : Milk Cow Hay	Ingestion rate for milk cow hay	CONTINUOUS LINEAR(kg dry wt hay/d)
Default value used		Value / Probability 5.12E+00 / 0.00E+00 5.43E+00 / 3.45E-02 5.57E+00 / 6.91E-02 5.68E+00 / 1.04E-01 5.79E+00 / 1.38E-01 5.89E+00 / 1.73E-01

		5.98E+00 2.07E-01 6.06E+00 2.42E-01 6.08E+00 2.50E-01 6.14E+00 2.76E-01 6.22E+00 3.11E-01 6.30E+00 3.45E-01 6.38E+00 3.80E-01 6.46E+00 4.15E-01 6.54E+00 4.49E-01 6.63E+00 4.84E-01 6.67E+00 4.99E-01 6.72E+00 5.18E-01 6.81E+00 5.53E-01 6.92E+00 5.87E-01 7.03E+00 6.22E-01 7.13E+00 6.56E-01 7.26E+00 6.91E-01 7.39E+00 7.25E-01 7.49E+00 7.50E-01 7.56E+00 7.60E-01 7.70E+00 7.94E-01 7.89E+00 8.29E-01 8.11E+00 8.64E-01 8.39E+00 8.98E-01 8.75E+00 9.33E-01 9.44E+00 9.67E-01 1.05E+01 9.91E-01 1.27E+01 1.00E+00
QH(4):Ingestion Rate : Layer Hen Hay	Ingestion rate for layer hen hay	CONSTANT(kg dry wt hay/d)
Default value used		Value 0.00E+00
QW(1):Water Rate : Beef Cattle	Water ingestion rate for beef cattle	CONSTANT(L/d)
Default value used		Value 5.00E+01
QW(2):Water Rate : Poultry	Water ingestion rate for poultry	CONSTANT(L/d)
Default value used		Value 3.00E-01
QW(3):Water Rate : Milk Cows	Water ingestion rate for milk cows	CONSTANT(L/d)
Default value used		Value 6.00E+01
QW(4):Water Rate : Layer Hens	Water ingestion rate for layer hens	CONSTANT(L/d)
Default value used		Value 3.00E-01
QD(1):Soil Fraction : Beef	Soil intake fraction for beef cattle	CONSTANT(none)

Cattle		
Default value used		Value 2.00E-02
QD(2):Soil Fraction : Poultry	Soil intake fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
QD(3):Soil Fraction : Milk Cows	Soil intake fraction for milk cows	CONSTANT(none)
Default value used		Value 2.00E-02
QD(4):Soil Fraction : Layer Hens	Soil intake fraction for layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(1):Mass-Loading : Leafy Vegetables	Mass-loading factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(2):Mass-Loading : Other Vegetables	Mass-loading factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(3):Mass-Loading : Fruits	Mass-loading factor for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(4):Mass-Loading : Grains	Mass-loading factor for grains	CONSTANT(none)
Default value used		Value 1.00E-01
LAMBDW:Weathering Rate	Weathering rate for activity removal from plants	CONSTANT(1/d)
Default value used		Value 4.95E-02
MLF(1):Mass-Loading : Beef Cow Forage	Mass-loading factor for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(2):Mass-Loading : Poultry Forage	Mass-loading factor for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(3):Mass-Loading : Milk Cow Forage	Mass-loading factor for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(4):Mass-Loading : Layer Hen Forage	Mass-loading factor for layer hen forage	CONSTANT(none)

Default value used		Value 1.00E-01
MLG(1):Mass-Loading : Beef Cattle Grain	Mass-loading factor for beef cattle grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(2):Mass-Loading : Poultry Grain	Mass-loading factor for poultry grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(3):Mass-Loading : Milk Cow Grain	Mass-loading factor for milk cow grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(4):Mass-Loading : Layer Hen Grain	Mass-loading factor for layer hen grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(1):Mass-Loading : Beef Cattle Hay	Mass-loading factor for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(2):Mass-Loading : Poultry Hay	Mass-loading factor for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(3):Mass-Loading : Milk Cow Hay	Mass-loading factor for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(4):Mass-Loading : Layer Hen Hay	Mass-loading factor for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
TFF(1):Feeding Period : Beef Cow Forage	Feeding period for beef cattle forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(2):Feeding Period : Poultry Forage	Feeding period for poultry forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(3):Feeding Period : Milk Cow Forage	Feeding period for milk cow forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(4):Feeding Period : Layer Hen Forage	Feeding period for layer hen forage	CONSTANT(days)
Default value used		Value 3.65E+02

TFG(1):Feeding Period : Beef Cattle Grain	Feeding period for beef cattle grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(2):Feeding Period : Poultry Grain	Feeding period for poultry grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(3):Feeding Period : Milk Cow Grain	Feeding period for milk cow grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(4):Feeding Period : Layer Hen Grain	Feeding period for layer hen grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(1):Feeding Period : Beef Cattle Hay	Feeding period for beef cattle hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(2):Feeding Period : Poultry Hay	Feeding period for poultry hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(3):Feeding Period : Milk Cow Hay	Feeding period for milk cow hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(4):Feeding Period : Layer Hen Hay	Feeding period for layer hen hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(1):Water Period : Beef Cattle	Water ingestion period for beef cattle	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(2):Water Period : Poultry	Water ingestion period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(3):Water Period : Milk Cows	Water ingestion period for milk cows	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(4):Water Period : Layer Hens	Water ingestion period for layer hens	CONSTANT(days)
Default value used		Value 3.65E+02
fha(1):Hydrogen Fraction : Beef Cattle	Hydrogen fraction for beef cattle	CONSTANT(none)

Default value used		Value 1.00E-01
fha(2):Hydrogen Fraction : Poultry	Hydrogen fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
fha(3):Hydrogen Fraction : Milk Cows	Hydrogen fraction for milk cows	CONSTANT(none)
Default value used		Value 1.10E-01
fha(4):Hydrogen Fraction : Eggs	Hydrogen fraction for eggs	CONSTANT(none)
Default value used		Value 1.10E-01
fhv(1):Hydrogen Fraction : Leafy Vegetables	Hydrogen fraction for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(2):Hydrogen Fraction : Other Vegetables	Hydrogen fraction for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(3):Hydrogen Fraction : Fruits	Hydrogen fraction for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(4):Hydrogen Fraction : Grains	Hydrogen fraction for grains	CONSTANT(none)
Default value used		Value 6.80E-02
fhf(1):Hydrogen Fraction : Beef Cow Forage	Hydrogen fraction for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(2):Hydrogen Fraction : Poultry Forage	Hydrogen fraction for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(3):Hydrogen Fraction : Milk Cow Forage	Hydrogen fraction for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(4):Hydrogen Fraction : Layer Hen Forage	Hydrogen fraction for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(1):Hydrogen Fraction : Beef Cattle Hay	Hydrogen fraction for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01

fhh(2):Hydrogen Fraction : Poultry Hay	Hydrogen fraction for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(3):Hydrogen Fraction : Milk Cow Hay	Hydrogen fraction for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(4):Hydrogen Fraction : Layer Hen Hay	Hydrogen fraction for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhg(1):Hydrogen Fraction : Beef Cattle Grain	Hydrogen fraction for beef cattle grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(2):Hydrogen Fraction : Poultry Grain	Hydrogen fraction for poultry grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(3):Hydrogen Fraction : Milk Cow Grain	Hydrogen fraction for milk cow grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(4):Hydrogen Fraction : Layer Hen Grain	Hydrogen fraction for layer hen grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhd016:Hydrogen Fraction : Soil	Fraction of hydrogen in soil	DERIVED(none)
Default value used		
sasvh:Tritium Equivalence: Plant/Soil	Tritium equivalence: plant/soil	CONSTANT(none)
Default value used		Value 1.00E+00
sawvh:Tritium Equivalence: Plant/Water	Tritium equivalence: plant/water	CONSTANT(none)
Default value used		Value 1.00E+00
satah:Tritium Equivalence: Animal Products	Tritium equivalence: animal product intake	CONSTANT(none)
Default value used		Value 1.00E+00
YA(1):Animal Product Yield : Beef Cattle	Annual yield of beef per individual animal	CONSTANT(kg/y)
Default value used		Value 2.09E+02
YA(2):Animal Product	Annual yield of chicken per individual animal	CONSTANT(kg/y)

Yield : Poultry		
Default value used		Value 1.53E+00
YA(3):Animal Product Yield : Milk Cows	Annual yield of milk per individual animal	CONSTANT(L/y)
Default value used		Value 7.41E+03
YA(4):Animal Product Yield : Layer Hens	Annual yield of eggs per individual animal	CONSTANT(kg/y)
Default value used		Value 1.26E+01
ARExt:External Exposure Area	Minimum surface area to which resident is exposed via external radiation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARInh:Inhalation Exposure Area	Minimum surface area to which resident is exposed via inhalation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARIng:Secondary Ingestion Exposure Area	Minimum surface area to which resident is exposed via secondary ingestion during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARAgr:Agricultural Exposure Area	Minimum surface area to which resident is exposed via any agricultural product during residential period	DERIVED(m**2)
Default value used		
ARH2O:Groundwater Exposure Area	Minimum surface area to which resident is exposed via groundwater during residential period	DERIVED(m**2)
Default value used		
ARAll:Exposure Area	Minimum surface area to which resident is exposed via any pathway during the residential period	DERIVED(m**2)
Default value used		

Element Dependant Parameters

Parameter Name	Description	Distribution

H:Coefficient	Partition coefficient for H	CONSTANT(mL/g)
Default value used		Value 0.00E+00
C:Coefficient	Partition coefficient for C	CONTINUOUS LINEAR(Log10(mL/g))
Default value used		

Value	Probability
-5.67E-01	0.00E+00
-4.70E-01	1.03E-02
-3.63E-01	3.44E-02
-2.73E-01	6.71E-02
-1.99E-01	9.98E-02
-1.30E-01	1.33E-01
-6.49E-02	1.65E-01
-3.96E-03	1.98E-01
5.94E-02	2.31E-01
1.24E-01	2.63E-01
1.86E-01	2.96E-01
2.51E-01	3.29E-01
3.18E-01	3.61E-01
3.89E-01	3.94E-01
4.64E-01	4.27E-01
5.40E-01	4.60E-01
6.19E-01	4.92E-01
6.40E-01	5.01E-01
7.07E-01	5.25E-01
7.99E-01	5.58E-01
9.00E-01	5.90E-01
1.01E+00	6.23E-01
1.13E+00	6.56E-01
1.26E+00	6.88E-01
1.41E+00	7.21E-01
1.59E+00	7.54E-01
1.78E+00	7.87E-01
2.03E+00	8.19E-01
2.32E+00	8.52E-01
2.71E+00	8.85E-01
3.26E+00	9.17E-01
4.14E+00	9.50E-01
5.03E+00	9.69E-01
6.32E+00	9.83E-01
8.02E+00	9.91E-01
1.44E+01	1.00E+00

Fe:Coefficient	Partition coefficient for Fe	CONTINUOUS LINEAR(Log10(mL/g))
Default value used		

Value	Probability
-1.11E+00	0.00E+00
9.49E-01	3.45E-02

		1.35E+00	6.91E-02
		1.62E+00	1.04E-01
		1.80E+00	1.38E-01
		1.94E+00	1.73E-01
		2.07E+00	2.07E-01
		2.17E+00	2.42E-01
		2.20E+00	2.50E-01
		2.26E+00	2.76E-01
		2.35E+00	3.11E-01
		2.43E+00	3.45E-01
		2.50E+00	3.80E-01
		2.57E+00	4.15E-01
		2.64E+00	4.49E-01
		2.70E+00	4.84E-01
		2.73E+00	4.99E-01
		2.76E+00	5.18E-01
		2.82E+00	5.53E-01
		2.87E+00	5.87E-01
		2.93E+00	6.22E-01
		2.99E+00	6.56E-01
		3.05E+00	6.91E-01
		3.11E+00	7.25E-01
		3.15E+00	7.50E-01
		3.17E+00	7.60E-01
		3.23E+00	7.94E-01
		3.29E+00	8.29E-01
		3.36E+00	8.64E-01
		3.45E+00	8.98E-01
		3.55E+00	9.33E-01
		3.69E+00	9.67E-01
		3.89E+00	9.91E-01
		4.14E+00	1.00E+00
Co:Coefficient	Partition coefficient for Co	CONTINUOUS LINEAR(Log10(mL/g))	
Default value used		Value	Probability
		-2.47E+00	0.00E+00
		1.95E-01	3.45E-02
		7.70E-01	6.91E-02
		1.13E+00	1.04E-01
		1.39E+00	1.38E-01
		1.59E+00	1.73E-01
		1.77E+00	2.07E-01
		1.91E+00	2.42E-01
		1.95E+00	2.50E-01
		2.04E+00	2.76E-01
		2.16E+00	3.11E-01
		2.28E+00	3.45E-01
		2.38E+00	3.80E-01

		2.47E+00 4.15E-01 2.56E+00 4.49E-01 2.65E+00 4.84E-01 2.69E+00 4.99E-01 2.73E+00 5.18E-01 2.82E+00 5.53E-01 2.90E+00 5.87E-01 2.97E+00 6.22E-01 3.05E+00 6.56E-01 3.13E+00 6.91E-01 3.21E+00 7.25E-01 3.28E+00 7.50E-01 3.30E+00 7.60E-01 3.39E+00 7.94E-01 3.48E+00 8.29E-01 3.58E+00 8.64E-01 3.70E+00 8.98E-01 3.84E+00 9.33E-01 4.03E+00 9.67E-01 4.30E+00 9.91E-01 4.65E+00 1.00E+00
Ni:Coefficient	Partition coefficient for Ni	NORMAL(Log10(mL/g))
Default value used		Mean 1.57E+00 Standard Deviation 1.48E+00
Sr:Coefficient	Partition coefficient for Sr	NORMAL(Log10(mL/g))
Default value used		Mean 1.50E+00 Standard Deviation 9.20E-01
Y:Coefficient	Partition coefficient for Y	NORMAL(Log10(mL/g))
Default value used		Mean 2.90E+00 Standard Deviation 1.40E+00
Nb:Coefficient	Partition coefficient for Nb	NORMAL(Log10(mL/g))
Default value used		Mean 2.80E+00 Standard Deviation 1.40E+00
Tc:Coefficient	Partition coefficient for Tc	NORMAL(Log10(mL/g))
Default value used		Mean 8.70E-01 Standard Deviation 1.33E+00
Cs:Coefficient	Partition coefficient for Cs	NORMAL(Log10(mL/g))
Default value used		Mean 2.65E+00 Standard Deviation 1.01E+00
H:Leafy	Leafy plant concentration factor for H	CONSTANT(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Value 0.00E+00
C:Leafy	Leafy plant concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt leafy per

		pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01
Fe:Leafy	Leafy plant concentration factor for Fe	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.18E+00 Standard Deviation of Ln 1.34E+00
Co:Leafy	Leafy plant concentration factor for Co	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -2.43E+00 Standard Deviation of Ln 1.55E+00
Ni:Leafy	Leafy plant concentration factor for Ni	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.38E+00 Standard Deviation of Ln 1.16E+00
Sr:Leafy	Leafy plant concentration factor for Sr	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) 5.88E-01 Standard Deviation of Ln 1.34E+00
Y:Leafy	Leafy plant concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 9.04E-01
Nb:Leafy	Leafy plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.91E+00 Standard Deviation of Ln 9.04E-01
Tc:Leafy	Leafy plant concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) 2.25E+00 Standard Deviation of Ln 9.04E-01
Cs:Leafy	Leafy plant concentration factor for Cs	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.19E+00 Standard Deviation of Ln 1.25E+00
H:Root	Root plant concentration factor for H	CONSTANT(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Value 0.00E+00
C:Root	Root plant concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01

Fe:Root	Root plant concentration factor for Fe	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.78E+00 Standard Deviation of Ln 1.25E+00
Co:Root	Root plant concentration factor for Co	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 1.19E+00
Ni:Root	Root plant concentration factor for Ni	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -3.86E+00 Standard Deviation of Ln 9.16E-01
Sr:Root	Root plant concentration factor for Sr	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -2.59E+00 Standard Deviation of Ln 1.34E+00
Y:Root	Root plant concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
Nb:Root	Root plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Tc:Root	Root plant concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) 4.05E-01 Standard Deviation of Ln 9.04E-01
Cs:Root	Root plant concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
H:Fruit	Fruit concentration factor for H	CONSTANT(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Value 0.00E+00
C:Fruit	Fruit concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01
Fe:Fruit	Fruit concentration factor for Fe	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.78E+00 Standard Deviation of Ln 1.25E+00

Co:Fruit	Fruit concentration factor for Co	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 1.19E+00
Ni:Fruit	Fruit concentration factor for Ni	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -3.86E+00 Standard Deviation of Ln 9.16E-01
Sr:Fruit	Fruit concentration factor for Sr	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -2.59E+00 Standard Deviation of Ln 1.34E+00
Y:Fruit	Fruit concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
Nb:Fruit	Fruit concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Tc:Fruit	Fruit concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) 4.05E-01 Standard Deviation of Ln 9.04E-01
Cs:Fruit	Fruit concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
H:Grain	Grain concentration factor for H	CONSTANT(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Value 0.00E+00
C:Grain	Grain concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01
Fe:Grain	Grain concentration factor for Fe	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.78E+00 Standard Deviation of Ln 1.25E+00
Co:Grain	Grain concentration factor for Co	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 1.19E+00

Ni:Grain	Grain concentration factor for Ni	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -3.86E+00 Standard Deviation of Ln 9.16E-01
Sr:Grain	Grain concentration factor for Sr	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -2.59E+00 Standard Deviation of Ln 1.34E+00
Y:Grain	Grain concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
Nb:Grain	Grain concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Tc:Grain	Grain concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) 4.05E-01 Standard Deviation of Ln 9.04E-01
Cs:Grain	Grain concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
H:Beef	Beef transfer factor for H	CONSTANT(d/kg)
Default value used		Value 0.00E+00
C:Beef	Beef transfer factor for C	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Fe:Beef	Beef transfer factor for Fe	CONSTANT(d/kg)
Default value used		Value 2.00E-02
Co:Beef	Beef transfer factor for Co	CONSTANT(d/kg)
Default value used		Value 2.00E-02
Ni:Beef	Beef transfer factor for Ni	CONSTANT(d/kg)
Default value used		Value 6.00E-03
Sr:Beef	Beef transfer factor for Sr	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Y:Beef	Beef transfer factor for Y	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Nb:Beef	Beef transfer factor for Nb	CONSTANT(d/kg)

Default value used		Value 2.50E-01
Tc:Beef	Beef transfer factor for Tc	CONSTANT(d/kg)
Default value used		Value 8.50E-03
Cs:Beef	Beef transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 2.00E-02
H:Poultry	Poultry transfer factor for H	CONSTANT(d/kg)
Default value used		Value 0.00E+00
C:Poultry	Poultry transfer factor for C	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Fe:Poultry	Poultry transfer factor for Fe	CONSTANT(d/kg)
Default value used		Value 1.50E+00
Co:Poultry	Poultry transfer factor for Co	CONSTANT(d/kg)
Default value used		Value 5.00E-01
Ni:Poultry	Poultry transfer factor for Ni	CONSTANT(d/kg)
Default value used		Value 1.00E-03
Sr:Poultry	Poultry transfer factor for Sr	CONSTANT(d/kg)
Default value used		Value 3.50E-02
Y:Poultry	Poultry transfer factor for Y	CONSTANT(d/kg)
Default value used		Value 1.00E-02
Nb:Poultry	Poultry transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 3.10E-04
Tc:Poultry	Poultry transfer factor for Tc	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Cs:Poultry	Poultry transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.40E+00
H:Milk	Milk transfer factor for H	CONSTANT(d/L)
Default value used		Value 0.00E+00
C:Milk	Milk transfer factor for C	CONSTANT(d/L)
Default value used		Value 0.00E+00
Fe:Milk	Milk transfer factor for Fe	CONSTANT(d/L)
Default value used		Value 2.50E-04
Co:Milk	Milk transfer factor for Co	CONSTANT(d/L)
Default value used		Value 2.00E-03
Ni:Milk	Milk transfer factor for Ni	CONSTANT(d/L)

Default value used		Value 1.00E-03
Sr:Milk	Milk transfer factor for Sr	CONSTANT(d/L)
Default value used		Value 1.50E-03
Y:Milk	Milk transfer factor for Y	CONSTANT(d/L)
Default value used		Value 2.00E-05
Nb:Milk	Milk transfer factor for Nb	CONSTANT(d/L)
Default value used		Value 2.00E-02
Tc:Milk	Milk transfer factor for Tc	CONSTANT(d/L)
Default value used		Value 1.00E-02
Cs:Milk	Milk transfer factor for Cs	CONSTANT(d/L)
Default value used		Value 7.00E-03
H:Eggs	Egg transfer factor for H	CONSTANT(d/kg)
Default value used		Value 0.00E+00
C:Eggs	Egg transfer factor for C	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Fe:Eggs	Egg transfer factor for Fe	CONSTANT(d/kg)
Default value used		Value 1.30E+00
Co:Eggs	Egg transfer factor for Co	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Ni:Eggs	Egg transfer factor for Ni	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Sr:Eggs	Egg transfer factor for Sr	CONSTANT(d/kg)
Default value used		Value 3.00E-01
Y:Eggs	Egg transfer factor for Y	CONSTANT(d/kg)
Default value used		Value 2.00E-03
Nb:Eggs	Egg transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 1.30E-03
Tc:Eggs	Egg transfer factor for Tc	CONSTANT(d/kg)
Default value used		Value 3.00E+00
Cs:Eggs	Egg transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.90E-01
H:Factor	Bioaccumulation factor for H in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+00
C:Factor	Bioaccumulation factor for C in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L

		water)
Default value used		Value 4.60E+03
Fe:Factor	Bioaccumulation factor for Fe in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03
Co:Factor	Bioaccumulation factor for Co in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 3.30E+02
Ni:Factor	Bioaccumulation factor for Ni in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
Sr:Factor	Bioaccumulation factor for Sr in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+01
Y:Factor	Bioaccumulation factor for Y in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Nb:Factor	Bioaccumulation factor for Nb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Tc:Factor	Bioaccumulation factor for Tc in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.50E+01
Cs:Factor	Bioaccumulation factor for Cs in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03

Correlation Coefficients:

Parameter One	Parameter Two	Correlation Coefficient
KSDEV:Permeability Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		
NDEV:Porosity Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		

Summary Results:

90.00% **of the** 109 **calculated TEDE values are** < 5.19E+01 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 5.15E+01 **to** 5.36E+01 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Soil Concentration (pCi/g)	Water Concentration (pCi/g)
3H	2.21E-02	2.10E-02
14C	1.56E-01	1.91E-10
55Fe	1.73E-01	3.22E-24
59Ni	7.48E-01	1.18E-10
60Co	7.82E+00	1.31E-19
63Ni	9.11E+01	1.42E-08
90Sr	4.38E-03	3.37E-16
90Y	0.00E+00	3.34E-16
94Nb	2.31E-03	7.30E-15
99Tc	7.64E-04	2.19E-10
134Cs	3.39E-07	6.28E-30

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
5.36E+01	4.35E+00	1.41E-06	1.50E-07	4.85E+01	6.25E-04	3.55E-03	1.30E-06

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
3H	6.32E-03
14C	1.04E-01
55Fe	4.20E-04
59Ni	2.07E-03
60Co	5.26E+01

63Ni	6.88E-01
90Sr	8.13E-02
90Y	4.20E-03
94Nb	1.00E-02
99Tc	1.30E-03
134Cs	1.52E-06
All Nuclides	5.36E+01

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
3H	6.32E-03	6.22E-07	1.40E-08	0.00E+00	3.94E-10	1.95E-08	5.71E-07
14C	1.04E-01	1.84E-13	1.94E-11	1.03E-06	9.31E-08	4.61E-06	2.37E-12
55Fe	4.19E-04	9.02E-28	4.09E-26	0.00E+00	1.18E-07	1.31E-06	2.38E-27
59Ni	1.89E-03	1.14E-14	2.39E-14	0.00E+00	5.78E-07	2.22E-06	3.02E-14
60Co	3.77E+00	1.63E-21	1.12E-20	4.85E+01	4.59E-04	2.79E-03	6.60E-21
63Ni	6.29E-01	3.78E-12	8.04E-12	0.00E+00	1.63E-04	7.41E-04	1.01E-11
90Sr	8.13E-02	2.22E-17	2.34E-17	1.47E-06	1.61E-06	8.73E-06	5.99E-17
90Y	4.15E-03	1.66E-18	8.74E-19	4.66E-05	1.03E-08	6.53E-07	4.28E-18
94Nb	4.63E-04	2.41E-17	1.17E-16	9.54E-03	2.74E-07	2.34E-07	1.09E-15
99Tc	1.30E-03	1.48E-13	5.10E-14	4.67E-08	1.82E-09	1.58E-08	9.92E-13
134Cs	3.48E-07	2.12E-31	9.33E-30	1.18E-06	3.84E-12	2.99E-10	1.50E-30

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 6/30/2008 7:36:31 PM
Site Name: EF1
Description: Analysis of potential dose from nuclides not discounted for resident
FileName:C:\Documents and Settings\Marty\My Documents\DnD_Res3.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 142
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 4.83E-03
152Eu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 4.09E-04
154Eu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 5.41E-04
155Eu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Percent total		Value 2.04E-05
239Pu	UNLIMITED	CONSTANT(pCi/g)

Justification for concentration: Percent total	Value 5.80E-05

Chain Data:

Number of chains: **5**

Chain No. 1: **137Cs**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
137Cs	1	1.10E+04					1.35E-08	8.63E-09	2.46E-14	3.40E-16
137mBa	Implicit		1	0.946			0.00E+00	0.00E+00	5.06E-11	1.48E-12

Chain No. 2: **152Eu**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
152Eu	1	4.87E+03					1.75E-09	5.97E-08	9.53E-11	2.78E-12
152Gd	2	3.94E+16	1	0.2792			4.34E-08	1.01E-06	0.00E+00	0.00E+00

Chain No. 3: **154Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
154Eu	1	3.21E+03					2.58E-09	7.73E-08	1.02E-10	3.04E-12

Chain No. 4: **155Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
155Eu	1	1.81E+03					4.13E-10	1.12E-08	5.10E-12	8.42E-14

Chain No. 5: **239Pu**
Nuclides in chain: **14**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
239Pu	1	8.79E+06					9.56E-07	1.16E-04	3.17E-14	1.31E-16
235U	2	2.57E+11	1	1	0	0	7.19E-08	3.32E-05	1.28E-11	3.24E-13
231Th	3	1.06E+00	2	1	0	0	3.65E-10	2.37E-10	1.60E-12	1.68E-14
231Pa	4	1.20E+07	3	1	0	0	2.86E-06	3.47E-04	3.52E-12	8.30E-14
227Ac	5	7.95E+03	4	1	0	0	3.80E-06	1.81E-03	1.36E-14	2.26E-16
223Fr	Implicit		5	0.0138			2.33E-09	1.68E-09	4.88E-12	8.74E-14
227Th	6	1.87E+01	5	0.9862	0	0	1.03E-08	4.37E-06	8.94E-12	2.29E-13
223Ra	7	1.14E+01	6	1	5	0.0138	1.78E-07	2.12E-06	1.11E-11	2.67E-13
219Rn	Implicit		7	1			0.00E+00	0.00E+00	4.74E-12	1.33E-13
215Po	Implicit		7	1			0.00E+00	0.00E+00	1.51E-14	4.30E-16
211Pb	Implicit		7	1			1.42E-10	2.35E-09	4.38E-12	1.26E-13
211Bi	Implicit		7	1			0.00E+00	0.00E+00	3.96E-12	1.10E-13
211Po	Implicit		7	0.0028			0.00E+00	0.00E+00	6.57E-13	1.94E-14
207Tl	Implicit		7	0.9972			0.00E+00	0.00E+00	3.25E-13	8.19E-15

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Nuclide	Soil Concentration (pCi/g)
137Cs	4.83E-03
137mBa	4.57E-03
152Eu	4.09E-04
152Gd	0.00E+00
154Eu	5.41E-04
155Eu	2.04E-05
239Pu	5.80E-05
235U	0.00E+00
231Th	0.00E+00
231Pa	0.00E+00
227Ac	0.00E+00
223Fr	0.00E+00

227Th	0.00E+00
223Ra	0.00E+00
219Rn	0.00E+00
215Po	0.00E+00
211Pb	0.00E+00
211Bi	0.00E+00
211Po	0.00E+00
207Tl	0.00E+00

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
Tv(1):Translocation:Leafy	Translocation factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E+00
Tv(2):Translocation:Root	Translocation factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(3):Translocation:Fruit	Translocation factor for fruit	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(4):Translocation:Grain	Translocation factor for grain	CONSTANT(none)
Default value used		Value 1.00E-01
Tf(1):Translocation:Beef Forage	Translocation factor for forage consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(2):Translocation:Poultry Forage	Translocation factor for forage consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(3):Translocation:Milk Cow	Translocatioin factor for forage consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(4):Translocation:Layer Hen Forage	Translocation factor for forage consumed by layer hens	CONSTANT(none)

Default value used		Value	1.00E+00
Tg(1):Translocation:Beef Grain	Translocation factor for stored grain consumed by beef cattle	CONSTANT(none)	
Default value used		Value	1.00E-01
Tg(2):Translocation:Poultry Grain	Translocation factor for stored grain consumed by poultry	CONSTANT(none)	
Default value used		Value	1.00E-01
Tg(3):Translocation:Milk Cow Grain	Translocation factor for stored grain consumed by milk cows	CONSTANT(none)	
Default value used		Value	1.00E-01
Tg(4):Translocation:Layer Hen Grain	Translocation factor for stored grain consumed by layer hens	CONSTANT(none)	
Default value used		Value	1.00E-01
Th(1):Translocation:Beef Hay	Translocation factor for stored hay consumed by beef cattle	CONSTANT(none)	
Default value used		Value	1.00E+00
Th(2):Translocation:Poultry Hay	Translocation factor for stored hay consumed by poultry	CONSTANT(none)	
Default value used		Value	1.00E+00
Th(3):Translocation:Milk Cow Hay	Translocation factor for stored hay consumed by milk cows	CONSTANT(none)	
Default value used		Value	1.00E+00
Th(4):Translocation:Layer Hen Hay	Translocation factor for stored hay consumed by layer hens	CONSTANT(none)	
Default value used		Value	1.00E+00
fca(1):Beef Carbon Fraction	Mass fraction of beef cattle that is carbon	CONSTANT(none)	
Default value used		Value	3.60E-01
fca(2):Poultry Carbon Fraction	Mass fraction of poultry that is carbon	CONSTANT(none)	
Default value used		Value	1.80E-01
fca(3):Milk Carbon Fraction	Mass fraction of milk that is carbon	CONSTANT(none)	
Default value used		Value	6.00E-02
fca(4):Eggs Carbon Fraction	Mass fraction of an egg that is carbon	CONSTANT(none)	
Default value used		Value	1.60E-01
fcf(1):Beef Forage Carbon	Mass fraction of wet forage	CONSTANT(none)	

Fraction	consumed by beef cattle that is carbon	
Default value used		Value 1.10E-01
fcf(2):Poultry Forage Carbon Fraction	Mass fraction of wet forage consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(3):Milk Cow Forage Carbon Fraction	Mass fraction of wet forage consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(4):Layer Hen Forage Carbon Fraction	Mass fraction of wet forage consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcg(1):Beef Grain Carbon Fraction	Mass fraction of wet stored grain consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(2):Poultry Grain Carbon Fraction	Mass fraction of wet stored grain consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(3):Milk Cow Grain Carbon Fraction	Mass fraction of wet stored grain consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(4):Layer Hen Grain Carbon Fraction	Mass fraction of wet stored grain consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fch(1):Beef Hay Carbon Fraction	Mass fraction of wet stored hay consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(2):Poultry Hay Carbon Fraction	Mass fraction of wet stored hay consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(3):Milk Cow Hay Carbon Fraction	Mass fraction of wet stored hay consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(4):Layer Hen Hay Carbon Fraction	Mass fraction of wet stored hay consumed by layer hens that is carbon	CONSTANT(none)

Default value used		Value 7.00E-02
fCd:Soil Carbon Fraction	Mass fraction of dry soil that is carbon	CONSTANT(none)
Default value used		Value 3.00E-02
SATac:Animal Product Specific Activity	Specific activity equivalence of animal product and specific activity of animal feed, forage, and soil	CONSTANT(none)
Default value used		Value 1.00E+00
xf(1):Beef Forage Contaminated Fraction	Fraction of forage consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(2):Poultry Forage Contaminated Fraction	Fraction of forage consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(3):Milk Cow Forage Contaminated Fraction	Fraction of forage consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(4):Layer Hen Forage Contaminated Fraction	Fraction of forage consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(1):Beef Grain Contaminated Fraction	Fraction of stored grain consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(2):Poultry Grain Contaminated Fraction	Fraction of stored grain consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(3):Milk Cow Grain Contaminated Fraction	Fraction of stored grain consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(4):Layer Hen Grain Contaminated Fraction	Fraction of stored grain that is consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(1):Beef Hay Contaminated Fraction	Fraction of stored hay consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(2):Poultry Hay Contaminated Fraction	Fraction of stored hay consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00

xh(3):Milk Cow Hay Contaminated Fraction	Fraction of stored hay consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(4):Layer Hen Hay Contaminated Fraction	Fraction of stored hay consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(1):Beef Water Contaminated Fraction	Fraction of water that is consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(2):Poultry Water Contaminated Fraction	Fraction of water consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(3):Milk Cow Water Contaminated Fraction	Fraction of water consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(4):Layer Hen Water Contaminated Fraction	Fraction of water consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
DIET:Garden Diet	Fraction of human diet grown onsite	CONSTANT(none)
Default value used		Value 1.00E+00
Uv(1):Diet - Leafy	Yearly human consumption of leafy vegetables	CONSTANT(kg/y)
Default value used		Value 2.14E+01
Uv(2):Diet - Roots	Yearly human consumption of other vegetables	CONSTANT(kg/y)
Default value used		Value 4.46E+01
Uv(3):Diet - Fruit	Yearly human consumption of fruits	CONSTANT(kg/y)
Default value used		Value 5.28E+01
Uv(4):Diet - Grain	Yearly human consumption of grains	CONSTANT(kg/y)
Default value used		Value 1.44E+01
Ua(1):Diet - Beef	Yearly human consumption of beef	CONSTANT(kg/y)
Default value used		Value 3.98E+01
Ua(2):Diet - Poultry	Yearly human consumption of poultry	CONSTANT(kg/y)
Default value used		Value 2.53E+01
Ua(3):Diet - Milk	Yearly human consumption of milk	CONSTANT(L/y)

Default value used		Value 2.33E+02
Ua(4):Diet - Egg	Yearly human consumption of eggs	CONSTANT(kg/y)
Default value used		Value 1.91E+01
Uf:Diet - Fish	Yearly human consumption of fish produced from an onsite pond	CONSTANT(kg/y)
Default value used		Value 2.06E+01
tf:Consumption Period	Consumption period for fish	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(1):Consumption Period - Leafy	Food consumption period for leafy vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(2):Consumption Period - Roots	Food consumption period for other vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(3):Consumption Period - Fruit	Food consumption period for fruits	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(4):Consumption Period - Grain	Food consumption period for grains	CONSTANT(days)
Default value used		Value 3.65E+02
tca(1):Consumption Period - Beef	Food consumption period for beef	CONSTANT(days)
Default value used		Value 3.65E+02
tca(2):Consumption Period - Poultry	Food consumption period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
tca(3):Consumption Period - Milk	Food consumption period for milk	CONSTANT(days)
Default value used		Value 3.65E+02
tca(4):Consumption Period - Egg	Food consumption period for eggs	CONSTANT(days)
Default value used		Value 3.65E+02
Nunsat:Number of Unsaturated Layers	Number of model layers used to represent the unsaturated zone	CONSTANT(none)
Default value used		Value 1.00E+01
TstartR:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00

TendR:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+05
dtR:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
PstepR:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
TI:Indoor Exposure Period	The time the resident spends indoors	CONSTANT(days/year)
Default value used		Value 2.40E+02
TX:Outdoor Exposure Period	The time the resident spends outdoors	CONSTANT(days/year)
Default value used		Value 4.02E+01
TG:Gardening Period	The time the resident spends gardening	CONSTANT(days/year)
Default value used		Value 2.92E+00
TTR:Total time in period	Total time in the one year exposure period	CONSTANT(days/year)
Default value used		Value 3.65E+02
SFI:Indoor Shielding Factor	Shielding factor for the residence	CONSTANT(none)
Default value used		Value 5.52E-01
SFO:Outdoor Shielding Factor	Shielding factor for the cover soil	CONSTANT(none)
Default value used		Value 1.00E+00
PD:Floor dust loading	Floor dust loading	UNIFORM(g/m**2)
Default value used		Lower Limit 2.00E-02 Upper Limit 3.00E-01
RFR:Indoor Resuspension Factor	Resuspension factor for indoor dust	LOGUNIFORM(1/m)
Default value used		Lower Limit 1.00E-07 Upper Limit 8.00E-05
CDO:Outdoor Dust Loading	Average dust loading outdoors	LOGUNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-07 Upper Limit 1.00E-04
CDI:Indoor Dust Loading	Average dust loading indoors	DERIVED(g/m**3)
Default value used		

PF:Indoor/Outdoor Penetration Factor	Fraction of outdoor dust in indoor air	UNIFORM(none)
Default value used		Lower Limit 2.00E-01 Upper Limit 7.00E-01
CDG:Gardening Dust Loading	Average dust loading while gardening	UNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-04 Upper Limit 7.00E-04
VR:Indoor Breathing Rate	Breathing rate while indoors	CONSTANT(m**3/hr)
Default value used		Value 9.00E-01
VX:Outdoor Breathing Rate	Breathing rate while outdoors	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
VG:Gardening Breathing Rate	Breathing rate while gardening	CONSTANT(m**3/hr)
Default value used		Value 1.70E+00
GR:Soil Ingestion Transfer Rate	Average rate of soil ingestion	CONSTANT(g/d)
Default value used		Value 5.00E-02
UW:Diet - Water	Drinking water ingestion rate	CONSTANT(L/d)
Default value used		Value 1.26E+00
H1:Surface Soil Thickness	Thickness of the surface soil layer	CONSTANT(m)
Default value used		Value 1.50E-01
H2:Unsaturated Zone Thickness	Thickness of the unsaturated zone	CONTINUOUS LINEAR(m)
Default value used		Value / Probability 3.05E-01 0.00E+00 6.68E-01 4.76E-03 8.11E-01 9.52E-03 9.21E-01 1.43E-02 9.94E-01 1.91E-02 1.03E+00 2.38E-02 1.07E+00 2.86E-02 1.14E+00 3.33E-02 1.21E+00 3.81E-02 1.30E+00 4.29E-02 1.31E+00 4.76E-02 1.32E+00 5.24E-02 1.56E+00 5.71E-02 1.58E+00 6.19E-02 1.61E+00 6.67E-02

	1.69E+00	7.62E-02
	1.78E+00	8.57E-02
	1.80E+00	9.05E-02
	1.81E+00	9.52E-02
	1.84E+00	1.00E-01
	1.87E+00	1.05E-01
	1.92E+00	1.10E-01
	2.04E+00	1.14E-01
	2.10E+00	1.19E-01
	2.11E+00	1.24E-01
	2.32E+00	1.29E-01
	2.36E+00	1.33E-01
	2.37E+00	1.38E-01
	2.39E+00	1.43E-01
	2.44E+00	1.48E-01
	2.44E+00	1.52E-01
	2.45E+00	1.57E-01
	2.59E+00	1.62E-01
	2.63E+00	1.67E-01
	2.69E+00	1.71E-01
	2.79E+00	1.76E-01
	2.81E+00	1.81E-01
	2.90E+00	1.86E-01
	2.95E+00	1.91E-01
	3.07E+00	1.95E-01
	3.18E+00	2.00E-01
	3.22E+00	2.05E-01
	3.30E+00	2.10E-01
	3.34E+00	2.14E-01
	3.37E+00	2.19E-01
	3.44E+00	2.24E-01
	3.58E+00	2.29E-01
	3.62E+00	2.33E-01
	3.66E+00	2.38E-01
	3.74E+00	2.43E-01
	3.86E+00	2.48E-01
	3.88E+00	2.52E-01
	4.17E+00	2.57E-01
	4.26E+00	2.62E-01
	4.44E+00	2.71E-01
	4.63E+00	2.76E-01
	4.87E+00	2.81E-01
	5.13E+00	2.86E-01
	5.18E+00	2.91E-01
	5.54E+00	2.95E-01
	5.83E+00	3.00E-01
	5.86E+00	3.05E-01
	5.86E+00	3.10E-01
	5.90E+00	3.14E-01

	6.06E+00	3.19E-01
	6.13E+00	3.24E-01
	6.17E+00	3.29E-01
	6.22E+00	3.33E-01
	6.31E+00	3.38E-01
	6.36E+00	3.43E-01
	6.40E+00	3.48E-01
	6.46E+00	3.52E-01
	6.51E+00	3.57E-01
	6.55E+00	3.62E-01
	6.60E+00	3.67E-01
	6.86E+00	3.71E-01
	6.93E+00	3.76E-01
	6.95E+00	3.86E-01
	6.97E+00	3.91E-01
	7.09E+00	3.95E-01
	7.18E+00	4.00E-01
	7.35E+00	4.05E-01
	7.36E+00	4.10E-01
	7.40E+00	4.14E-01
	7.43E+00	4.19E-01
	7.46E+00	4.24E-01
	7.59E+00	4.29E-01
	7.60E+00	4.33E-01
	7.64E+00	4.38E-01
	7.87E+00	4.43E-01
	8.10E+00	4.48E-01
	8.28E+00	4.52E-01
	8.35E+00	4.57E-01
	8.71E+00	4.62E-01
	8.71E+00	4.67E-01
	8.73E+00	4.71E-01
	8.79E+00	4.76E-01
	8.80E+00	4.81E-01
	8.82E+00	4.86E-01
	8.85E+00	4.91E-01
	8.89E+00	4.95E-01
	8.90E+00	5.00E-01
	8.99E+00	5.05E-01
	9.00E+00	5.10E-01
	9.13E+00	5.14E-01
	9.14E+00	5.19E-01
	9.21E+00	5.24E-01
	9.31E+00	5.29E-01
	9.55E+00	5.33E-01
	9.60E+00	5.38E-01
	9.63E+00	5.43E-01
	9.86E+00	5.48E-01
	1.05E+01	5.52E-01

	1.07E+01	5.57E-01
	1.13E+01	5.62E-01
	1.15E+01	5.67E-01
	1.17E+01	5.71E-01
	1.20E+01	5.76E-01
	1.26E+01	5.81E-01
	1.26E+01	5.86E-01
	1.28E+01	5.91E-01
	1.32E+01	5.95E-01
	1.32E+01	6.00E-01
	1.34E+01	6.05E-01
	1.34E+01	6.10E-01
	1.36E+01	6.14E-01
	1.37E+01	6.19E-01
	1.38E+01	6.24E-01
	1.41E+01	6.29E-01
	1.45E+01	6.33E-01
	1.51E+01	6.38E-01
	1.52E+01	6.43E-01
	1.61E+01	6.48E-01
	1.62E+01	6.52E-01
	1.65E+01	6.57E-01
	1.66E+01	6.62E-01
	1.69E+01	6.67E-01
	1.74E+01	6.71E-01
	1.82E+01	6.76E-01
	1.84E+01	6.81E-01
	1.84E+01	6.86E-01
	1.87E+01	6.91E-01
	1.95E+01	6.95E-01
	2.01E+01	7.00E-01
	2.07E+01	7.05E-01
	2.08E+01	7.10E-01
	2.17E+01	7.14E-01
	2.24E+01	7.19E-01
	2.27E+01	7.24E-01
	2.29E+01	7.29E-01
	2.29E+01	7.33E-01
	2.40E+01	7.38E-01
	2.47E+01	7.43E-01
	2.60E+01	7.48E-01
	2.65E+01	7.52E-01
	2.72E+01	7.57E-01
	2.73E+01	7.62E-01
	2.76E+01	7.67E-01
	2.77E+01	7.71E-01
	2.78E+01	7.76E-01
	2.80E+01	7.81E-01
	2.86E+01	7.86E-01

		2.94E+01 7.91E-01 3.01E+01 7.95E-01 3.03E+01 8.00E-01 3.06E+01 8.10E-01 3.08E+01 8.14E-01 3.11E+01 8.19E-01 3.17E+01 8.24E-01 3.17E+01 8.29E-01 3.17E+01 8.33E-01 3.22E+01 8.38E-01 3.39E+01 8.43E-01 3.48E+01 8.48E-01 3.54E+01 8.52E-01 3.60E+01 8.57E-01 3.68E+01 8.62E-01 4.03E+01 8.67E-01 4.07E+01 8.71E-01 4.24E+01 8.76E-01 4.29E+01 8.81E-01 4.42E+01 8.86E-01 4.72E+01 8.91E-01 4.97E+01 8.95E-01 5.12E+01 9.00E-01 6.13E+01 9.05E-01 6.19E+01 9.10E-01 6.23E+01 9.14E-01 6.32E+01 9.19E-01 6.59E+01 9.24E-01 6.73E+01 9.29E-01 7.47E+01 9.33E-01 7.92E+01 9.38E-01 8.12E+01 9.43E-01 8.28E+01 9.48E-01 8.47E+01 9.52E-01 8.96E+01 9.57E-01 9.47E+01 9.62E-01 1.08E+02 9.67E-01 1.13E+02 9.71E-01 1.15E+02 9.76E-01 1.42E+02 9.81E-01 1.77E+02 9.86E-01 1.78E+02 9.91E-01 1.80E+02 9.95E-01 3.16E+02 1.00E+00
N1:Surface Soil Porosity	Porosity of the surface soil layer	DERIVED(none)
Default value used		
N2:Unsaturated Zone	Porosity of the unsaturated zone	DERIVED(none)

Porosity		
Default value used		
F1:Surface Soil Saturation	Saturation ratio of the surface soil layer	DERIVED(none)
Default value used		
F2:Unsaturated Zone Saturation	Saturation ratio of the unsaturated zone	DERIVED(none)
Default value used		
INFIL:Infiltration Rate	Net rate of infiltration to aquifer	DERIVED(m/y)
Default value used		
SCSST:Soil Classification	SCS soil classification ID	DISCRETE CUMULATIVE(none)
Default value used		Value / Probability 1.00E+00 / 1.00E-04 2.00E+00 / 1.34E-03 3.00E+00 / 1.06E-02 4.00E+00 / 2.51E-02 5.00E+00 / 6.17E-02 6.00E+00 / 1.09E-01 7.00E+00 / 1.62E-01 8.00E+00 / 2.12E-01 9.00E+00 / 2.85E-01 1.00E+01 / 5.10E-01 1.10E+01 / 7.58E-01 1.20E+01 / 1.00E+00
NDEV:Porosity Probability	Relative porosity value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
KSDEV:Permeability Probability	Relative permeability value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
BDEV:Parameter "b" Probability	Relative value of "b" parameter within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
AP:Water Application Rate	Total water application rate on cultivated area	CONTINUOUS LINEAR(m/y)
Default value used		Value / Probability

		6.07E-01 0.00E+00 6.10E-01 4.62E-01 6.35E-01 4.76E-01 7.62E-01 5.40E-01 8.89E-01 6.29E-01 1.02E+00 7.05E-01 1.14E+00 8.04E-01 1.27E+00 8.79E-01 1.40E+00 9.41E-01 1.52E+00 9.82E-01 1.65E+00 9.98E-01 1.78E+00 1.00E+00
IR:Irrigation Rate	Annual average irrigation rate	CONSTANT(L/m**2-d)
Default value used		Value 1.29E+00
RHO1:Surface Soil Density	Bulk density of soil in the surface soil layer	DERIVED(g/mL)
Default value used		
RHO2:Unsaturated Zone Density	Bulk density of soil in the unsaturated zone	DERIVED(g/mL)
Default value used		
Ksat1:Surface Soil Permeabiliy	Saturated permeability of the surface soil layer	DERIVED(cm/sec)
Default value used		
VDR:Volume of Water Consumed	Volume of water withdrawn for consumptive use	CONSTANT(L)
Default value used		Value 1.18E+05
VSW:Volume of Water in Pond	Volume of water in the pond	CONSTANT(L)
Default value used		Value 1.30E+06
AR:Cultivated Area	Area of land cultivated	DERIVED(m**2)
Default value used		
sh:Soil Moisture Content	Moisture content of soil	DERIVED(none)
Default value used		
TTG:Gardening Period	Total time in gardening period	CONSTANT(days)
Default value used		Value 9.00E+01
TD:Drinking-water consumption period	Drinking-water consumption period	CONSTANT(days)
Default value used		Value 3.65E+02
THV(1):Holdup Period :	Holdup period for leafy vegetables	CONSTANT(days)

Leafy		
Default value used		Value 1.00E+00
THV(2):Holdup Period : Other vegetables	Holdup period for other vegetables	CONSTANT(days)
Default value used		Value 1.40E+01
THV(3):Holdup Period : Fruits	Holdup period for fruits	CONSTANT(days)
Default value used		Value 1.40E+01
THV(4):Holdup Period : Grains	Holdup period for grains	CONSTANT(days)
Default value used		Value 1.40E+01
THA(1):Holdup Period : Beef	Holdup period for beef	CONSTANT(days)
Default value used		Value 2.00E+01
THA(2):Holdup Period : Poultry	Holdup period for poultry	CONSTANT(days)
Default value used		Value 1.00E+00
THA(3):Holdup Period : Milk	Holdup period for milk	CONSTANT(days)
Default value used		Value 1.00E+00
THA(4):Holdup Period : Eggs	Holdup period for eggs	CONSTANT(days)
Default value used		Value 1.00E+00
TGV(1):Growing Period : Leafy	Minimum growing period for leafy vegetables	CONSTANT(days)
Default value used		Value 4.50E+01
TGV(2):Growing Period : Other vegetables	Minimum growing period for other vegetables	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(3):Growing Period : Fruits	Minimum growing period for fruits	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(4):Growing Period : Grains	Minimum growing period for grains	CONSTANT(days)
Default value used		Value 9.00E+01
TGF(1):Growing Period : Beef Forage	Minimum growing period for forage consumed by beef cattle	CONSTANT(days)

Default value used		Value 3.00E+01
TGF(2):Growing Period : Poultry Forage	Minimum growing period for forage consumed by poultry	DERIVED(days)
Default value used		
TGF(3):Growing Period : Milk Cow Forage	Minimum growing period for forage consumed by milk cows	DERIVED(days)
Default value used		
TGF(4):Growing Period : Layer Hen Forage	Minimum growing period for forage consumed by layer hens	DERIVED(days)
Default value used		
TGG(1):Growing Period : Beef Cow Grain	Minimum growing period for stored grain consumed by beef cattle	CONSTANT(days)
Default value used		Value 9.00E+01
TGG(2):Growing Period : Poultry Grain	Minimum growing period for stored grain consumed by poultry	DERIVED(days)
Default value used		
TGG(3):Growing Period : Milk Cow Grain	Minimum growing period for stored grain consumed by milk cows	DERIVED(days)
Default value used		
TGG(4):Growing Period : Layer Hen Grain	Minimum growing period for stored grain consumed by layer hens	DERIVED(days)
Default value used		
TGH(1):Growing Period : Beef Cow Hay	Minimum growing period for stored hay consumed by beef cattle	CONSTANT(days)
Default value used		Value 4.50E+01
TGH(2):Growing Period : Poultry Hay	Minimum growing period for stored hay consumed by poultry	DERIVED(days)
Default value used		
TGH(3):Growing Period : Milk Cow Hay	Minimum growing period for stored hay consumed by milk cows	DERIVED(days)
Default value used		
TGH(4):Growing Period : Layer Hen Hay	Minimum growing period for stored hay consumed by layer hens	DERIVED(days)
Default value used		
RV(1):Interception Fraction	Interception fraction for leafy	UNIFORM(none)

: Leafy	vegetables	
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(2):Interception Fraction : Other vegetables	Interception fraction for other vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(3):Interception Fraction : Fruits	Interception fraction for fruits	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(4):Interception Fraction : Grains	Interception fraction for grains	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(1):Interception Fraction : Beef Forage	Interception fraction for beef cattle forage	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(2):Interception Fraction : Poultry forage	Interception fraction for poultry forage	DERIVED(none)
Default value used		
RF(3):Interception Fraction : Milk Cow Forage	Interception fraction for milk cow forage	DERIVED(none)
Default value used		
RF(4):Interception Fraction : Layer Hen Forage	Interception fraction for layer hen forage	DERIVED(none)
Default value used		
RG(1):Interception Fraction : Beef Cow Grain	Interception fraction for beef cattle grain	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RG(2):Interception Fraction : Poultry Grain	Interception fraction for poultry grain	DERIVED(none)
Default value used		
RG(3):Interception Fraction : Milk Cow Grain	Interception fraction for milk cow grain	DERIVED(none)
Default value used		

RG(4):Interception Fraction : Layer Hen Grain	Interception fraction for layer hen grain	DERIVED(none)
Default value used		
RH(1):Interception Fraction : Beef Cow Hay	Interception fraction for beef cattle hay	DERIVED(none)
Default value used		
RH(2):Interception Fraction : Poultry Hay	Interception fraction for poultry hay	DERIVED(none)
Default value used		
RH(3):Interception Fraction : Milk Cow Hay	Interception fraction for milk cow hay	DERIVED(none)
Default value used		
RH(4):Interception Fraction : Layer Hen Hay	Interception fraction for layer hen hay	DERIVED(none)
Default value used		
YV(1):Crop Yield : Leafy	Crop yield for leafy vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value / Probability 2.70E+00 0.00E+00 2.71E+00 1.60E-03 2.74E+00 6.00E-03 2.76E+00 1.76E-02 2.78E+00 4.36E-02 2.80E+00 8.48E-02 2.82E+00 1.56E-01 2.85E+00 2.57E-01 2.87E+00 3.64E-01 2.89E+00 5.00E-01 2.91E+00 6.39E-01 2.93E+00 7.46E-01 2.96E+00 8.42E-01 2.98E+00 9.09E-01 3.00E+00 9.60E-01 3.02E+00 9.84E-01 3.04E+00 9.94E-01 3.07E+00 9.97E-01 3.09E+00 9.99E-01 3.11E+00 1.00E+00 3.13E+00 1.00E+00 3.15E+00 1.00E+00
YV(2):Crop Yield : Other	Crop yield for other vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used		Value	Probability
		2.26E+00	0.00E+00
		2.29E+00	8.00E-04
		2.30E+00	1.20E-03
		2.31E+00	6.40E-03
		2.33E+00	1.52E-02
		2.34E+00	3.28E-02
		2.35E+00	7.44E-02
		2.36E+00	1.40E-01
		2.38E+00	2.49E-01
		2.39E+00	3.80E-01
		2.40E+00	5.30E-01
		2.42E+00	6.61E-01
		2.43E+00	7.88E-01
		2.44E+00	8.86E-01
		2.45E+00	9.42E-01
		2.47E+00	9.75E-01
		2.48E+00	9.88E-01
		2.49E+00	9.96E-01
		2.51E+00	9.97E-01
		2.52E+00	9.99E-01
		2.53E+00	1.00E+00
		2.54E+00	1.00E+00
YV(3):Crop Yield : Fruits	Crop yield for fruits	CONTINUOUS LINEAR(kg wet wt/m**2)	
Default value used		Value	Probability
		2.17E+00	0.00E+00
		2.20E+00	1.20E-03
		2.21E+00	2.40E-03
		2.23E+00	6.80E-03
		2.25E+00	1.80E-02
		2.27E+00	4.36E-02
		2.29E+00	7.64E-02
		2.31E+00	1.38E-01
		2.32E+00	2.14E-01
		2.34E+00	3.27E-01
		2.36E+00	4.50E-01
		2.38E+00	5.76E-01
		2.40E+00	6.87E-01
		2.42E+00	7.88E-01
		2.43E+00	8.68E-01
		2.45E+00	9.25E-01
		2.47E+00	9.60E-01
		2.49E+00	9.81E-01
		2.51E+00	9.92E-01
		2.53E+00	9.98E-01

		2.54E+00 1.00E+00 2.56E+00 1.00E+00
YV(4):Crop Yield : Grains	Crop yield for grains	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value Probability 2.85E-01 0.00E+00 2.90E-01 6.00E-04 3.02E-01 2.80E-03 3.14E-01 9.40E-03 3.26E-01 2.14E-02 3.38E-01 5.42E-02 3.50E-01 1.08E-01 3.62E-01 2.02E-01 3.74E-01 3.15E-01 3.86E-01 4.50E-01 3.98E-01 5.92E-01 4.10E-01 7.20E-01 4.23E-01 8.26E-01 4.35E-01 9.03E-01 4.47E-01 9.51E-01 4.59E-01 9.77E-01 4.71E-01 9.91E-01 4.83E-01 9.96E-01 4.95E-01 9.99E-01 5.07E-01 1.00E+00 5.19E-01 1.00E+00 5.31E-01 1.00E+00
YF(1):Crop Yield : Beef Forage	Crop yield for beef cattle forage	BETA(kg dry wt forage/m**2)
Default value used		Lower Limit 3.70E-01 Upper Limit 5.24E-01 p 2.36E+00 q 1.40E+00
YF(2):Crop Yield : Poultry Forage	Crop yield for poultry forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(3):Crop Yield : Milk Cow Forage	Crop yield for milk cow forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(4):Crop Yield : Layer Hen Forage	Crop yield for layer hen forage	DERIVED(kg wet wt forage/m**2)
Default value used		

YG(1):Crop Yield : Beef Cow Grain	Crop yield for beef cattle grain	NORMAL(kg dry wt grain /m**2)
Default value used		Mean 5.78E-01 Standard Deviation 7.77E-02
YG(2):Crop Yield : Poultry Grain	Crop yield for poultry grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(3):Crop Yield : Milk Cow Grain	Crop yield for milk cow grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(4):Crop Yield : Layer Hen Grain	Crop yield for layer hen grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YH(1):Crop Yield : Beef Cow Hay	Crop yield for beef cattle hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(2):Crop Yield : Poultry Hay	Crop yield for poultry hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(3):Crop Yield : Milk Cow Hay	Crop yield for milk cow hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(4):Crop Yield : Layer Hen Hay	Crop yield for layer hen hay	DERIVED(kg wet wt/m**2)
Default value used		
WV(1):Wet/dry : Leafy Vegetables	Wet/dry conversion factor for leafy vegetables	CONTINUOUS LINEAR(none)
Default value used		Value / Probability 3.32E-02 / 0.00E+00 4.89E-02 / 3.45E-02 5.47E-02 / 6.91E-02 5.96E-02 / 1.04E-01 6.36E-02 / 1.38E-01 6.70E-02 / 1.73E-01 7.05E-02 / 2.07E-01 7.38E-02 / 2.42E-01 7.48E-02 / 2.50E-01 7.72E-02 / 2.76E-01

		8.03E-02 3.11E-01 8.34E-02 3.45E-01 8.66E-02 3.80E-01 9.00E-02 4.15E-01 9.36E-02 4.49E-01 9.73E-02 4.84E-01 9.91E-02 4.99E-01 1.01E-01 5.18E-01 1.05E-01 5.53E-01 1.09E-01 5.87E-01 1.13E-01 6.22E-01 1.18E-01 6.56E-01 1.23E-01 6.91E-01 1.29E-01 7.25E-01 1.33E-01 7.50E-01 1.35E-01 7.60E-01 1.42E-01 7.94E-01 1.50E-01 8.29E-01 1.59E-01 8.64E-01 1.70E-01 8.98E-01 1.85E-01 9.33E-01 2.10E-01 9.67E-01 2.56E-01 9.91E-01 3.24E-01 1.00E+00
WV(2):Wet/dry : Other Vegetables	Wet/dry conversion factor for other vegetables	CONTINUOUS LINEAR(none)
Default value used		Value Probability 3.58E-02 0.00E+00 4.87E-02 3.45E-02 5.46E-02 6.91E-02 5.90E-02 1.04E-01 6.29E-02 1.38E-01 6.69E-02 1.73E-01 7.02E-02 2.07E-01 7.34E-02 2.42E-01 7.41E-02 2.50E-01 7.65E-02 2.76E-01 7.99E-02 3.11E-01 8.32E-02 3.45E-01 8.66E-02 3.80E-01 9.05E-02 4.15E-01 9.41E-02 4.49E-01 9.82E-02 4.84E-01 9.98E-02 4.99E-01 1.02E-01 5.18E-01 1.06E-01 5.53E-01 1.09E-01 5.87E-01

		1.14E-01	6.22E-01
		1.19E-01	6.56E-01
		1.24E-01	6.91E-01
		1.29E-01	7.25E-01
		1.33E-01	7.50E-01
		1.35E-01	7.60E-01
		1.42E-01	7.94E-01
		1.50E-01	8.29E-01
		1.59E-01	8.64E-01
		1.70E-01	8.98E-01
		1.87E-01	9.33E-01
		2.12E-01	9.67E-01
		2.62E-01	9.91E-01
		3.13E-01	1.00E+00
WV(3):Wet/dry : Fruit	Wet/dry conversion factor for fruits	CONTINUOUS LINEAR(none)	
Default value used		Value	Probability
		3.66E-02	0.00E+00
		4.87E-02	3.45E-02
		5.45E-02	6.91E-02
		5.93E-02	1.04E-01
		6.31E-02	1.38E-01
		6.72E-02	1.73E-01
		7.10E-02	2.07E-01
		7.44E-02	2.42E-01
		7.52E-02	2.50E-01
		7.78E-02	2.76E-01
		8.13E-02	3.11E-01
		8.45E-02	3.45E-01
		8.78E-02	3.80E-01
		9.11E-02	4.15E-01
		9.46E-02	4.49E-01
		9.82E-02	4.84E-01
		9.97E-02	4.99E-01
		1.02E-01	5.18E-01
		1.06E-01	5.53E-01
		1.10E-01	5.87E-01
		1.14E-01	6.22E-01
		1.19E-01	6.56E-01
		1.24E-01	6.91E-01
		1.29E-01	7.25E-01
		1.34E-01	7.50E-01
		1.35E-01	7.60E-01
		1.42E-01	7.94E-01
		1.49E-01	8.29E-01
		1.58E-01	8.64E-01
		1.70E-01	8.98E-01
		1.87E-01	9.33E-01

		2.14E-01 9.67E-01 2.58E-01 9.91E-01 3.25E-01 1.00E+00
WV(4):Wet/dry : Grain	Wet/dry conversion factor for grains	CONSTANT(none)
Default value used		Value 8.80E-01
WF(1):Wet/dry : Beef Cow Forage	Wet/dry conversion factor for beef cattle forage	BETA(none)
Default value used		Lower Limit 1.83E-01 Upper Limit 3.23E-01 p 1.15E+00 q 1.18E+00
WF(2):Wet/dry : Poultry Forage	Wet/dry conversion factor for poultry forage	DERIVED(none)
Default value used		
WF(3):Wet/dry : Milk Cow Forage	Wet/dry conversion factor for milk cow forage	DERIVED(none)
Default value used		
WF(4):Wet/dry : Layer Hen Forage	Wet/dry conversion factor for layer hen forage	DERIVED(none)
Default value used		
WG(1):Wet/dry : Beef Cow Grain	Wet/dry conversion factor for beef cattle grain	CONSTANT(none)
Default value used		Value 8.80E-01
WG(2):Wet/dry : Poultry Grain	Wet/dry conversion factor for poultry grain	DERIVED(none)
Default value used		
WG(3):Wet/dry : Milk Cow Grain	Wet/dry conversion factor for milk cow grain	DERIVED(none)
Default value used		
WG(4):Wet/dry : Layer Hen Grain	Wet/dry conversion factor for layer hen grain	DERIVED(none)
Default value used		
WH(1):Wet/dry : Beef Cow Hay	Wet/dry conversion factor for beef cattle hay	DERIVED(none)
Default value used		
WH(2):Wet/dry : Poultry Hay	Wet/dry conversion factor for poultry hay	DERIVED(none)

Default value used		
WH(3):Wet/dry : Milk Cow Hay	Wet/dry conversion factor for milk cow hay	DERIVED(none)
Default value used		
WH(4):Wet/dry : Layer Hen Hay	Wet/dry conversion factor for layer hen hay	DERIVED(none)
Default value used		
QF(1):Ingestion Rate : Beef Cow Forage	Ingestion rate for beef cattle forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QF(2):Ingestion Rate : Poultry Forage	Ingestion rate for poultry forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 3.48E-03 Upper Limit 2.82E-02 p 1.51E+00 q 1.41E+00
QF(3):Ingestion Rate : Milk Cow Forage	Ingestion rate for milk cow forage	CONTINUOUS LINEAR(kg dry wt forage/d)
Default value used		Value Probability 6.35E+00 0.00E+00 6.77E+00 3.45E-02 6.96E+00 6.91E-02 7.10E+00 1.04E-01 7.24E+00 1.38E-01 7.35E+00 1.73E-01 7.47E+00 2.07E-01 7.57E+00 2.42E-01 7.60E+00 2.50E-01 7.67E+00 2.76E-01 7.77E+00 3.11E-01 7.87E+00 3.45E-01 7.98E+00 3.80E-01 8.08E+00 4.15E-01 8.18E+00 4.49E-01 8.31E+00 4.84E-01 8.37E+00 4.99E-01 8.42E+00 5.18E-01 8.54E+00 5.53E-01 8.67E+00 5.87E-01

		8.81E+00 6.22E-01 8.95E+00 6.56E-01 9.10E+00 6.91E-01 9.26E+00 7.25E-01 9.38E+00 7.50E-01 9.45E+00 7.60E-01 9.68E+00 7.94E-01 9.93E+00 8.29E-01 1.02E+01 8.64E-01 1.06E+01 8.98E-01 1.11E+01 9.33E-01 1.20E+01 9.67E-01 1.33E+01 9.91E-01 1.53E+01 1.00E+00
QF(4):Ingestion Rate : Layer Hen Forage	Ingestion rate for layer hen forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.19E-02 Upper Limit 2.22E-02 p 1.45E+00 q 7.92E-01
QG(1):Ingestion Rate : Beef Cattle Grain	Ingestion rate for beef cattle grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QG(2):Ingestion Rate : Poultry Grain	Ingestion rate for poultry grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 1.04E-02 Upper Limit 8.45E-02 p 1.51E+00 q 1.41E+00
QG(3):Ingestion Rate : Milk Cow Grain	Ingestion rate for milk cow grain	NORMAL(kg dry wt grain/d)
Default value used		Mean 1.71E+00 Standard Deviation 2.62E-01
QG(4):Ingestion Rate : Layer Hen Grain	Ingestion rate for layer hen grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 3.58E-02 Upper Limit 6.67E-02 p 1.43E+00 q 7.92E-01
QH(1):Ingestion Rate : Beef Cattle Hay	Ingestion rate for beef cattle hay	BETA(kg dry wt hay/d)

Default value used		Lower Limit 3.38E+00 Upper Limit 4.58E+00 p 1.99E+00 q 9.11E-01
QH(2):Ingestion Rate : Poultry Hay	Ingestion rate for poultry hay	CONSTANT(kg dry wt hay/d)
Default value used		Value 0.00E+00
QH(3):Ingestion Rate : Milk Cow Hay	Ingestion rate for milk cow hay	CONTINUOUS LINEAR(kg dry wt hay/d)
Default value used		Value / Probability 5.12E+00 0.00E+00 5.43E+00 3.45E-02 5.57E+00 6.91E-02 5.68E+00 1.04E-01 5.79E+00 1.38E-01 5.89E+00 1.73E-01 5.98E+00 2.07E-01 6.06E+00 2.42E-01 6.08E+00 2.50E-01 6.14E+00 2.76E-01 6.22E+00 3.11E-01 6.30E+00 3.45E-01 6.38E+00 3.80E-01 6.46E+00 4.15E-01 6.54E+00 4.49E-01 6.63E+00 4.84E-01 6.67E+00 4.99E-01 6.72E+00 5.18E-01 6.81E+00 5.53E-01 6.92E+00 5.87E-01 7.03E+00 6.22E-01 7.13E+00 6.56E-01 7.26E+00 6.91E-01 7.39E+00 7.25E-01 7.49E+00 7.50E-01 7.56E+00 7.60E-01 7.70E+00 7.94E-01 7.89E+00 8.29E-01 8.11E+00 8.64E-01 8.39E+00 8.98E-01 8.75E+00 9.33E-01 9.44E+00 9.67E-01 1.05E+01 9.91E-01 1.27E+01 1.00E+00
QH(4):Ingestion Rate :	Ingestion rate for layer hen hay	CONSTANT(kg dry wt hay/d)

Layer Hen Hay		
Default value used		Value 0.00E+00
QW(1):Water Rate : Beef Cattle	Water ingestion rate for beef cattle	CONSTANT(L/d)
Default value used		Value 5.00E+01
QW(2):Water Rate : Poultry	Water ingestion rate for poultry	CONSTANT(L/d)
Default value used		Value 3.00E-01
QW(3):Water Rate : Milk Cows	Water ingestion rate for milk cows	CONSTANT(L/d)
Default value used		Value 6.00E+01
QW(4):Water Rate : Layer Hens	Water ingestion rate for layer hens	CONSTANT(L/d)
Default value used		Value 3.00E-01
QD(1):Soil Fraction : Beef Cattle	Soil intake fraction for beef cattle	CONSTANT(none)
Default value used		Value 2.00E-02
QD(2):Soil Fraction : Poultry	Soil intake fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
QD(3):Soil Fraction : Milk Cows	Soil intake fraction for milk cows	CONSTANT(none)
Default value used		Value 2.00E-02
QD(4):Soil Fraction : Layer Hens	Soil intake fraction for layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(1):Mass-Loading : Leafy Vegetables	Mass-loading factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(2):Mass-Loading : Other Vegetables	Mass-loading factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(3):Mass-Loading : Fruits	Mass-loading factor for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(4):Mass-Loading : Grains	Mass-loading factor for grains	CONSTANT(none)

Default value used		Value 1.00E-01
LAMBDW:Weathering Rate	Weathering rate for activity removal from plants	CONSTANT(1/d)
Default value used		Value 4.95E-02
MLF(1):Mass-Loading : Beef Cow Forage	Mass-loading factor for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(2):Mass-Loading : Poultry Forage	Mass-loading factor for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(3):Mass-Loading : Milk Cow Forage	Mass-loading factor for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(4):Mass-Loading : Layer Hen Forage	Mass-loading factor for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(1):Mass-Loading : Beef Cattle Grain	Mass-loading factor for beef cattle grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(2):Mass-Loading : Poultry Grain	Mass-loading factor for poultry grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(3):Mass-Loading : Milk Cow Grain	Mass-loading factor for milk cow grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(4):Mass-Loading : Layer Hen Grain	Mass-loading factor for layer hen grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(1):Mass-Loading : Beef Cattle Hay	Mass-loading factor for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(2):Mass-Loading : Poultry Hay	Mass-loading factor for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(3):Mass-Loading : Milk Cow Hay	Mass-loading factor for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01

MLH(4):Mass-Loading : Layer Hen Hay	Mass-loading factor for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
TFF(1):Feeding Period : Beef Cow Forage	Feeding period for beef cattle forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(2):Feeding Period : Poultry Forage	Feeding period for poultry forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(3):Feeding Period : Milk Cow Forage	Feeding period for milk cow forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(4):Feeding Period : Layer Hen Forage	Feeding period for layer hen forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(1):Feeding Period : Beef Cattle Grain	Feeding period for beef cattle grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(2):Feeding Period : Poultry Grain	Feeding period for poultry grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(3):Feeding Period : Milk Cow Grain	Feeding period for milk cow grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(4):Feeding Period : Layer Hen Grain	Feeding period for layer hen grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(1):Feeding Period : Beef Cattle Hay	Feeding period for beef cattle hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(2):Feeding Period : Poultry Hay	Feeding period for poultry hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(3):Feeding Period : Milk Cow Hay	Feeding period for milk cow hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(4):Feeding Period : Layer Hen Hay	Feeding period for layer hen hay	CONSTANT(days)

Default value used		Value 3.65E+02
TFW(1):Water Period : Beef Cattle	Water ingestion period for beef cattle	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(2):Water Period : Poultry	Water ingestion period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(3):Water Period : Milk Cows	Water ingestion period for milk cows	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(4):Water Period : Layer Hens	Water ingestion period for layer hens	CONSTANT(days)
Default value used		Value 3.65E+02
fha(1):Hydrogen Fraction : Beef Cattle	Hydrogen fraction for beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
fha(2):Hydrogen Fraction : Poultry	Hydrogen fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
fha(3):Hydrogen Fraction : Milk Cows	Hydrogen fraction for milk cows	CONSTANT(none)
Default value used		Value 1.10E-01
fha(4):Hydrogen Fraction : Eggs	Hydrogen fraction for eggs	CONSTANT(none)
Default value used		Value 1.10E-01
fhv(1):Hydrogen Fraction : Leafy Vegetables	Hydrogen fraction for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(2):Hydrogen Fraction : Other Vegetables	Hydrogen fraction for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(3):Hydrogen Fraction : Fruits	Hydrogen fraction for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(4):Hydrogen Fraction : Grains	Hydrogen fraction for grains	CONSTANT(none)
Default value used		Value 6.80E-02

fhf(1):Hydrogen Fraction : Beef Cow Forage	Hydrogen fraction for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(2):Hydrogen Fraction : Poultry Forage	Hydrogen fraction for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(3):Hydrogen Fraction : Milk Cow Forage	Hydrogen fraction for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(4):Hydrogen Fraction : Layer Hen Forage	Hydrogen fraction for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(1):Hydrogen Fraction : Beef Cattle Hay	Hydrogen fraction for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(2):Hydrogen Fraction : Poultry Hay	Hydrogen fraction for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(3):Hydrogen Fraction : Milk Cow Hay	Hydrogen fraction for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(4):Hydrogen Fraction : Layer Hen Hay	Hydrogen fraction for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhg(1):Hydrogen Fraction : Beef Cattle Grain	Hydrogen fraction for beef cattle grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(2):Hydrogen Fraction : Poultry Grain	Hydrogen fraction for poultry grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(3):Hydrogen Fraction : Milk Cow Grain	Hydrogen fraction for milk cow grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(4):Hydrogen Fraction : Layer Hen Grain	Hydrogen fraction for layer hen grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhd016:Hydrogen Fraction : Soil	Fraction of hydrogen in soil	DERIVED(none)

Default value used		
sasvh:Tritium Equivalence: Plant/Soil	Tritium equivalence: plant/soil	CONSTANT(none)
Default value used		Value 1.00E+00
sawvh:Tritium Equivalence: Plant/Water	Tritium equivalence: plant/water	CONSTANT(none)
Default value used		Value 1.00E+00
satah:Tritium Equivalence: Animal Products	Tritium equivalence: animal product intake	CONSTANT(none)
Default value used		Value 1.00E+00
YA(1):Animal Product Yield : Beef Cattle	Annual yield of beef per individual animal	CONSTANT(kg/y)
Default value used		Value 2.09E+02
YA(2):Animal Product Yield : Poultry	Annual yield of chicken per individual animal	CONSTANT(kg/y)
Default value used		Value 1.53E+00
YA(3):Animal Product Yield : Milk Cows	Annual yield of milk per individual animal	CONSTANT(L/y)
Default value used		Value 7.41E+03
YA(4):Animal Product Yield : Layer Hens	Annual yield of eggs per individual animal	CONSTANT(kg/y)
Default value used		Value 1.26E+01
ARExt:External Exposure Area	Minimum surface area to which resident is exposed via external radiation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARInh:Inhalation Exposure Area	Minimum surface area to which resident is exposed via inhalation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARIng:Secondary Ingestion Exposure Area	Minimum surface area to which resident is exposed via secondary ingestion during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARAgr:Agricultural Exposure Area	Minimum surface area to which resident is exposed via any agricultural product during residential period	DERIVED(m**2)
Default value used		
ARH2O:Groundwater	Minimum surface area to which	DERIVED(m**2)

Exposure Area	resident is exposed via groundwater during residential period	
Default value used		
ARAll:Exposure Area	Minimum surface area to which resident is exposed via any pathway during the residential period	DERIVED(m**2)
Default value used		

Element Dependant Parameters

Parameter Name	Description	Distribution	
Cs:Coefficient	Partition coefficient for Cs	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.01E+00
Ba:Coefficient	Partition coefficient for Ba	NORMAL(Log10(mL/g))	
Default value used		Mean	1.65E+00
		Standard Deviation	3.53E+00
Eu:Coefficient	Partition coefficient for Eu	NORMAL(Log10(mL/g))	
Default value used		Mean	2.98E+00
		Standard Deviation	1.74E+00
Gd:Coefficient	Partition coefficient for Gd	NORMAL(Log10(mL/g))	
Default value used		Mean	7.00E-01
		Standard Deviation	1.40E+00
Tl:Coefficient	Partition coefficient for Tl	NORMAL(Log10(mL/g))	
Default value used		Mean	2.20E+00
		Standard Deviation	1.40E+00
Pb:Coefficient	Partition coefficient for Pb	NORMAL(Log10(mL/g))	
Default value used		Mean	3.38E+00
		Standard Deviation	1.20E+00
Bi:Coefficient	Partition coefficient for Bi	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.40E+00
Po:Coefficient	Partition coefficient for Po	NORMAL(Log10(mL/g))	
Default value used		Mean	2.26E+00
		Standard Deviation	7.30E-01

Rn:Coefficient	Partition coefficient for Rn	CONSTANT(mL/g)
Default value used		Value 0.00E+00
Ra:Coefficient	Partition coefficient for Ra	NORMAL(Log10(mL/g))
Default value used		Mean 3.55E+00 Standard Deviation 7.40E-01
Ac:Coefficient	Partition coefficient for Ac	NORMAL(Log10(mL/g))
Default value used		Mean 3.24E+00 Standard Deviation 1.40E+00
Th:Coefficient	Partition coefficient for Th	NORMAL(Log10(mL/g))
Default value used		Mean 3.77E+00 Standard Deviation 1.57E+00
Pa:Coefficient	Partition coefficient for Pa	NORMAL(Log10(mL/g))
Default value used		Mean 3.31E+00 Standard Deviation 1.40E+00
U:Coefficient	Partition coefficient for U	NORMAL(Log10(mL/g))
Default value used		Mean 2.10E+00 Standard Deviation 1.36E+00
Pu:Coefficient	Partition coefficient for Pu	NORMAL(Log10(mL/g))
Default value used		Mean 2.98E+00 Standard Deviation 8.20E-01
Cs:Leafy	Leafy plant concentration factor for Cs	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.19E+00 Standard Deviation of Ln 1.25E+00
Ba:Leafy	Leafy plant concentration factor for Ba	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.24E+00 Standard Deviation of Ln 1.06E+00
Eu:Leafy	Leafy plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Gd:Leafy	Leafy plant concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Tl:Leafy	Leafy plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01

Pb:Leafy	Leafy plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.10E+00 Standard Deviation of Ln 9.04E-01
Bi:Leafy	Leafy plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.35E+00 Standard Deviation of Ln 9.04E-01
Po:Leafy	Leafy plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.99E+00 Standard Deviation of Ln 9.04E-01
Rn:Leafy	Leafy plant concentration factor for Rn	CONSTANT(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Leafy	Leafy plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 9.04E-01
Ac:Leafy	Leafy plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.65E+00 Standard Deviation of Ln 9.04E-01
Th:Leafy	Leafy plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -7.07E+00 Standard Deviation of Ln 9.04E-01
Pa:Leafy	Leafy plant concentration factor for Pa	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.99E+00 Standard Deviation of Ln 9.04E-01
U:Leafy	Leafy plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.77E+00 Standard Deviation of Ln 9.04E-01
Pu:Leafy	Leafy plant concentration factor for Pu	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -7.71E+00 Standard Deviation of Ln 9.04E-01
Cs:Root	Root plant concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00

Ba:Root	Root plant concentration factor for Ba	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -6.65E+00 Standard Deviation of Ln 1.13E+00
Eu:Root	Root plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Gd:Root	Root plant concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Root	Root plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Root	Root plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Root	Root plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Root	Root plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Rn:Root	Root plant concentration factor for Rn	CONSTANT(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Root	Root plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Root	Root plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Root	Root plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01

Pa:Root	Root plant concentration factor for Pa	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -8.29E+00 Standard Deviation of Ln 9.04E-01
U:Root	Root plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Pu:Root	Root plant concentration factor for Pu	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -1.00E+01 Standard Deviation of Ln 9.04E-01
Cs:Fruit	Fruit concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Ba:Fruit	Fruit concentration factor for Ba	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -6.65E+00 Standard Deviation of Ln 1.13E+00
Eu:Fruit	Fruit concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Gd:Fruit	Fruit concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Fruit	Fruit concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Fruit	Fruit concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Fruit	Fruit concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Fruit	Fruit concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00

		Standard Deviation of Ln 9.04E-01
Rn:Fruit	Fruit concentration factor for Rn	CONSTANT(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Fruit	Fruit concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Fruit	Fruit concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Fruit	Fruit concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
Pa:Fruit	Fruit concentration factor for Pa	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -8.29E+00 Standard Deviation of Ln 9.04E-01
U:Fruit	Fruit concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Pu:Fruit	Fruit concentration factor for Pu	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -1.00E+01 Standard Deviation of Ln 9.04E-01
Cs:Grain	Grain concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Ba:Grain	Grain concentration factor for Ba	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -6.65E+00 Standard Deviation of Ln 1.13E+00
Eu:Grain	Grain concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Gd:Grain	Grain concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00

		Standard Deviation of Ln 9.04E-01
Tl:Grain	Grain concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Grain	Grain concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Grain	Grain concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Grain	Grain concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Rn:Grain	Grain concentration factor for Rn	CONSTANT(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Grain	Grain concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Grain	Grain concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Grain	Grain concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
Pa:Grain	Grain concentration factor for Pa	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -8.29E+00 Standard Deviation of Ln 9.04E-01
U:Grain	Grain concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Pu:Grain	Grain concentration factor for Pu	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -1.00E+01

		Standard Deviation of Ln	9.04E-01
Cs:Beef	Beef transfer factor for Cs	CONSTANT(d/kg)	
Default value used		Value	2.00E-02
Ba:Beef	Beef transfer factor for Ba	CONSTANT(d/kg)	
Default value used		Value	1.50E-04
Eu:Beef	Beef transfer factor for Eu	CONSTANT(d/kg)	
Default value used		Value	5.00E-03
Gd:Beef	Beef transfer factor for Gd	CONSTANT(d/kg)	
Default value used		Value	3.50E-03
Tl:Beef	Beef transfer factor for Tl	CONSTANT(d/kg)	
Default value used		Value	4.00E-02
Pb:Beef	Beef transfer factor for Pb	CONSTANT(d/kg)	
Default value used		Value	3.00E-04
Bi:Beef	Beef transfer factor for Bi	CONSTANT(d/kg)	
Default value used		Value	4.00E-04
Po:Beef	Beef transfer factor for Po	CONSTANT(d/kg)	
Default value used		Value	3.00E-04
Rn:Beef	Beef transfer factor for Rn	CONSTANT(d/kg)	
Default value used		Value	0.00E+00
Ra:Beef	Beef transfer factor for Ra	CONSTANT(d/kg)	
Default value used		Value	2.50E-04
Ac:Beef	Beef transfer factor for Ac	CONSTANT(d/kg)	
Default value used		Value	2.50E-05
Th:Beef	Beef transfer factor for Th	CONSTANT(d/kg)	
Default value used		Value	6.00E-06
Pa:Beef	Beef transfer factor for Pa	CONSTANT(d/kg)	
Default value used		Value	1.00E-05
U:Beef	Beef transfer factor for U	CONSTANT(d/kg)	
Default value used		Value	2.00E-04
Pu:Beef	Beef transfer factor for Pu	CONSTANT(d/kg)	
Default value used		Value	5.00E-07
Cs:Poultry	Poultry transfer factor for Cs	CONSTANT(d/kg)	
Default value used		Value	4.40E+00
Ba:Poultry	Poultry transfer factor for Ba	CONSTANT(d/kg)	

Default value used		Value 8.10E-04
Eu:Poultry	Poultry transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Gd:Poultry	Poultry transfer factor for Gd	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Tl:Poultry	Poultry transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 3.00E-01
Pb:Poultry	Poultry transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 2.00E-01
Bi:Poultry	Poultry transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Po:Poultry	Poultry transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 9.00E-01
Rn:Poultry	Poultry transfer factor for Rn	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Ra:Poultry	Poultry transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Ac:Poultry	Poultry transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Th:Poultry	Poultry transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Pa:Poultry	Poultry transfer factor for Pa	CONSTANT(d/kg)
Default value used		Value 4.00E-03
U:Poultry	Poultry transfer factor for U	CONSTANT(d/kg)
Default value used		Value 1.20E+00
Pu:Poultry	Poultry transfer factor for Pu	CONSTANT(d/kg)
Default value used		Value 1.50E-04
Cs:Milk	Milk transfer factor for Cs	CONSTANT(d/L)
Default value used		Value 7.00E-03
Ba:Milk	Milk transfer factor for Ba	CONSTANT(d/L)
Default value used		Value 3.50E-04
Eu:Milk	Milk transfer factor for Eu	CONSTANT(d/L)
Default value used		Value 2.00E-05
Gd:Milk	Milk transfer factor for Gd	CONSTANT(d/L)

Default value used		Value 2.00E-05
Tl:Milk	Milk transfer factor for Tl	CONSTANT(d/L)
Default value used		Value 2.00E-03
Pb:Milk	Milk transfer factor for Pb	CONSTANT(d/L)
Default value used		Value 2.50E-04
Bi:Milk	Milk transfer factor for Bi	CONSTANT(d/L)
Default value used		Value 5.00E-04
Po:Milk	Milk transfer factor for Po	CONSTANT(d/L)
Default value used		Value 3.50E-04
Rn:Milk	Milk transfer factor for Rn	CONSTANT(d/L)
Default value used		Value 0.00E+00
Ra:Milk	Milk transfer factor for Ra	CONSTANT(d/L)
Default value used		Value 4.50E-04
Ac:Milk	Milk transfer factor for Ac	CONSTANT(d/L)
Default value used		Value 2.00E-05
Th:Milk	Milk transfer factor for Th	CONSTANT(d/L)
Default value used		Value 5.00E-06
Pa:Milk	Milk transfer factor for Pa	CONSTANT(d/L)
Default value used		Value 5.00E-06
U:Milk	Milk transfer factor for U	CONSTANT(d/L)
Default value used		Value 6.00E-04
Pu:Milk	Milk transfer factor for Pu	CONSTANT(d/L)
Default value used		Value 1.00E-07
Cs:Eggs	Egg transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.90E-01
Ba:Eggs	Egg transfer factor for Ba	CONSTANT(d/kg)
Default value used		Value 1.50E+00
Eu:Eggs	Egg transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Gd:Eggs	Egg transfer factor for Gd	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Tl:Eggs	Egg transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Pb:Eggs	Egg transfer factor for Pb	CONSTANT(d/kg)

Default value used		Value 8.00E-01
Bi:Eggs	Egg transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Po:Eggs	Egg transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 7.00E+00
Rn:Eggs	Egg transfer factor for Rn	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Ra:Eggs	Egg transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 2.00E-05
Ac:Eggs	Egg transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 2.00E-03
Th:Eggs	Egg transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 2.00E-03
Pa:Eggs	Egg transfer factor for Pa	CONSTANT(d/kg)
Default value used		Value 2.00E-03
U:Eggs	Egg transfer factor for U	CONSTANT(d/kg)
Default value used		Value 9.90E-01
Pu:Eggs	Egg transfer factor for Pu	CONSTANT(d/kg)
Default value used		Value 8.00E-03
Cs:Factor	Bioaccumulation factor for Cs in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03
Ba:Factor	Bioaccumulation factor for Ba in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Eu:Factor	Bioaccumulation factor for Eu in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Gd:Factor	Bioaccumulation factor for Gd in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Tl:Factor	Bioaccumulation factor for Tl in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 0.00E+00
Pb:Factor	Bioaccumulation factor for Pb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02

Bi:Factor	Bioaccumulation factor for Bi in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.50E+01
Po:Factor	Bioaccumulation factor for Po in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+02
Rn:Factor	Bioaccumulation factor for Rn in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 0.00E+00
Ra:Factor	Bioaccumulation factor for Ra in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 7.00E+01
Ac:Factor	Bioaccumulation factor for Ac in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Th:Factor	Bioaccumulation factor for Th in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
Pa:Factor	Bioaccumulation factor for Pa in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.10E+01
U:Factor	Bioaccumulation factor for U in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+01
Pu:Factor	Bioaccumulation factor for Pu in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+02

Correlation Coefficients:

Parameter One	Parameter Two	Correlation Coefficient
KSDEV:Permeability Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		
NDEV:Porosity Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		

Summary Results:

90.00% **of the** 142 **calculated TEDE values are <** 1.41E-02 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.38E-02 **to** 1.48E-02 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Soil Concentration (pCi/g)	Water Concentration (pCi/g)
137Cs	4.83E-03	5.80E-24
137mBa	4.57E-03	5.49E-24
152Eu	4.09E-04	1.44E-22
152Gd	0.00E+00	1.50E-21
154Eu	5.41E-04	1.36E-21
155Eu	2.04E-05	1.08E-22
239Pu	5.80E-05	2.03E-17
235U	0.00E+00	3.41E-21
231Th	0.00E+00	3.49E-21
231Pa	0.00E+00	8.54E-21
227Ac	0.00E+00	3.22E-20
223Fr	0.00E+00	4.45E-22
227Th	0.00E+00	2.96E-20
223Ra	0.00E+00	2.88E-20
219Rn	0.00E+00	2.88E-20
215Po	0.00E+00	2.88E-20
211Pb	0.00E+00	2.88E-20
211Bi	0.00E+00	2.88E-20
211Po	0.00E+00	8.06E-23
207Tl	0.00E+00	2.87E-20

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
1.48E-02	4.71E-03	5.34E-17	2.58E-16	9.90E-03	8.02E-06	6.39E-06	1.13E-16

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
137Cs	4.43E-03
137mBa	7.05E-03
152Eu	1.18E-03
152Gd	3.38E-19
154Eu	1.69E-03
155Eu	1.80E-06
239Pu	6.64E-04
235U	5.31E-14
231Th	7.07E-16
231Pa	1.51E-17
227Ac	1.15E-18
223Fr	1.17E-23
227Th	4.06E-21
223Ra	5.81E-20
219Rn	1.37E-22
215Po	4.44E-25
211Pb	1.76E-22
211Bi	1.14E-22
211Po	5.61E-26
207Tl	8.44E-24
All Nuclides	1.48E-02

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
137Cs	4.14E-03	1.34E-25	5.86E-24	1.71E-06	4.84E-08	3.37E-06	9.34E-25
137mBa	0.00E+00	0.00E+00	0.00E+00	7.05E-03	0.00E+00	0.00E+00	0.00E+00
152Eu	9.43E-06	4.30E-25	2.29E-25	1.17E-03	2.80E-08	3.65E-08	6.96E-25
152Gd	3.20E-19	1.12E-22	5.79E-23	0.00E+00	3.91E-22	8.20E-22	1.72E-22
154Eu	1.80E-05	6.01E-24	3.31E-24	1.67E-03	4.75E-08	7.02E-08	1.24E-23
155Eu	1.04E-07	7.61E-26	4.42E-26	1.69E-06	2.53E-10	4.11E-10	1.65E-25

239Pu	6.58E-04	3.31E-17	1.75E-16	8.02E-09	7.90E-06	2.90E-06	5.25E-17
235U	4.30E-14	4.19E-22	5.01E-22	9.65E-15	1.09E-15	1.08E-16	9.68E-22
231Th	2.11E-16	2.18E-24	5.20E-24	4.96E-16	7.67E-21	5.42E-19	4.76E-24
231Pa	1.49E-17	4.17E-20	9.80E-21	1.71E-20	7.54E-20	2.97E-20	7.17E-20
227Ac	2.01E-19	2.09E-19	1.23E-19	3.67E-25	3.07E-21	3.11E-22	3.25E-19
223Fr	1.70E-24	1.77E-24	1.04E-24	1.96E-24	3.93E-29	2.63E-27	2.75E-24
227Th	4.32E-22	5.21E-22	1.23E-21	2.79E-22	5.54E-24	6.32E-25	8.64E-22
223Ra	6.66E-21	8.75E-21	1.45E-20	2.76E-22	2.28E-24	9.28E-24	1.59E-20
219Rn	0.00E+00	0.00E+00	0.00E+00	1.37E-22	0.00E+00	0.00E+00	0.00E+00
215Po	0.00E+00	0.00E+00	0.00E+00	4.44E-25	0.00E+00	0.00E+00	0.00E+00
211Pb	5.32E-24	6.98E-24	1.15E-23	1.30E-22	2.53E-27	7.40E-27	1.27E-23
211Bi	0.00E+00	0.00E+00	0.00E+00	1.14E-22	0.00E+00	0.00E+00	0.00E+00
211Po	0.00E+00	0.00E+00	0.00E+00	5.61E-26	0.00E+00	0.00E+00	0.00E+00
207Tl	0.00E+00	0.00E+00	0.00E+00	8.44E-24	0.00E+00	0.00E+00	0.00E+00

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 7/17/2008 7:15:00 PM
Site Name: EF1
Description: Analysis of potential dose from nuclides discounted for building occupancy
FileName:C:\Documents and Settings\Marty\My Documents\DnD_Bld1.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
41Ca	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 2.92E-02
54Mn	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 1.52E-08
79Se	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 3.57E-03
93Zr	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 5.86E-04
93Mo	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 4.83E-03
121mSn	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Percent total		Value 2.09E-04

129I	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Percent total		Value	3.41E-06
135Cs	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Percent total		Value	2.27E-04
151Sm	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Percent total		Value	6.28E-02
166mHo	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Percent total		Value	9.57E-01
233U	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Percent total		Value	2.81E-03
36Cl	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Percent total		Value	3.22E+00
65Zn	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Percent total		Value	5.41E-13

Chain Data:

Number of chains: **13**

Chain No. 1: **36Cl**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
36Cl	1	1.10E+08					8.18E-10	5.93E-09	5.81E-14	1.06E-15

Chain No. 2: **41Ca**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
41Ca	1	5.11E+07					3.44E-10	3.64E-10	0.00E+00	0.00E+00

Chain No. 3: **54Mn**
Nuclides in chain: **1**

Nuclide	Chain	Half	First	Fractional	Second	Fractional	Ingestion	Inhalation	Surface	15 cm

	Position	Life	Parent	Yield	Parent	Yield	CEDE Factor (Sv/Bq)	CEDE Factor (Sv/Bq)	Dose Rate Factor ((Sv/d)/(Bq/m^2))	Dose Rate Factor ((Sv/d)/(Bq/m^3))
54Mn	1	3.13E+02					7.48E-10	1.81E-09	7.01E-11	2.07E-12

Chain No. 4: **65Zn**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
65Zn	1	2.44E+02					3.90E-09	5.51E-09	4.78E-11	1.45E-12

Chain No. 5: **79Se**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
79Se	1	2.37E+07					2.35E-09	2.66E-09	1.79E-15	8.60E-18

Chain No. 6: **93Zr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
93Zr	1	5.59E+08					4.48E-10	8.67E-08	0.00E+00	0.00E+00
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 7: **93Mo**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
93Mo	1	1.28E+06					3.64E-10	7.68E-09	4.61E-13	2.73E-16
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 8: **121mSn**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
121mSn	1	2.01E+04					4.19E-10	3.11E-09	4.22E-13	9.11E-16
121Sn	2	1.13E+00	1	0.776	0	0	2.44E-10	1.38E-10	9.07E-15	9.02E-17

Chain No. 9: **129I**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
129I	1	5.73E+09					7.46E-08	4.69E-08	2.23E-12	5.98E-15

Chain No. 10: **135Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
135Cs	1	8.40E+08					1.91E-09	1.23E-09	2.87E-15	1.77E-17

Chain No. 11: **151Sm**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
151Sm	1	3.29E+04					1.05E-10	8.10E-09	4.34E-16	4.55E-19

Chain No. 12: **166mHo**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
166mHo	1	4.38E+05					2.18E-09	2.09E-07	1.47E-10	4.23E-12

Chain No. 13: **233U**
Nuclides in chain: **10**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
233U	1	5.79E+07					7.81E-08	3.66E-05	6.18E-14	6.25E-16
229Th	2	2.68E+06	1	1	0	0	9.54E-07	5.80E-04	7.38E-12	1.47E-13
225Ra	3	1.48E+01	2	1	0	0	1.04E-07	2.10E-06	1.15E-12	5.09E-15
225Ac	4	1.00E+01	3	1	0	0	3.00E-08	2.92E-06	1.37E-12	2.89E-14
221Fr	Implicit		4	1			0.00E+00	0.00E+00	2.57E-12	6.82E-14
217At	Implicit		4	1			0.00E+00	0.00E+00	2.61E-14	7.43E-16
213Bi	Implicit		4	1			1.95E-10	4.63E-09	1.14E-11	3.24E-13
213Po	Implicit		4	0.9784			0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	Implicit		4	0.0216			0.00E+00	0.00E+00	1.64E-10	4.99E-12
209Pb	Implicit		4	1			5.75E-11	2.56E-11	2.60E-14	3.52E-16

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Nuclide	Surface Concentration (dpm/100 cm**2)
41Ca	2.92E-02
54Mn	1.52E-08
79Se	3.57E-03
93Zr	5.86E-04
93mNb	0.00E+00
93Mo	4.83E-03
121mSn	2.09E-04
121Sn	0.00E+00
129I	3.41E-06
135Cs	2.27E-04
151Sm	6.28E-02
166mHo	9.57E-01
233U	2.81E-03
229Th	0.00E+00
225Ra	0.00E+00
225Ac	0.00E+00
221Fr	0.00E+00
217At	0.00E+00

213Bi	0.00E+00
213Po	0.00E+00
209Tl	0.00E+00
209Pb	0.00E+00
36Cl	3.22E+00
65Zn	5.41E-13

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
To:Time In Building	The time in the building during the occupancy period	CONSTANT(hr/week)
Default value used		Value 4.50E+01
Tto:Occupancy Period	The duration of the occupancy exposure period	CONSTANT(days)
Default value used		Value 3.65E+02
Vo:Breathing Rate	The average volumetric breathing rate during building occupancy for an 8-hour work day	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	DERIVED(1/m)
Default value used		
GO*:Ingestion Rate	Effective secondary ingestion transfer rate of removable surface activity from building surfaces to the mouth during building occupancy = GO * Fl	DERIVED(m**2/hr)
Default value used		
Tstart:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
Tend:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+02
dt:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02

Pstep:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
AOExt:External Exposure Area	Minimum surface area to which occupant is exposed via external radiation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOInh:Inhalation Exposure Area	Minimum surface area to which occupant is exposed via inhalation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOIng:Secondary Ingestion Exposure Area	Minimum surface area to which occupant is exposed via secondary ingestion during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AO:Exposure Area	Minimum surface area to which occupant is exposed during the occupancy period	DERIVED(m**2)
Default value used		
Fl:Loose Fraction	Fraction of surface contamination available for resuspension and ingestion	CONSTANT(none)
Default value used		Value 1.00E-01
Rfo:Loose Resuspension Factor	Resuspension factor for loose contamination	CONTINUOUS LOGARITHMIC(1/m)
Default value used		Value / Probability 9.12E-06 / 0.00E+00 1.10E-04 / 7.67E-01 1.46E-04 / 9.09E-01 1.62E-04 / 9.50E-01 1.85E-04 / 9.90E-01 1.90E-04 / 1.00E+00
GO:Loose Ingestion Rate	The secondary ingestion transfer rate of loose removable surface activity from building surfaces to the mouth during building occupancy	CONSTANT(m**2/hr)
Default value used		Value 1.10E-04

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 4.80E-03 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 4.53E-03 to 5.15E-03 mrem/year

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Concentration at Time of Peak Dose:

Nuclide	Surface Concentration (dpm/100 cm**2)
41Ca	2.92E-02
54Mn	1.04E-08
79Se	3.57E-03
93Zr	5.86E-04
93mNb	1.36E-04
93Mo	4.83E-03
121mSn	2.08E-04
121Sn	1.61E-04
129I	3.41E-06
135Cs	2.27E-04
151Sm	6.25E-02
166mHo	9.56E-01
233U	2.81E-03
229Th	1.33E-07
225Ra	1.18E-07
225Ac	1.09E-07
221Fr	1.09E-07
217At	1.09E-07
213Bi	1.09E-07
213Po	1.06E-07
209Tl	2.35E-09
209Pb	1.09E-07
36Cl	3.22E+00

65Zn	3.37E-13

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	External	Inhalation	Secondary Ingestion
5.15E-03	2.29E-03	2.84E-03	2.13E-05

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
41Ca	1.37E-07
54Mn	1.21E-11
79Se	1.20E-07
93Zr	4.48E-07
93mNb	9.69E-09
93Mo	3.70E-07
121mSn	7.50E-09
121Sn	3.87E-10
129I	2.63E-09
135Cs	4.33E-09
151Sm	4.49E-06
166mHo	4.05E-03
233U	9.06E-04
229Th	6.78E-07
225Ra	2.24E-09
225Ac	2.81E-09
221Fr	4.54E-12
217At	4.61E-14
213Bi	2.46E-11
213Po	0.00E+00
209Tl	6.25E-12
209Pb	9.72E-14
36Cl	1.83E-04
65Zn	2.84E-16

All Nuclides	5.15E-03

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	External	Inhalation	Secondary Ingestion
41Ca	0.00E+00	9.36E-08	4.31E-08
54Mn	1.19E-11	1.66E-13	3.35E-14
79Se	1.04E-10	8.35E-08	3.60E-08
93Zr	0.00E+00	4.47E-07	1.13E-09
93mNb	1.79E-10	9.43E-09	8.20E-11
93Mo	3.62E-08	3.26E-07	7.54E-09
121mSn	1.43E-09	5.70E-09	3.74E-10
121Sn	2.37E-11	1.95E-10	1.68E-10
129I	1.24E-10	1.41E-09	1.09E-09
135Cs	1.06E-11	2.46E-09	1.86E-09
151Sm	4.41E-10	4.46E-06	2.82E-08
166mHo	2.28E-03	1.76E-03	8.94E-06
233U	2.82E-09	9.05E-04	9.41E-07
229Th	1.59E-11	6.77E-07	5.43E-10
225Ra	2.21E-12	2.18E-09	5.27E-11
225Ac	2.42E-12	2.79E-09	1.40E-11
221Fr	4.54E-12	0.00E+00	0.00E+00
217At	4.61E-14	0.00E+00	0.00E+00
213Bi	2.01E-11	4.43E-12	9.09E-14
213Po	0.00E+00	0.00E+00	0.00E+00
209Tl	6.25E-12	0.00E+00	0.00E+00
209Pb	4.59E-14	2.45E-14	2.68E-14
36Cl	3.04E-06	1.68E-04	1.13E-05
65Zn	2.62E-16	1.63E-17	5.64E-18

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 7/17/2008 7:24:57 PM
Site Name: EF1
Description: Analysis of potential dose from nuclides discounted for resident farmer
FileName:C:\Documents and Settings\Marty\My Documents\DnD_Res1.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 189
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution	
36Cl	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	3.22E-03
41Ca	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	2.92E-05
54Mn	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	1.52E-11
79Se	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	3.57E-06
93Zr	UNLIMITED	CONSTANT(pCi/g)	

Justification for concentration: Percent total		Value	5.86E-07
121mSn	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	2.09E-07
93Mo	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	4.83E-06
129I	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	3.41E-09
135Cs	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	2.27E-07
151Sm	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	6.28E-05
166mHo	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	9.57E-04
233U	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	2.81E-06
65Zn	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Percent total		Value	5.41E-16

Chain Data:

Number of chains: **13**

Chain No. 1: **36Cl**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
36Cl	1	1.10E+08					8.18E-10	5.93E-09	5.81E-14	1.06E-15

Chain No. 2: **41Ca**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
41Ca	1	5.11E+07					3.44E-10	3.64E-10	0.00E+00	0.00E+00

Chain No. 3: **54Mn**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
54Mn	1	3.13E+02					7.48E-10	1.81E-09	7.01E-11	2.07E-12

Chain No. 4: **65Zn**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
65Zn	1	2.44E+02					3.90E-09	5.51E-09	4.78E-11	1.45E-12

Chain No. 5: **79Se**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
79Se	1	2.37E+07					2.35E-09	2.66E-09	1.79E-15	8.60E-18

Chain No. 6: **93Zr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
93Zr	1	5.59E+08					4.48E-10	8.67E-08	0.00E+00	0.00E+00
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 7: **93Mo**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
93Mo	1	1.28E+06					3.64E-10	7.68E-09	4.61E-13	2.73E-16
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 8: **121mSn**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
121mSn	1	2.01E+04					4.19E-10	3.11E-09	4.22E-13	9.11E-16
121Sn	2	1.13E+00	1	0.776	0	0	2.44E-10	1.38E-10	9.07E-15	9.02E-17

Chain No. 9: **129I**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
129I	1	5.73E+09					7.46E-08	4.69E-08	2.23E-12	5.98E-15

Chain No. 10: **135Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
135Cs	1	8.40E+08					1.91E-09	1.23E-09	2.87E-15	1.77E-17

Chain No. 11: **151Sm**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
151Sm	1	3.29E+04					1.05E-10	8.10E-09	4.34E-16	4.55E-19

Chain No. 12: **166mHo**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
166mHo	1	4.38E+05					2.18E-09	2.09E-07	1.47E-10	4.23E-12

Chain No. 13: **233U**
Nuclides in chain: **10**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
233U	1	5.79E+07					7.81E-08	3.66E-05	6.18E-14	6.25E-16
229Th	2	2.68E+06	1	1	0	0	9.54E-07	5.80E-04	7.38E-12	1.47E-13
225Ra	3	1.48E+01	2	1	0	0	1.04E-07	2.10E-06	1.15E-12	5.09E-15
225Ac	4	1.00E+01	3	1	0	0	3.00E-08	2.92E-06	1.37E-12	2.89E-14
221Fr	Implicit		4	1			0.00E+00	0.00E+00	2.57E-12	6.82E-14
217At	Implicit		4	1			0.00E+00	0.00E+00	2.61E-14	7.43E-16
213Bi	Implicit		4	1			1.95E-10	4.63E-09	1.14E-11	3.24E-13
213Po	Implicit		4	0.9784			0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	Implicit		4	0.0216			0.00E+00	0.00E+00	1.64E-10	4.99E-12
209Pb	Implicit		4	1			5.75E-11	2.56E-11	2.60E-14	3.52E-16

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Nuclide	Soil Concentration (pCi/g)
36Cl	3.22E-03
41Ca	2.92E-05
54Mn	1.52E-11
79Se	3.57E-06
93Zr	5.86E-07
93mNb	0.00E+00
121mSn	2.09E-07
121Sn	0.00E+00
93Mo	4.83E-06
129I	3.41E-09
135Cs	2.27E-07
151Sm	6.28E-05
166mHo	9.57E-04
233U	2.81E-06
229Th	0.00E+00

225Ra	0.00E+00
225Ac	0.00E+00
221Fr	0.00E+00
217At	0.00E+00
213Bi	0.00E+00
213Po	0.00E+00
209Tl	0.00E+00
209Pb	0.00E+00
65Zn	5.41E-16

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
Tv(1):Translocation:Leafy	Translocation factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E+00
Tv(2):Translocation:Root	Translocation factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(3):Translocation:Fruit	Translocation factor for fruit	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(4):Translocation:Grain	Translocation factor for grain	CONSTANT(none)
Default value used		Value 1.00E-01
Tf(1):Translocation:Beef Forage	Translocation factor for forage consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(2):Translocation:Poultry Forage	Translocation factor for forage consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(3):Translocation:Milk Cow	Translocatioin factor for forage consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(4):Translocation:Layer	Translocation factor for forage consumed by layer hens	CONSTANT(none)

Hen Forage		
Default value used		Value 1.00E+00
Tg(1):Translocation:Beef Grain	Translocation factor for stored grain consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(2):Translocation:Poultry Grain	Translocation factor for stored grain consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(3):Translocation:Milk Cow Grain	Translocation factor for stored grain consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(4):Translocation:Layer Hen Grain	Translocation factor for stored grain consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
Th(1):Translocation:Beef Hay	Translocation factor for stored hay consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Th(2):Translocation:Poultry Hay	Translocation factor for stored hay consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Th(3):Translocation:Milk Cow Hay	Translocation factor for stored hay consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Th(4):Translocation:Layer Hen Hay	Translocation factor for stored hay consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
fca(1):Beef Carbon Fraction	Mass fraction of beef cattle that is carbon	CONSTANT(none)
Default value used		Value 3.60E-01
fca(2):Poultry Carbon Fraction	Mass fraction of poultry that is carbon	CONSTANT(none)
Default value used		Value 1.80E-01
fca(3):Milk Carbon Fraction	Mass fraction of milk that is carbon	CONSTANT(none)
Default value used		Value 6.00E-02
fca(4):Eggs Carbon Fraction	Mass fraction of an egg that is carbon	CONSTANT(none)
Default value used		Value 1.60E-01

fcf(1):Beef Forage Carbon Fraction	Mass fraction of wet forage consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(2):Poultry Forage Carbon Fraction	Mass fraction of wet forage consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(3):Milk Cow Forage Carbon Fraction	Mass fraction of wet forage consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(4):Layer Hen Forage Carbon Fraction	Mass fraction of wet forage consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcg(1):Beef Grain Carbon Fraction	Mass fraction of wet stored grain consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(2):Poultry Grain Carbon Fraction	Mass fraction of wet stored grain consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(3):Milk Cow Grain Carbon Fraction	Mass fraction of wet stored grain consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(4):Layer Hen Grain Carbon Fraction	Mass fraction of wet stored grain consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fch(1):Beef Hay Carbon Fraction	Mass fraction of wet stored hay consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(2):Poultry Hay Carbon Fraction	Mass fraction of wet stored hay consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(3):Milk Cow Hay Carbon Fraction	Mass fraction of wet stored hay consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(4):Layer Hen Hay	Mass fraction of wet stored hay consumed by layer hens that is	CONSTANT(none)

Carbon Fraction	carbon	
Default value used		Value 7.00E-02
fCd:Soil Carbon Fraction	Mass fraction of dry soil that is carbon	CONSTANT(none)
Default value used		Value 3.00E-02
SATac:Animal Product Specific Activity	Specific activity equivalence of animal product and specific activity of animal feed, forage, and soil	CONSTANT(none)
Default value used		Value 1.00E+00
xf(1):Beef Forage Contaminated Fraction	Fraction of forage consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(2):Poultry Forage Contaminated Fraction	Fraction of forage consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(3):Milk Cow Forage Contaminated Fraction	Fraction of forage consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(4):Layer Hen Forage Contaminated Fraction	Fraction of forage consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(1):Beef Grain Contaminated Fraction	Fraction of stored grain consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(2):Poultry Grain Contaminated Fraction	Fraction of stored grain consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(3):Milk Cow Grain Contaminated Fraction	Fraction of stored grain consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(4):Layer Hen Grain Contaminated Fraction	Fraction of stored grain that is consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(1):Beef Hay Contaminated Fraction	Fraction of stored hay consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(2):Poultry Hay Contaminated Fraction	Fraction of stored hay consumed by poultry that is contaminated	CONSTANT(none)

Default value used		Value 1.00E+00
xh(3):Milk Cow Hay Contaminated Fraction	Fraction of stored hay consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(4):Layer Hen Hay Contaminated Fraction	Fraction of stored hay consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(1):Beef Water Contaminated Fraction	Fraction of water that is consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(2):Poultry Water Contaminated Fraction	Fraction of water consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(3):Milk Cow Water Contaminated Fraction	Fraction of water consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(4):Layer Hen Water Contaminated Fraction	Fraction of water consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
DIET:Garden Diet	Fraction of human diet grown onsite	CONSTANT(none)
Default value used		Value 1.00E+00
Uv(1):Diet - Leafy	Yearly human consumption of leafy vegetables	CONSTANT(kg/y)
Default value used		Value 2.14E+01
Uv(2):Diet - Roots	Yearly human consumption of other vegetables	CONSTANT(kg/y)
Default value used		Value 4.46E+01
Uv(3):Diet - Fruit	Yearly human consumption of fruits	CONSTANT(kg/y)
Default value used		Value 5.28E+01
Uv(4):Diet - Grain	Yearly human consumption of grains	CONSTANT(kg/y)
Default value used		Value 1.44E+01
Ua(1):Diet - Beef	Yearly human consumption of beef	CONSTANT(kg/y)
Default value used		Value 3.98E+01
Ua(2):Diet - Poultry	Yearly human consumption of poultry	CONSTANT(kg/y)
Default value used		Value 2.53E+01

Ua(3):Diet - Milk	Yearly human consumption of milk	CONSTANT(L/y)
Default value used		Value 2.33E+02
Ua(4):Diet - Egg	Yearly human consumption of eggs	CONSTANT(kg/y)
Default value used		Value 1.91E+01
Uf:Diet - Fish	Yearly human consumption of fish produced from an onsite pond	CONSTANT(kg/y)
Default value used		Value 2.06E+01
tf:Consumption Period	Consumption period for fish	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(1):Consumption Period - Leafy	Food consumption period for leafy vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(2):Consumption Period - Roots	Food consumption period for other vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(3):Consumption Period - Fruit	Food consumption period for fruits	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(4):Consumption Period - Grain	Food consumption period for grains	CONSTANT(days)
Default value used		Value 3.65E+02
tca(1):Consumption Period - Beef	Food consumption period for beef	CONSTANT(days)
Default value used		Value 3.65E+02
tca(2):Consumption Period - Poultry	Food consumption period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
tca(3):Consumption Period - Milk	Food consumption period for milk	CONSTANT(days)
Default value used		Value 3.65E+02
tca(4):Consumption Period - Egg	Food consumption period for eggs	CONSTANT(days)
Default value used		Value 3.65E+02
Nunsat:Number of Unsaturated Layers	Number of model layers used to represent the unsaturated zone	CONSTANT(none)
Default value used		Value 1.00E+01
TstartR:Start Time	The start time of the scenario in days	CONSTANT(days)

Default value used		Value 0.00E+00
TendR:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+05
dtR:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
PstepR:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
TI:Indoor Exposure Period	The time the resident spends indoors	CONSTANT(days/year)
Default value used		Value 2.40E+02
TX:Outdoor Exposure Period	The time the resident spends outdoors	CONSTANT(days/year)
Default value used		Value 4.02E+01
TG:Gardening Period	The time the resident spends gardening	CONSTANT(days/year)
Default value used		Value 2.92E+00
TTR:Total time in period	Total time in the one year exposure period	CONSTANT(days/year)
Default value used		Value 3.65E+02
SFI:Indoor Shielding Factor	Shielding factor for the residence	CONSTANT(none)
Default value used		Value 5.52E-01
SFO:Outdoor Shielding Factor	Shielding factor for the cover soil	CONSTANT(none)
Default value used		Value 1.00E+00
PD:Floor dust loading	Floor dust loading	UNIFORM(g/m**2)
Default value used		Lower Limit 2.00E-02 Upper Limit 3.00E-01
RFR:Indoor Resuspension Factor	Resuspension factor for indoor dust	LOGUNIFORM(1/m)
Default value used		Lower Limit 1.00E-07 Upper Limit 8.00E-05
CDO:Outdoor Dust Loading	Average dust loading outdoors	LOGUNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-07 Upper Limit 1.00E-04
CDI:Indoor Dust Loading	Average dust loading indoors	DERIVED(g/m**3)

Default value used		
PF:Indoor/Outdoor Penetration Factor	Fraction of outdoor dust in indoor air	UNIFORM(none)
Default value used		Lower Limit 2.00E-01 Upper Limit 7.00E-01
CDG:Gardening Dust Loading	Average dust loading while gardening	UNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-04 Upper Limit 7.00E-04
VR:Indoor Breathing Rate	Breathing rate while indoors	CONSTANT(m**3/hr)
Default value used		Value 9.00E-01
VX:Outdoor Breathing Rate	Breathing rate while outdoors	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
VG:Gardening Breathing Rate	Breathing rate while gardening	CONSTANT(m**3/hr)
Default value used		Value 1.70E+00
GR:Soil Ingestion Transfer Rate	Average rate of soil ingestion	CONSTANT(g/d)
Default value used		Value 5.00E-02
UW:Diet - Water	Drinking water ingestion rate	CONSTANT(L/d)
Default value used		Value 1.26E+00
H1:Surface Soil Thickness	Thickness of the surface soil layer	CONSTANT(m)
Default value used		Value 1.50E-01
H2:Unsaturated Zone Thickness	Thickness of the unsaturated zone	CONTINUOUS LINEAR(m)
Default value used		Value Probability 3.05E-01 0.00E+00 6.68E-01 4.76E-03 8.11E-01 9.52E-03 9.21E-01 1.43E-02 9.94E-01 1.91E-02 1.03E+00 2.38E-02 1.07E+00 2.86E-02 1.14E+00 3.33E-02 1.21E+00 3.81E-02 1.30E+00 4.29E-02 1.31E+00 4.76E-02 1.32E+00 5.24E-02 1.56E+00 5.71E-02

1.58E+00	6.19E-02
1.61E+00	6.67E-02
1.69E+00	7.62E-02
1.78E+00	8.57E-02
1.80E+00	9.05E-02
1.81E+00	9.52E-02
1.84E+00	1.00E-01
1.87E+00	1.05E-01
1.92E+00	1.10E-01
2.04E+00	1.14E-01
2.10E+00	1.19E-01
2.11E+00	1.24E-01
2.32E+00	1.29E-01
2.36E+00	1.33E-01
2.37E+00	1.38E-01
2.39E+00	1.43E-01
2.44E+00	1.48E-01
2.44E+00	1.52E-01
2.45E+00	1.57E-01
2.59E+00	1.62E-01
2.63E+00	1.67E-01
2.69E+00	1.71E-01
2.79E+00	1.76E-01
2.81E+00	1.81E-01
2.90E+00	1.86E-01
2.95E+00	1.91E-01
3.07E+00	1.95E-01
3.18E+00	2.00E-01
3.22E+00	2.05E-01
3.30E+00	2.10E-01
3.34E+00	2.14E-01
3.37E+00	2.19E-01
3.44E+00	2.24E-01
3.58E+00	2.29E-01
3.62E+00	2.33E-01
3.66E+00	2.38E-01
3.74E+00	2.43E-01
3.86E+00	2.48E-01
3.88E+00	2.52E-01
4.17E+00	2.57E-01
4.26E+00	2.62E-01
4.44E+00	2.71E-01
4.63E+00	2.76E-01
4.87E+00	2.81E-01
5.13E+00	2.86E-01
5.18E+00	2.91E-01
5.54E+00	2.95E-01
5.83E+00	3.00E-01
5.86E+00	3.05E-01

	5.86E+00	3.10E-01
	5.90E+00	3.14E-01
	6.06E+00	3.19E-01
	6.13E+00	3.24E-01
	6.17E+00	3.29E-01
	6.22E+00	3.33E-01
	6.31E+00	3.38E-01
	6.36E+00	3.43E-01
	6.40E+00	3.48E-01
	6.46E+00	3.52E-01
	6.51E+00	3.57E-01
	6.55E+00	3.62E-01
	6.60E+00	3.67E-01
	6.86E+00	3.71E-01
	6.93E+00	3.76E-01
	6.95E+00	3.86E-01
	6.97E+00	3.91E-01
	7.09E+00	3.95E-01
	7.18E+00	4.00E-01
	7.35E+00	4.05E-01
	7.36E+00	4.10E-01
	7.40E+00	4.14E-01
	7.43E+00	4.19E-01
	7.46E+00	4.24E-01
	7.59E+00	4.29E-01
	7.60E+00	4.33E-01
	7.64E+00	4.38E-01
	7.87E+00	4.43E-01
	8.10E+00	4.48E-01
	8.28E+00	4.52E-01
	8.35E+00	4.57E-01
	8.71E+00	4.62E-01
	8.71E+00	4.67E-01
	8.73E+00	4.71E-01
	8.79E+00	4.76E-01
	8.80E+00	4.81E-01
	8.82E+00	4.86E-01
	8.85E+00	4.91E-01
	8.89E+00	4.95E-01
	8.90E+00	5.00E-01
	8.99E+00	5.05E-01
	9.00E+00	5.10E-01
	9.13E+00	5.14E-01
	9.14E+00	5.19E-01
	9.21E+00	5.24E-01
	9.31E+00	5.29E-01
	9.55E+00	5.33E-01
	9.60E+00	5.38E-01
	9.63E+00	5.43E-01

	9.86E+00	5.48E-01
	1.05E+01	5.52E-01
	1.07E+01	5.57E-01
	1.13E+01	5.62E-01
	1.15E+01	5.67E-01
	1.17E+01	5.71E-01
	1.20E+01	5.76E-01
	1.26E+01	5.81E-01
	1.26E+01	5.86E-01
	1.28E+01	5.91E-01
	1.32E+01	5.95E-01
	1.32E+01	6.00E-01
	1.34E+01	6.05E-01
	1.34E+01	6.10E-01
	1.36E+01	6.14E-01
	1.37E+01	6.19E-01
	1.38E+01	6.24E-01
	1.41E+01	6.29E-01
	1.45E+01	6.33E-01
	1.51E+01	6.38E-01
	1.52E+01	6.43E-01
	1.61E+01	6.48E-01
	1.62E+01	6.52E-01
	1.65E+01	6.57E-01
	1.66E+01	6.62E-01
	1.69E+01	6.67E-01
	1.74E+01	6.71E-01
	1.82E+01	6.76E-01
	1.84E+01	6.81E-01
	1.84E+01	6.86E-01
	1.87E+01	6.91E-01
	1.95E+01	6.95E-01
	2.01E+01	7.00E-01
	2.07E+01	7.05E-01
	2.08E+01	7.10E-01
	2.17E+01	7.14E-01
	2.24E+01	7.19E-01
	2.27E+01	7.24E-01
	2.29E+01	7.29E-01
	2.29E+01	7.33E-01
	2.40E+01	7.38E-01
	2.47E+01	7.43E-01
	2.60E+01	7.48E-01
	2.65E+01	7.52E-01
	2.72E+01	7.57E-01
	2.73E+01	7.62E-01
	2.76E+01	7.67E-01
	2.77E+01	7.71E-01
	2.78E+01	7.76E-01

	2.80E+01	7.81E-01
	2.86E+01	7.86E-01
	2.94E+01	7.91E-01
	3.01E+01	7.95E-01
	3.03E+01	8.00E-01
	3.06E+01	8.10E-01
	3.08E+01	8.14E-01
	3.11E+01	8.19E-01
	3.17E+01	8.24E-01
	3.17E+01	8.29E-01
	3.17E+01	8.33E-01
	3.22E+01	8.38E-01
	3.39E+01	8.43E-01
	3.48E+01	8.48E-01
	3.54E+01	8.52E-01
	3.60E+01	8.57E-01
	3.68E+01	8.62E-01
	4.03E+01	8.67E-01
	4.07E+01	8.71E-01
	4.24E+01	8.76E-01
	4.29E+01	8.81E-01
	4.42E+01	8.86E-01
	4.72E+01	8.91E-01
	4.97E+01	8.95E-01
	5.12E+01	9.00E-01
	6.13E+01	9.05E-01
	6.19E+01	9.10E-01
	6.23E+01	9.14E-01
	6.32E+01	9.19E-01
	6.59E+01	9.24E-01
	6.73E+01	9.29E-01
	7.47E+01	9.33E-01
	7.92E+01	9.38E-01
	8.12E+01	9.43E-01
	8.28E+01	9.48E-01
	8.47E+01	9.52E-01
	8.96E+01	9.57E-01
	9.47E+01	9.62E-01
	1.08E+02	9.67E-01
	1.13E+02	9.71E-01
	1.15E+02	9.76E-01
	1.42E+02	9.81E-01
	1.77E+02	9.86E-01
	1.78E+02	9.91E-01
	1.80E+02	9.95E-01
	3.16E+02	1.00E+00

N1:Surface Soil Porosity	Porosity of the surface soil layer	DERIVED(none)
Default value used		

N2:Unsaturated Zone Porosity	Porosity of the unsaturated zone	DERIVED(none)
Default value used		
F1:Surface Soil Saturation	Saturation ratio of the surface soil layer	DERIVED(none)
Default value used		
F2:Unsaturated Zone Saturation	Saturation ratio of the unsaturated zone	DERIVED(none)
Default value used		
INFIL:Infiltration Rate	Net rate of infiltration to aquifer	DERIVED(m/y)
Default value used		
SCSST:Soil Classification	SCS soil classification ID	DISCRETE CUMULATIVE(none)
Default value used		Value / Probability 1.00E+00 1.00E-04 2.00E+00 1.34E-03 3.00E+00 1.06E-02 4.00E+00 2.51E-02 5.00E+00 6.17E-02 6.00E+00 1.09E-01 7.00E+00 1.62E-01 8.00E+00 2.12E-01 9.00E+00 2.85E-01 1.00E+01 5.10E-01 1.10E+01 7.58E-01 1.20E+01 1.00E+00
NDEV:Porosity Probability	Relative porosity value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
KSDEV:Permeability Probability	Relative permeability value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
BDEV:Parameter "b" Probability	Relative value of "b" parameter within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
AP:Water Application Rate	Total water application rate on cultivated area	CONTINUOUS LINEAR(m/y)
Default value used		

		Value / Probability 6.07E-01 0.00E+00 6.10E-01 4.62E-01 6.35E-01 4.76E-01 7.62E-01 5.40E-01 8.89E-01 6.29E-01 1.02E+00 7.05E-01 1.14E+00 8.04E-01 1.27E+00 8.79E-01 1.40E+00 9.41E-01 1.52E+00 9.82E-01 1.65E+00 9.98E-01 1.78E+00 1.00E+00
IR:Irrigation Rate	Annual average irrigation rate	CONSTANT(L/m**2-d)
Default value used		Value 1.29E+00
RHO1:Surface Soil Density	Bulk density of soil in the surface soil layer	DERIVED(g/mL)
Default value used		
RHO2:Unsaturated Zone Density	Bulk density of soil in the unsaturated zone	DERIVED(g/mL)
Default value used		
Ksat1:Surface Soil Permeabiliy	Saturated permeability of the surface soil layer	DERIVED(cm/sec)
Default value used		
VDR:Volume of Water Consumed	Volume of water withdrawn for consumptive use	CONSTANT(L)
Default value used		Value 1.18E+05
VSW:Volume of Water in Pond	Volume of water in the pond	CONSTANT(L)
Default value used		Value 1.30E+06
AR:Cultivated Area	Area of land cultivated	DERIVED(m**2)
Default value used		
sh:Soil Moisture Content	Moisture content of soil	DERIVED(none)
Default value used		
TTG:Gardening Period	Total time in gardening period	CONSTANT(days)
Default value used		Value 9.00E+01
TD:Drinking-water consumption period	Drinking-water consumption period	CONSTANT(days)
Default value used		Value 3.65E+02

THV(1):Holdup Period : Leafy	Holdup period for leafy vegetables	CONSTANT(days)
Default value used		Value 1.00E+00
THV(2):Holdup Period : Other vegetables	Holdup period for other vegetables	CONSTANT(days)
Default value used		Value 1.40E+01
THV(3):Holdup Period : Fruits	Holdup period for fruits	CONSTANT(days)
Default value used		Value 1.40E+01
THV(4):Holdup Period : Grains	Holdup period for grains	CONSTANT(days)
Default value used		Value 1.40E+01
THA(1):Holdup Period : Beef	Holdup period for beef	CONSTANT(days)
Default value used		Value 2.00E+01
THA(2):Holdup Period : Poultry	Holdup period for poultry	CONSTANT(days)
Default value used		Value 1.00E+00
THA(3):Holdup Period : Milk	Holdup period for milk	CONSTANT(days)
Default value used		Value 1.00E+00
THA(4):Holdup Period : Eggs	Holdup period for eggs	CONSTANT(days)
Default value used		Value 1.00E+00
TGV(1):Growing Period : Leafy	Minimum growing period for leafy vegetables	CONSTANT(days)
Default value used		Value 4.50E+01
TGV(2):Growing Period : Other vegetables	Minimum growing period for other vegetables	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(3):Growing Period : Fruits	Minimum growing period for fruits	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(4):Growing Period : Grains	Minimum growing period for grains	CONSTANT(days)
Default value used		Value 9.00E+01
TGF(1):Growing Period : Beef Forage	Minimum growing period for forage consumed by beef cattle	CONSTANT(days)

Default value used		Value 3.00E+01
TGF(2):Growing Period : Poultry Forage	Minimum growing period for forage consumed by poultry	DERIVED(days)
Default value used		
TGF(3):Growing Period : Milk Cow Forage	Minimum growing period for forage consumed by milk cows	DERIVED(days)
Default value used		
TGF(4):Growing Period : Layer Hen Forage	Minimum growing period for forage consumed by layer hens	DERIVED(days)
Default value used		
TGG(1):Growing Period : Beef Cow Grain	Minimum growing period for stored grain consumed by beef cattle	CONSTANT(days)
Default value used		Value 9.00E+01
TGG(2):Growing Period : Poultry Grain	Minimum growing period for stored grain consumed by poultry	DERIVED(days)
Default value used		
TGG(3):Growing Period : Milk Cow Grain	Minimum growing period for stored grain consumed by milk cows	DERIVED(days)
Default value used		
TGG(4):Growing Period : Layer Hen Grain	Minimum growing period for stored grain consumed by layer hens	DERIVED(days)
Default value used		
TGH(1):Growing Period : Beef Cow Hay	Minimum growing period for stored hay consumed by beef cattle	CONSTANT(days)
Default value used		Value 4.50E+01
TGH(2):Growing Period : Poultry Hay	Minimum growing period for stored hay consumed by poultry	DERIVED(days)
Default value used		
TGH(3):Growing Period : Milk Cow Hay	Minimum growing period for stored hay consumed by milk cows	DERIVED(days)
Default value used		
TGH(4):Growing Period : Layer Hen Hay	Minimum growing period for stored hay consumed by layer hens	DERIVED(days)
Default value used		
RV(1):Interception Fraction	Interception fraction for leafy	UNIFORM(none)

: Leafy	vegetables	
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(2):Interception Fraction : Other vegetables	Interception fraction for other vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(3):Interception Fraction : Fruits	Interception fraction for fruits	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(4):Interception Fraction : Grains	Interception fraction for grains	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(1):Interception Fraction : Beef Forage	Interception fraction for beef cattle forage	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(2):Interception Fraction : Poultry forage	Interception fraction for poultry forage	DERIVED(none)
Default value used		
RF(3):Interception Fraction : Milk Cow Forage	Interception fraction for milk cow forage	DERIVED(none)
Default value used		
RF(4):Interception Fraction : Layer Hen Forage	Interception fraction for layer hen forage	DERIVED(none)
Default value used		
RG(1):Interception Fraction : Beef Cow Grain	Interception fraction for beef cattle grain	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RG(2):Interception Fraction : Poultry Grain	Interception fraction for poultry grain	DERIVED(none)
Default value used		
RG(3):Interception Fraction : Milk Cow Grain	Interception fraction for milk cow grain	DERIVED(none)
Default value used		

RG(4):Interception Fraction : Layer Hen Grain	Interception fraction for layer hen grain	DERIVED(none)
Default value used		
RH(1):Interception Fraction : Beef Cow Hay	Interception fraction for beef cattle hay	DERIVED(none)
Default value used		
RH(2):Interception Fraction : Poultry Hay	Interception fraction for poultry hay	DERIVED(none)
Default value used		
RH(3):Interception Fraction : Milk Cow Hay	Interception fraction for milk cow hay	DERIVED(none)
Default value used		
RH(4):Interception Fraction : Layer Hen Hay	Interception fraction for layer hen hay	DERIVED(none)
Default value used		
YV(1):Crop Yield : Leafy	Crop yield for leafy vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value / Probability 2.70E+00 0.00E+00 2.71E+00 1.60E-03 2.74E+00 6.00E-03 2.76E+00 1.76E-02 2.78E+00 4.36E-02 2.80E+00 8.48E-02 2.82E+00 1.56E-01 2.85E+00 2.57E-01 2.87E+00 3.64E-01 2.89E+00 5.00E-01 2.91E+00 6.39E-01 2.93E+00 7.46E-01 2.96E+00 8.42E-01 2.98E+00 9.09E-01 3.00E+00 9.60E-01 3.02E+00 9.84E-01 3.04E+00 9.94E-01 3.07E+00 9.97E-01 3.09E+00 9.99E-01 3.11E+00 1.00E+00 3.13E+00 1.00E+00 3.15E+00 1.00E+00
YV(2):Crop Yield : Other	Crop yield for other vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used	Value / Probability 2.26E+00 0.00E+00 2.29E+00 8.00E-04 2.30E+00 1.20E-03 2.31E+00 6.40E-03 2.33E+00 1.52E-02 2.34E+00 3.28E-02 2.35E+00 7.44E-02 2.36E+00 1.40E-01 2.38E+00 2.49E-01 2.39E+00 3.80E-01 2.40E+00 5.30E-01 2.42E+00 6.61E-01 2.43E+00 7.88E-01 2.44E+00 8.86E-01 2.45E+00 9.42E-01 2.47E+00 9.75E-01 2.48E+00 9.88E-01 2.49E+00 9.96E-01 2.51E+00 9.97E-01 2.52E+00 9.99E-01 2.53E+00 1.00E+00 2.54E+00 1.00E+00

YV(3):Crop Yield : Fruits	Crop yield for fruits	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used	Value / Probability 2.17E+00 0.00E+00 2.20E+00 1.20E-03 2.21E+00 2.40E-03 2.23E+00 6.80E-03 2.25E+00 1.80E-02 2.27E+00 4.36E-02 2.29E+00 7.64E-02 2.31E+00 1.38E-01 2.32E+00 2.14E-01 2.34E+00 3.27E-01 2.36E+00 4.50E-01 2.38E+00 5.76E-01 2.40E+00 6.87E-01 2.42E+00 7.88E-01 2.43E+00 8.68E-01 2.45E+00 9.25E-01 2.47E+00 9.60E-01 2.49E+00 9.81E-01 2.51E+00 9.92E-01 2.53E+00 9.98E-01

		2.54E+00 1.00E+00 2.56E+00 1.00E+00
YV(4):Crop Yield : Grains	Crop yield for grains	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value / Probability 2.85E-01 0.00E+00 2.90E-01 6.00E-04 3.02E-01 2.80E-03 3.14E-01 9.40E-03 3.26E-01 2.14E-02 3.38E-01 5.42E-02 3.50E-01 1.08E-01 3.62E-01 2.02E-01 3.74E-01 3.15E-01 3.86E-01 4.50E-01 3.98E-01 5.92E-01 4.10E-01 7.20E-01 4.23E-01 8.26E-01 4.35E-01 9.03E-01 4.47E-01 9.51E-01 4.59E-01 9.77E-01 4.71E-01 9.91E-01 4.83E-01 9.96E-01 4.95E-01 9.99E-01 5.07E-01 1.00E+00 5.19E-01 1.00E+00 5.31E-01 1.00E+00
YF(1):Crop Yield : Beef Forage	Crop yield for beef cattle forage	BETA(kg dry wt forage/m**2)
Default value used		Lower Limit 3.70E-01 Upper Limit 5.24E-01 p 2.36E+00 q 1.40E+00
YF(2):Crop Yield : Poultry Forage	Crop yield for poultry forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(3):Crop Yield : Milk Cow Forage	Crop yield for milk cow forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(4):Crop Yield : Layer Hen Forage	Crop yield for layer hen forage	DERIVED(kg wet wt forage/m**2)
Default value used		

YG(1):Crop Yield : Beef Cow Grain	Crop yield for beef cattle grain	NORMAL(kg dry wt grain /m**2)
Default value used		Mean 5.78E-01 Standard Deviation 7.77E-02
YG(2):Crop Yield : Poultry Grain	Crop yield for poultry grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(3):Crop Yield : Milk Cow Grain	Crop yield for milk cow grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(4):Crop Yield : Layer Hen Grain	Crop yield for layer hen grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YH(1):Crop Yield : Beef Cow Hay	Crop yield for beef cattle hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(2):Crop Yield : Poultry Hay	Crop yield for poultry hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(3):Crop Yield : Milk Cow Hay	Crop yield for milk cow hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(4):Crop Yield : Layer Hen Hay	Crop yield for layer hen hay	DERIVED(kg wet wt/m**2)
Default value used		
WV(1):Wet/dry : Leafy Vegetables	Wet/dry conversion factor for leafy vegetables	CONTINUOUS LINEAR(none)
Default value used		Value / Probability 3.32E-02 0.00E+00 4.89E-02 3.45E-02 5.47E-02 6.91E-02 5.96E-02 1.04E-01 6.36E-02 1.38E-01 6.70E-02 1.73E-01 7.05E-02 2.07E-01 7.38E-02 2.42E-01 7.48E-02 2.50E-01 7.72E-02 2.76E-01

		8.03E-02 3.11E-01 8.34E-02 3.45E-01 8.66E-02 3.80E-01 9.00E-02 4.15E-01 9.36E-02 4.49E-01 9.73E-02 4.84E-01 9.91E-02 4.99E-01 1.01E-01 5.18E-01 1.05E-01 5.53E-01 1.09E-01 5.87E-01 1.13E-01 6.22E-01 1.18E-01 6.56E-01 1.23E-01 6.91E-01 1.29E-01 7.25E-01 1.33E-01 7.50E-01 1.35E-01 7.60E-01 1.42E-01 7.94E-01 1.50E-01 8.29E-01 1.59E-01 8.64E-01 1.70E-01 8.98E-01 1.85E-01 9.33E-01 2.10E-01 9.67E-01 2.56E-01 9.91E-01 3.24E-01 1.00E+00
WV(2):Wet/dry : Other Vegetables	Wet/dry conversion factor for other vegetables	CONTINUOUS LINEAR(none)
Default value used		Value Probability 3.58E-02 0.00E+00 4.87E-02 3.45E-02 5.46E-02 6.91E-02 5.90E-02 1.04E-01 6.29E-02 1.38E-01 6.69E-02 1.73E-01 7.02E-02 2.07E-01 7.34E-02 2.42E-01 7.41E-02 2.50E-01 7.65E-02 2.76E-01 7.99E-02 3.11E-01 8.32E-02 3.45E-01 8.66E-02 3.80E-01 9.05E-02 4.15E-01 9.41E-02 4.49E-01 9.82E-02 4.84E-01 9.98E-02 4.99E-01 1.02E-01 5.18E-01 1.06E-01 5.53E-01 1.09E-01 5.87E-01

		1.14E-01	6.22E-01
		1.19E-01	6.56E-01
		1.24E-01	6.91E-01
		1.29E-01	7.25E-01
		1.33E-01	7.50E-01
		1.35E-01	7.60E-01
		1.42E-01	7.94E-01
		1.50E-01	8.29E-01
		1.59E-01	8.64E-01
		1.70E-01	8.98E-01
		1.87E-01	9.33E-01
		2.12E-01	9.67E-01
		2.62E-01	9.91E-01
		3.13E-01	1.00E+00
WV(3):Wet/dry : Fruit	Wet/dry conversion factor for fruits	CONTINUOUS LINEAR(none)	
Default value used		Value	Probability
		3.66E-02	0.00E+00
		4.87E-02	3.45E-02
		5.45E-02	6.91E-02
		5.93E-02	1.04E-01
		6.31E-02	1.38E-01
		6.72E-02	1.73E-01
		7.10E-02	2.07E-01
		7.44E-02	2.42E-01
		7.52E-02	2.50E-01
		7.78E-02	2.76E-01
		8.13E-02	3.11E-01
		8.45E-02	3.45E-01
		8.78E-02	3.80E-01
		9.11E-02	4.15E-01
		9.46E-02	4.49E-01
		9.82E-02	4.84E-01
		9.97E-02	4.99E-01
		1.02E-01	5.18E-01
		1.06E-01	5.53E-01
		1.10E-01	5.87E-01
		1.14E-01	6.22E-01
		1.19E-01	6.56E-01
		1.24E-01	6.91E-01
		1.29E-01	7.25E-01
		1.34E-01	7.50E-01
		1.35E-01	7.60E-01
		1.42E-01	7.94E-01
		1.49E-01	8.29E-01
		1.58E-01	8.64E-01
		1.70E-01	8.98E-01
		1.87E-01	9.33E-01

		2.14E-01 9.67E-01 2.58E-01 9.91E-01 3.25E-01 1.00E+00
WV(4):Wet/dry : Grain	Wet/dry conversion factor for grains	CONSTANT(none)
Default value used		Value 8.80E-01
WF(1):Wet/dry : Beef Cow Forage	Wet/dry conversion factor for beef cattle forage	BETA(none)
Default value used		Lower Limit 1.83E-01 Upper Limit 3.23E-01 p 1.15E+00 q 1.18E+00
WF(2):Wet/dry : Poultry Forage	Wet/dry conversion factor for poultry forage	DERIVED(none)
Default value used		
WF(3):Wet/dry : Milk Cow Forage	Wet/dry conversion factor for milk cow forage	DERIVED(none)
Default value used		
WF(4):Wet/dry : Layer Hen Forage	Wet/dry conversion factor for layer hen forage	DERIVED(none)
Default value used		
WG(1):Wet/dry : Beef Cow Grain	Wet/dry conversion factor for beef cattle grain	CONSTANT(none)
Default value used		Value 8.80E-01
WG(2):Wet/dry : Poultry Grain	Wet/dry conversion factor for poultry grain	DERIVED(none)
Default value used		
WG(3):Wet/dry : Milk Cow Grain	Wet/dry conversion factor for milk cow grain	DERIVED(none)
Default value used		
WG(4):Wet/dry : Layer Hen Grain	Wet/dry conversion factor for layer hen grain	DERIVED(none)
Default value used		
WH(1):Wet/dry : Beef Cow Hay	Wet/dry conversion factor for beef cattle hay	DERIVED(none)
Default value used		
WH(2):Wet/dry : Poultry Hay	Wet/dry conversion factor for poultry hay	DERIVED(none)

Default value used		
WH(3):Wet/dry : Milk Cow Hay	Wet/dry conversion factor for milk cow hay	DERIVED(none)
Default value used		
WH(4):Wet/dry : Layer Hen Hay	Wet/dry conversion factor for layer hen hay	DERIVED(none)
Default value used		
QF(1):Ingestion Rate : Beef Cow Forage	Ingestion rate for beef cattle forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QF(2):Ingestion Rate : Poultry Forage	Ingestion rate for poultry forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 3.48E-03 Upper Limit 2.82E-02 p 1.51E+00 q 1.41E+00
QF(3):Ingestion Rate : Milk Cow Forage	Ingestion rate for milk cow forage	CONTINUOUS LINEAR(kg dry wt forage/d)
Default value used		Value / Probability 6.35E+00 0.00E+00 6.77E+00 3.45E-02 6.96E+00 6.91E-02 7.10E+00 1.04E-01 7.24E+00 1.38E-01 7.35E+00 1.73E-01 7.47E+00 2.07E-01 7.57E+00 2.42E-01 7.60E+00 2.50E-01 7.67E+00 2.76E-01 7.77E+00 3.11E-01 7.87E+00 3.45E-01 7.98E+00 3.80E-01 8.08E+00 4.15E-01 8.18E+00 4.49E-01 8.31E+00 4.84E-01 8.37E+00 4.99E-01 8.42E+00 5.18E-01 8.54E+00 5.53E-01 8.67E+00 5.87E-01

		8.81E+00 6.22E-01 8.95E+00 6.56E-01 9.10E+00 6.91E-01 9.26E+00 7.25E-01 9.38E+00 7.50E-01 9.45E+00 7.60E-01 9.68E+00 7.94E-01 9.93E+00 8.29E-01 1.02E+01 8.64E-01 1.06E+01 8.98E-01 1.11E+01 9.33E-01 1.20E+01 9.67E-01 1.33E+01 9.91E-01 1.53E+01 1.00E+00
QF(4):Ingestion Rate : Layer Hen Forage	Ingestion rate for layer hen forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.19E-02 Upper Limit 2.22E-02 p 1.45E+00 q 7.92E-01
QG(1):Ingestion Rate : Beef Cattle Grain	Ingestion rate for beef cattle grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QG(2):Ingestion Rate : Poultry Grain	Ingestion rate for poultry grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 1.04E-02 Upper Limit 8.45E-02 p 1.51E+00 q 1.41E+00
QG(3):Ingestion Rate : Milk Cow Grain	Ingestion rate for milk cow grain	NORMAL(kg dry wt grain/d)
Default value used		Mean 1.71E+00 Standard Deviation 2.62E-01
QG(4):Ingestion Rate : Layer Hen Grain	Ingestion rate for layer hen grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 3.58E-02 Upper Limit 6.67E-02 p 1.43E+00 q 7.92E-01
QH(1):Ingestion Rate : Beef Cattle Hay	Ingestion rate for beef cattle hay	BETA(kg dry wt hay/d)

Default value used		Lower Limit 3.38E+00 Upper Limit 4.58E+00 p 1.99E+00 q 9.11E-01
QH(2):Ingestion Rate : Poultry Hay	Ingestion rate for poultry hay	CONSTANT(kg dry wt hay/d)
Default value used		Value 0.00E+00
QH(3):Ingestion Rate : Milk Cow Hay	Ingestion rate for milk cow hay	CONTINUOUS LINEAR(kg dry wt hay/d)
Default value used		

Value	Probability
5.12E+00	0.00E+00
5.43E+00	3.45E-02
5.57E+00	6.91E-02
5.68E+00	1.04E-01
5.79E+00	1.38E-01
5.89E+00	1.73E-01
5.98E+00	2.07E-01
6.06E+00	2.42E-01
6.08E+00	2.50E-01
6.14E+00	2.76E-01
6.22E+00	3.11E-01
6.30E+00	3.45E-01
6.38E+00	3.80E-01
6.46E+00	4.15E-01
6.54E+00	4.49E-01
6.63E+00	4.84E-01
6.67E+00	4.99E-01
6.72E+00	5.18E-01
6.81E+00	5.53E-01
6.92E+00	5.87E-01
7.03E+00	6.22E-01
7.13E+00	6.56E-01
7.26E+00	6.91E-01
7.39E+00	7.25E-01
7.49E+00	7.50E-01
7.56E+00	7.60E-01
7.70E+00	7.94E-01
7.89E+00	8.29E-01
8.11E+00	8.64E-01
8.39E+00	8.98E-01
8.75E+00	9.33E-01
9.44E+00	9.67E-01
1.05E+01	9.91E-01
1.27E+01	1.00E+00

QH(4):Ingestion Rate :	Ingestion rate for layer hen hay	CONSTANT(kg dry wt hay/d)

Layer Hen Hay		
Default value used		Value 0.00E+00
QW(1):Water Rate : Beef Cattle	Water ingestion rate for beef cattle	CONSTANT(L/d)
Default value used		Value 5.00E+01
QW(2):Water Rate : Poultry	Water ingestion rate for poultry	CONSTANT(L/d)
Default value used		Value 3.00E-01
QW(3):Water Rate : Milk Cows	Water ingestion rate for milk cows	CONSTANT(L/d)
Default value used		Value 6.00E+01
QW(4):Water Rate : Layer Hens	Water ingestion rate for layer hens	CONSTANT(L/d)
Default value used		Value 3.00E-01
QD(1):Soil Fraction : Beef Cattle	Soil intake fraction for beef cattle	CONSTANT(none)
Default value used		Value 2.00E-02
QD(2):Soil Fraction : Poultry	Soil intake fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
QD(3):Soil Fraction : Milk Cows	Soil intake fraction for milk cows	CONSTANT(none)
Default value used		Value 2.00E-02
QD(4):Soil Fraction : Layer Hens	Soil intake fraction for layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(1):Mass-Loading : Leafy Vegetables	Mass-loading factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(2):Mass-Loading : Other Vegetables	Mass-loading factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(3):Mass-Loading : Fruits	Mass-loading factor for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(4):Mass-Loading : Grains	Mass-loading factor for grains	CONSTANT(none)

Default value used		Value 1.00E-01
LAMBDW:Weathering Rate	Weathering rate for activity removal from plants	CONSTANT(1/d)
Default value used		Value 4.95E-02
MLF(1):Mass-Loading : Beef Cow Forage	Mass-loading factor for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(2):Mass-Loading : Poultry Forage	Mass-loading factor for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(3):Mass-Loading : Milk Cow Forage	Mass-loading factor for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(4):Mass-Loading : Layer Hen Forage	Mass-loading factor for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(1):Mass-Loading : Beef Cattle Grain	Mass-loading factor for beef cattle grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(2):Mass-Loading : Poultry Grain	Mass-loading factor for poultry grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(3):Mass-Loading : Milk Cow Grain	Mass-loading factor for milk cow grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(4):Mass-Loading : Layer Hen Grain	Mass-loading factor for layer hen grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(1):Mass-Loading : Beef Cattle Hay	Mass-loading factor for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(2):Mass-Loading : Poultry Hay	Mass-loading factor for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(3):Mass-Loading : Milk Cow Hay	Mass-loading factor for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01

MLH(4):Mass-Loading : Layer Hen Hay	Mass-loading factor for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
TFF(1):Feeding Period : Beef Cow Forage	Feeding period for beef cattle forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(2):Feeding Period : Poultry Forage	Feeding period for poultry forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(3):Feeding Period : Milk Cow Forage	Feeding period for milk cow forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(4):Feeding Period : Layer Hen Forage	Feeding period for layer hen forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(1):Feeding Period : Beef Cattle Grain	Feeding period for beef cattle grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(2):Feeding Period : Poultry Grain	Feeding period for poultry grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(3):Feeding Period : Milk Cow Grain	Feeding period for milk cow grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(4):Feeding Period : Layer Hen Grain	Feeding period for layer hen grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(1):Feeding Period : Beef Cattle Hay	Feeding period for beef cattle hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(2):Feeding Period : Poultry Hay	Feeding period for poultry hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(3):Feeding Period : Milk Cow Hay	Feeding period for milk cow hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(4):Feeding Period : Layer Hen Hay	Feeding period for layer hen hay	CONSTANT(days)

Default value used		Value 3.65E+02
TFW(1):Water Period : Beef Cattle	Water ingestion period for beef cattle	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(2):Water Period : Poultry	Water ingestion period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(3):Water Period : Milk Cows	Water ingestion period for milk cows	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(4):Water Period : Layer Hens	Water ingestion period for layer hens	CONSTANT(days)
Default value used		Value 3.65E+02
fha(1):Hydrogen Fraction : Beef Cattle	Hydrogen fraction for beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
fha(2):Hydrogen Fraction : Poultry	Hydrogen fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
fha(3):Hydrogen Fraction : Milk Cows	Hydrogen fraction for milk cows	CONSTANT(none)
Default value used		Value 1.10E-01
fha(4):Hydrogen Fraction : Eggs	Hydrogen fraction for eggs	CONSTANT(none)
Default value used		Value 1.10E-01
fhv(1):Hydrogen Fraction : Leafy Vegetables	Hydrogen fraction for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(2):Hydrogen Fraction : Other Vegetables	Hydrogen fraction for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(3):Hydrogen Fraction : Fruits	Hydrogen fraction for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(4):Hydrogen Fraction : Grains	Hydrogen fraction for grains	CONSTANT(none)
Default value used		Value 6.80E-02

fhf(1):Hydrogen Fraction : Beef Cow Forage	Hydrogen fraction for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(2):Hydrogen Fraction : Poultry Forage	Hydrogen fraction for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(3):Hydrogen Fraction : Milk Cow Forage	Hydrogen fraction for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(4):Hydrogen Fraction : Layer Hen Forage	Hydrogen fraction for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(1):Hydrogen Fraction : Beef Cattle Hay	Hydrogen fraction for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(2):Hydrogen Fraction : Poultry Hay	Hydrogen fraction for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(3):Hydrogen Fraction : Milk Cow Hay	Hydrogen fraction for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(4):Hydrogen Fraction : Layer Hen Hay	Hydrogen fraction for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhg(1):Hydrogen Fraction : Beef Cattle Grain	Hydrogen fraction for beef cattle grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(2):Hydrogen Fraction : Poultry Grain	Hydrogen fraction for poultry grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(3):Hydrogen Fraction : Milk Cow Grain	Hydrogen fraction for milk cow grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(4):Hydrogen Fraction : Layer Hen Grain	Hydrogen fraction for layer hen grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhd016:Hydrogen Fraction : Soil	Fraction of hydrogen in soil	DERIVED(none)

Default value used		
sasvh:Tritium Equivalence: Plant/Soil	Tritium equivalence: plant/soil	CONSTANT(none)
Default value used		Value 1.00E+00
sawvh:Tritium Equivalence: Plant/Water	Tritium equivalence: plant/water	CONSTANT(none)
Default value used		Value 1.00E+00
satah:Tritium Equivalence: Animal Products	Tritium equivalence: animal product intake	CONSTANT(none)
Default value used		Value 1.00E+00
YA(1):Animal Product Yield : Beef Cattle	Annual yield of beef per individual animal	CONSTANT(kg/y)
Default value used		Value 2.09E+02
YA(2):Animal Product Yield : Poultry	Annual yield of chicken per individual animal	CONSTANT(kg/y)
Default value used		Value 1.53E+00
YA(3):Animal Product Yield : Milk Cows	Annual yield of milk per individual animal	CONSTANT(L/y)
Default value used		Value 7.41E+03
YA(4):Animal Product Yield : Layer Hens	Annual yield of eggs per individual animal	CONSTANT(kg/y)
Default value used		Value 1.26E+01
ARExt:External Exposure Area	Minimum surface area to which resident is exposed via external radiation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARInh:Inhalation Exposure Area	Minimum surface area to which resident is exposed via inhalation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARIng:Secondary Ingestion Exposure Area	Minimum surface area to which resident is exposed via secondary ingestion during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARAgr:Agricultural Exposure Area	Minimum surface area to which resident is exposed via any agricultural product during residential period	DERIVED(m**2)
Default value used		
ARH2O:Groundwater	Minimum surface area to which	DERIVED(m**2)

Exposure Area	resident is exposed via groundwater during residential period	
Default value used		
ARAll:Exposure Area	Minimum surface area to which resident is exposed via any pathway during the residential period	DERIVED(m**2)
Default value used		

Element Dependant Parameters

Parameter Name	Description	Distribution	
Cl:Coefficient	Partition coefficient for Cl	NORMAL(Log10(mL/g))	
Default value used		Mean	7.00E-01
		Standard Deviation	1.40E+00
Ca:Coefficient	Partition coefficient for Ca	NORMAL(Log10(mL/g))	
Default value used		Mean	3.17E+00
		Standard Deviation	1.40E+00
Mn:Coefficient	Partition coefficient for Mn	CONTINUOUS LINEAR(Log10(mL/g))	
Default value used			
		Value	Probability
		8.81E-01	0.00E+00
		1.00E+00	1.03E-02
		1.10E+00	3.44E-02
		1.18E+00	6.71E-02
		1.24E+00	9.98E-02
		1.30E+00	1.33E-01
		1.36E+00	1.65E-01
		1.41E+00	1.98E-01
		1.46E+00	2.31E-01
		1.51E+00	2.63E-01
		1.57E+00	2.96E-01
		1.62E+00	3.29E-01
		1.67E+00	3.61E-01
		1.73E+00	3.94E-01
		1.79E+00	4.27E-01
		1.85E+00	4.60E-01
		1.91E+00	4.92E-01
		1.93E+00	5.01E-01
		1.98E+00	5.25E-01

		2.05E+00	5.58E-01
		2.13E+00	5.90E-01
		2.21E+00	6.23E-01
		2.30E+00	6.56E-01
		2.40E+00	6.88E-01
		2.51E+00	7.21E-01
		2.64E+00	7.54E-01
		2.79E+00	7.87E-01
		2.96E+00	8.19E-01
		3.17E+00	8.52E-01
		3.43E+00	8.85E-01
		3.83E+00	9.17E-01
		4.43E+00	9.50E-01
		5.03E+00	9.69E-01
		5.87E+00	9.83E-01
		6.91E+00	9.91E-01
		1.04E+01	1.00E+00
Zn:Coefficient	Partition coefficient for Zn	NORMAL(Log10(mL/g))	
Default value used		Mean	3.03E+00
		Standard Deviation	1.93E+00
Se:Coefficient	Partition coefficient for Se	NORMAL(Log10(mL/g))	
Default value used		Mean	2.06E+00
		Standard Deviation	2.50E-01
Zr:Coefficient	Partition coefficient for Zr	NORMAL(Log10(mL/g))	
Default value used		Mean	3.38E+00
		Standard Deviation	1.40E+00
Nb:Coefficient	Partition coefficient for Nb	NORMAL(Log10(mL/g))	
Default value used		Mean	2.80E+00
		Standard Deviation	1.40E+00
Mo:Coefficient	Partition coefficient for Mo	NORMAL(Log10(mL/g))	
Default value used		Mean	1.42E+00
		Standard Deviation	7.50E-01
Sn:Coefficient	Partition coefficient for Sn	NORMAL(Log10(mL/g))	
Default value used		Mean	2.70E+00
		Standard Deviation	1.40E+00
I:Coefficient	Partition coefficient for I	NORMAL(Log10(mL/g))	
Default value used		Mean	6.60E-01
		Standard Deviation	9.50E-01
Cs:Coefficient	Partition coefficient for Cs	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.01E+00

Sm:Coefficient	Partition coefficient for Sm	NORMAL(Log10(mL/g))
Default value used		Mean 2.97E+00 Standard Deviation 1.40E+00
Ho:Coefficient	Partition coefficient for Ho	NORMAL(Log10(mL/g))
Default value used		Mean 2.97E+00 Standard Deviation 1.40E+00
Tl:Coefficient	Partition coefficient for Tl	NORMAL(Log10(mL/g))
Default value used		Mean 2.20E+00 Standard Deviation 1.40E+00
Pb:Coefficient	Partition coefficient for Pb	NORMAL(Log10(mL/g))
Default value used		Mean 3.38E+00 Standard Deviation 1.20E+00
Bi:Coefficient	Partition coefficient for Bi	NORMAL(Log10(mL/g))
Default value used		Mean 2.65E+00 Standard Deviation 1.40E+00
Po:Coefficient	Partition coefficient for Po	NORMAL(Log10(mL/g))
Default value used		Mean 2.26E+00 Standard Deviation 7.30E-01
Ra:Coefficient	Partition coefficient for Ra	NORMAL(Log10(mL/g))
Default value used		Mean 3.55E+00 Standard Deviation 7.40E-01
Ac:Coefficient	Partition coefficient for Ac	NORMAL(Log10(mL/g))
Default value used		Mean 3.24E+00 Standard Deviation 1.40E+00
Th:Coefficient	Partition coefficient for Th	NORMAL(Log10(mL/g))
Default value used		Mean 3.77E+00 Standard Deviation 1.57E+00
U:Coefficient	Partition coefficient for U	NORMAL(Log10(mL/g))
Default value used		Mean 2.10E+00 Standard Deviation 1.36E+00
Cl:Leafy	Leafy plant concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Leafy	Leafy plant concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) 1.25E+00 Standard Deviation of Ln 9.04E-01
Mn:Leafy	Leafy plant concentration factor for Mn	LOGNORMAL-N(pCi/kg dry-wt leafy per

		pCi/kg soil)
Default value used		Mean of Ln(X) -1.11E+00 Standard Deviation of Ln 2.03E+00
Zn:Leafy	Leafy plant concentration factor for Zn	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.45E-01 Standard Deviation of Ln 9.56E-01
Se:Leafy	Leafy plant concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Leafy	Leafy plant concentration factor for Zr	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -2.63E+00 Standard Deviation of Ln 6.93E-01
Nb:Leafy	Leafy plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.91E+00 Standard Deviation of Ln 9.04E-01
Mo:Leafy	Leafy plant concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) 7.88E-01 Standard Deviation of Ln 1.19E+00
Sn:Leafy	Leafy plant concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.51E+00 Standard Deviation of Ln 9.04E-01
I:Leafy	Leafy plant concentration factor for I	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -1.83E+00 Standard Deviation of Ln 1.25E+00
Cs:Leafy	Leafy plant concentration factor for Cs	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.19E+00 Standard Deviation of Ln 1.25E+00
Sm:Leafy	Leafy plant concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Ho:Leafy	Leafy plant concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01

Tl:Leafy	Leafy plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Pb:Leafy	Leafy plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.10E+00 Standard Deviation of Ln 9.04E-01
Bi:Leafy	Leafy plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.35E+00 Standard Deviation of Ln 9.04E-01
Po:Leafy	Leafy plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.99E+00 Standard Deviation of Ln 9.04E-01
Ra:Leafy	Leafy plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 9.04E-01
Ac:Leafy	Leafy plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.65E+00 Standard Deviation of Ln 9.04E-01
Th:Leafy	Leafy plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -7.07E+00 Standard Deviation of Ln 9.04E-01
U:Leafy	Leafy plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.77E+00 Standard Deviation of Ln 9.04E-01
Cl:Root	Root plant concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Root	Root plant concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Mn:Root	Root plant concentration factor for Mn	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -2.12E+00

		Standard Deviation of Ln 1.59E+00
Zn:Root	Root plant concentration factor for Zn	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -2.21E+00 Standard Deviation of Ln 1.36E+00
Se:Root	Root plant concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Root	Root plant concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00
Nb:Root	Root plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Root	Root plant concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Root	Root plant concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Root	Root plant concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Root	Root plant concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Root	Root plant concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Root	Root plant concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Root	Root plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)

Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Root	Root plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Root	Root plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Root	Root plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Root	Root plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Root	Root plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Root	Root plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Root	Root plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Fruit	Fruit concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Fruit	Fruit concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Mn:Fruit	Fruit concentration factor for Mn	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -2.12E+00 Standard Deviation of Ln 1.59E+00
Zn:Fruit	Fruit concentration factor for Zn	LOGNORMAL-N(pCi/kg wet-wt fruit per

		pCi/kg soil)
Default value used		Mean of Ln(X) -2.21E+00 Standard Deviation of Ln 1.36E+00
Se:Fruit	Fruit concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Fruit	Fruit concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00
Nb:Fruit	Fruit concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Fruit	Fruit concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Fruit	Fruit concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Fruit	Fruit concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Fruit	Fruit concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Fruit	Fruit concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Fruit	Fruit concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Fruit	Fruit concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01

Pb:Fruit	Fruit concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Fruit	Fruit concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Fruit	Fruit concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Fruit	Fruit concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Fruit	Fruit concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Fruit	Fruit concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Fruit	Fruit concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Grain	Grain concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Grain	Grain concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Mn:Grain	Grain concentration factor for Mn	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -2.12E+00 Standard Deviation of Ln 1.59E+00
Zn:Grain	Grain concentration factor for Zn	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -2.21E+00

		Standard Deviation of Ln 1.36E+00
Se:Grain	Grain concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Grain	Grain concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00
Nb:Grain	Grain concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Grain	Grain concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Grain	Grain concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Grain	Grain concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Grain	Grain concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Grain	Grain concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Grain	Grain concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Grain	Grain concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Grain	Grain concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)

Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Grain	Grain concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Grain	Grain concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Grain	Grain concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Grain	Grain concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Grain	Grain concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Grain	Grain concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Beef	Beef transfer factor for Cl	CONSTANT(d/kg)
Default value used		Value 8.00E-02
Ca:Beef	Beef transfer factor for Ca	CONSTANT(d/kg)
Default value used		Value 7.00E-04
Mn:Beef	Beef transfer factor for Mn	CONSTANT(d/kg)
Default value used		Value 4.00E-04
Zn:Beef	Beef transfer factor for Zn	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Se:Beef	Beef transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 1.50E-02
Zr:Beef	Beef transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 5.50E-03
Nb:Beef	Beef transfer factor for Nb	CONSTANT(d/kg)

Default value used		Value 2.50E-01
Mo:Beef	Beef transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 6.00E-03
Sn:Beef	Beef transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 8.00E-02
I:Beef	Beef transfer factor for I	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Cs:Beef	Beef transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 2.00E-02
Sm:Beef	Beef transfer factor for Sm	CONSTANT(d/kg)
Default value used		Value 5.00E-03
Ho:Beef	Beef transfer factor for Ho	CONSTANT(d/kg)
Default value used		Value 4.50E-03
Tl:Beef	Beef transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 4.00E-02
Pb:Beef	Beef transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Bi:Beef	Beef transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 4.00E-04
Po:Beef	Beef transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Ra:Beef	Beef transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 2.50E-04
Ac:Beef	Beef transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 2.50E-05
Th:Beef	Beef transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 6.00E-06
U:Beef	Beef transfer factor for U	CONSTANT(d/kg)
Default value used		Value 2.00E-04
Cl:Poultry	Poultry transfer factor for Cl	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Ca:Poultry	Poultry transfer factor for Ca	CONSTANT(d/kg)
Default value used		Value 4.40E-02
Mn:Poultry	Poultry transfer factor for Mn	CONSTANT(d/kg)

Default value used		Value 5.00E-02
Zn:Poultry	Poultry transfer factor for Zn	CONSTANT(d/kg)
Default value used		Value 6.50E+00
Se:Poultry	Poultry transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 8.50E+00
Zr:Poultry	Poultry transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 6.40E-05
Nb:Poultry	Poultry transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 3.10E-04
Mo:Poultry	Poultry transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 1.90E-01
Sn:Poultry	Poultry transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 2.00E-01
I:Poultry	Poultry transfer factor for I	CONSTANT(d/kg)
Default value used		Value 1.80E-02
Cs:Poultry	Poultry transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.40E+00
Sm:Poultry	Poultry transfer factor for Sm	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Ho:Poultry	Poultry transfer factor for Ho	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Tl:Poultry	Poultry transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 3.00E-01
Pb:Poultry	Poultry transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 2.00E-01
Bi:Poultry	Poultry transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Po:Poultry	Poultry transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 9.00E-01
Ra:Poultry	Poultry transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Ac:Poultry	Poultry transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Th:Poultry	Poultry transfer factor for Th	CONSTANT(d/kg)

Default value used		Value 4.00E-03
U:Poultry	Poultry transfer factor for U	CONSTANT(d/kg)
Default value used		Value 1.20E+00
Cl:Milk	Milk transfer factor for Cl	CONSTANT(d/L)
Default value used		Value 1.50E-02
Ca:Milk	Milk transfer factor for Ca	CONSTANT(d/L)
Default value used		Value 1.00E-02
Mn:Milk	Milk transfer factor for Mn	CONSTANT(d/L)
Default value used		Value 3.50E-04
Zn:Milk	Milk transfer factor for Zn	CONSTANT(d/L)
Default value used		Value 1.00E-02
Se:Milk	Milk transfer factor for Se	CONSTANT(d/L)
Default value used		Value 4.00E-03
Zr:Milk	Milk transfer factor for Zr	CONSTANT(d/L)
Default value used		Value 3.00E-05
Nb:Milk	Milk transfer factor for Nb	CONSTANT(d/L)
Default value used		Value 2.00E-02
Mo:Milk	Milk transfer factor for Mo	CONSTANT(d/L)
Default value used		Value 1.50E-03
Sn:Milk	Milk transfer factor for Sn	CONSTANT(d/L)
Default value used		Value 1.00E-03
I:Milk	Milk transfer factor for I	CONSTANT(d/L)
Default value used		Value 1.00E-02
Cs:Milk	Milk transfer factor for Cs	CONSTANT(d/L)
Default value used		Value 7.00E-03
Sm:Milk	Milk transfer factor for Sm	CONSTANT(d/L)
Default value used		Value 2.00E-05
Ho:Milk	Milk transfer factor for Ho	CONSTANT(d/L)
Default value used		Value 2.00E-05
Tl:Milk	Milk transfer factor for Tl	CONSTANT(d/L)
Default value used		Value 2.00E-03
Pb:Milk	Milk transfer factor for Pb	CONSTANT(d/L)
Default value used		Value 2.50E-04
Bi:Milk	Milk transfer factor for Bi	CONSTANT(d/L)

Default value used		Value 5.00E-04
Po:Milk	Milk transfer factor for Po	CONSTANT(d/L)
Default value used		Value 3.50E-04
Ra:Milk	Milk transfer factor for Ra	CONSTANT(d/L)
Default value used		Value 4.50E-04
Ac:Milk	Milk transfer factor for Ac	CONSTANT(d/L)
Default value used		Value 2.00E-05
Th:Milk	Milk transfer factor for Th	CONSTANT(d/L)
Default value used		Value 5.00E-06
U:Milk	Milk transfer factor for U	CONSTANT(d/L)
Default value used		Value 6.00E-04
Cl:Eggs	Egg transfer factor for Cl	CONSTANT(d/kg)
Default value used		Value 2.00E+00
Ca:Eggs	Egg transfer factor for Ca	CONSTANT(d/kg)
Default value used		Value 4.40E-01
Mn:Eggs	Egg transfer factor for Mn	CONSTANT(d/kg)
Default value used		Value 6.50E-02
Zn:Eggs	Egg transfer factor for Zn	CONSTANT(d/kg)
Default value used		Value 2.60E+00
Se:Eggs	Egg transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 9.30E+00
Zr:Eggs	Egg transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 1.90E-04
Nb:Eggs	Egg transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 1.30E-03
Mo:Eggs	Egg transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 7.80E-01
Sn:Eggs	Egg transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 8.00E-01
I:Eggs	Egg transfer factor for I	CONSTANT(d/kg)
Default value used		Value 2.80E+00
Cs:Eggs	Egg transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.90E-01
Sm:Eggs	Egg transfer factor for Sm	CONSTANT(d/kg)

Default value used		Value	7.00E-03
Ho:Eggs	Egg transfer factor for Ho	CONSTANT(d/kg)	
Default value used		Value	7.00E-03
Tl:Eggs	Egg transfer factor for Tl	CONSTANT(d/kg)	
Default value used		Value	8.00E-01
Pb:Eggs	Egg transfer factor for Pb	CONSTANT(d/kg)	
Default value used		Value	8.00E-01
Bi:Eggs	Egg transfer factor for Bi	CONSTANT(d/kg)	
Default value used		Value	8.00E-01
Po:Eggs	Egg transfer factor for Po	CONSTANT(d/kg)	
Default value used		Value	7.00E+00
Ra:Eggs	Egg transfer factor for Ra	CONSTANT(d/kg)	
Default value used		Value	2.00E-05
Ac:Eggs	Egg transfer factor for Ac	CONSTANT(d/kg)	
Default value used		Value	2.00E-03
Th:Eggs	Egg transfer factor for Th	CONSTANT(d/kg)	
Default value used		Value	2.00E-03
U:Eggs	Egg transfer factor for U	CONSTANT(d/kg)	
Default value used		Value	9.90E-01
Cl:Factor	Bioaccumulation factor for Cl in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)	
Default value used		Value	5.00E+01
Ca:Factor	Bioaccumulation factor for Ca in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)	
Default value used		Value	4.00E+01
Mn:Factor	Bioaccumulation factor for Mn in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)	
Default value used		Value	4.00E+02
Zn:Factor	Bioaccumulation factor for Zn in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)	
Default value used		Value	2.50E+03
Se:Factor	Bioaccumulation factor for Se in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)	
Default value used		Value	1.70E+02
Zr:Factor	Bioaccumulation factor for Zr in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)	
Default value used		Value	2.00E+02

Nb:Factor	Bioaccumulation factor for Nb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Mo:Factor	Bioaccumulation factor for Mo in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+01
Sn:Factor	Bioaccumulation factor for Sn in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 3.00E+03
I:Factor	Bioaccumulation factor for I in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+02
Cs:Factor	Bioaccumulation factor for Cs in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03
Sm:Factor	Bioaccumulation factor for Sm in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Ho:Factor	Bioaccumulation factor for Ho in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Tl:Factor	Bioaccumulation factor for Tl in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 0.00E+00
Pb:Factor	Bioaccumulation factor for Pb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
Bi:Factor	Bioaccumulation factor for Bi in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.50E+01
Po:Factor	Bioaccumulation factor for Po in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+02
Ra:Factor	Bioaccumulation factor for Ra in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 7.00E+01
Ac:Factor	Bioaccumulation factor for Ac in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Th:Factor	Bioaccumulation factor for Th in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)

Default value used		Value	1.00E+02
U:Factor	Bioaccumulation factor for U in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)	
Default value used		Value	5.00E+01

Correlation Coefficients:

Parameter One	Parameter Two	Correlation Coefficient
KSDEV:Permeability Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		
NDEV:Porosity Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		

Summary Results:

90.00% of the 189 calculated TEDE values are < 2.24E-01 mrem/year . The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.84E-01 to 2.76E-01 mrem/year

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Concentration at Time of Peak Dose:

Nuclide	Soil Concentration (pCi/g)	Water Concentration (pCi/g)
36Cl	3.22E-03	1.23E-07
41Ca	2.92E-05	2.19E-17
54Mn	1.52E-11	1.89E-34
79Se	3.57E-06	4.04E-18
93Zr	5.86E-07	9.02E-19
93mNb	0.00E+00	2.92E-17
121mSn	2.09E-07	1.03E-21
121Sn	0.00E+00	7.98E-22

93Mo	4.83E-06	7.75E-18
129I	3.41E-09	1.85E-14
135Cs	2.27E-07	3.70E-19
151Sm	6.28E-05	1.73E-19
166mHo	9.57E-04	7.47E-17
233U	2.81E-06	1.88E-17
229Th	0.00E+00	1.73E-18
225Ra	0.00E+00	1.64E-18
225Ac	0.00E+00	1.88E-18
221Fr	0.00E+00	1.88E-18
217At	0.00E+00	1.88E-18
213Bi	0.00E+00	1.88E-18
213Po	0.00E+00	1.84E-18
209Tl	0.00E+00	4.06E-20
209Pb	0.00E+00	1.88E-18
65Zn	5.41E-16	1.09E-32

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
2.76E-01	2.72E-01	1.50E-09	2.43E-09	4.27E-03	3.53E-07	2.60E-07	1.97E-08

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
36Cl	2.72E-01
41Ca	1.33E-05
54Mn	2.64E-11
79Se	4.52E-07
93Zr	5.83E-09
93mNb	3.83E-09
121mSn	2.86E-09
121Sn	1.22E-09
93Mo	6.26E-07

129I	3.84E-08
135Cs	2.73E-08
151Sm	8.98E-08
166mHo	4.30E-03
233U	3.49E-06
229Th	2.67E-09
225Ra	2.71E-10
225Ac	7.56E-11
221Fr	7.71E-12
217At	8.40E-14
213Bi	3.71E-11
213Po	0.00E+00
209Tl	1.22E-11
209Pb	1.78E-13
65Zn	1.47E-15
All Nuclides	2.76E-01

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
36Cl	2.72E-01	1.73E-10	1.81E-10	3.61E-06	2.09E-08	1.38E-07	1.02E-08
41Ca	1.33E-05	1.29E-20	1.06E-20	0.00E+00	1.16E-11	5.27E-10	1.28E-19
54Mn	3.51E-12	2.42E-37	2.07E-36	2.29E-11	2.17E-17	4.09E-16	4.22E-37
79Se	4.51E-07	1.62E-20	6.42E-20	3.24E-11	1.04E-11	4.39E-10	1.10E-19
93Zr	5.79E-09	6.90E-22	3.08E-21	0.00E+00	5.55E-11	1.38E-11	1.52E-21
93mNb	3.71E-09	7.05E-21	3.15E-20	6.78E-12	1.10E-12	1.00E-12	2.40E-19
121mSn	2.66E-09	7.36E-25	5.10E-23	2.00E-10	7.08E-13	4.57E-12	6.23E-24
121Sn	1.20E-09	3.33E-25	2.31E-23	1.53E-11	2.42E-14	2.05E-12	2.82E-24
93Mo	6.24E-07	4.82E-21	1.04E-21	1.39E-09	4.05E-11	9.20E-11	1.17E-20
129I	3.59E-08	2.35E-15	2.48E-14	2.16E-11	1.75E-13	1.33E-11	1.52E-14
135Cs	2.73E-08	1.21E-21	5.04E-20	4.24E-12	3.05E-13	2.27E-11	8.25E-21
151Sm	8.90E-08	3.10E-23	1.76E-23	3.00E-11	5.54E-10	3.44E-10	1.00E-22
166mHo	2.76E-05	2.78E-19	1.57E-19	4.27E-03	2.19E-07	1.09E-07	6.64E-19
233U	3.42E-06	2.51E-18	2.95E-18	1.85E-09	1.12E-07	1.15E-08	5.13E-18
229Th	2.61E-09	2.82E-18	6.28E-18	2.03E-11	7.92E-11	6.63E-12	4.84E-18

225Ra	2.69E-10	2.91E-19	4.69E-19	6.26E-13	2.54E-13	6.43E-13	5.48E-19
225Ac	7.14E-11	9.63E-20	5.75E-20	3.27E-12	3.21E-13	1.71E-13	1.54E-19
221Fr	0.00E+00	0.00E+00	0.00E+00	7.71E-12	0.00E+00	0.00E+00	0.00E+00
217At	0.00E+00	0.00E+00	0.00E+00	8.40E-14	0.00E+00	0.00E+00	0.00E+00
213Bi	4.64E-13	6.26E-22	3.74E-22	3.66E-11	5.09E-16	1.11E-15	9.99E-22
213Po	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	0.00E+00	0.00E+00	0.00E+00	1.22E-11	0.00E+00	0.00E+00	0.00E+00
209Pb	1.37E-13	1.85E-22	1.10E-22	3.98E-14	2.82E-18	3.27E-16	2.94E-22
65Zn	8.83E-16	7.26E-35	4.16E-33	5.19E-16	2.18E-21	6.88E-20	4.68E-34

Technical Based Document

NSEF-08-0022

Detroit Edison

Enrico Fermi Unit 1

Instrument Efficiency Determination for Use in Minimum Detectable Concentration Calculations

Martin C. Erickson

Revision 1
September 09, 2009

Approved by: K. D. Lindsey /s/ Date: September 2009
EF1 Health Physicist

Table of Contents

Tables

Appendices

1.0 Executive Summary

The Minimum Detectable Concentration (MDC) of the field survey instrumentation is an important factor affecting the quality of the Final Status Survey (FSS). The efficiency of an instrument inversely impacts the MDC value therefore affecting the validity of the data gathered. The objective of this document is to determine the instrument and source efficiency values used to calculate MDC.

The conventional process of determining the activity of a measurement is to use the 4π detector efficiency. While in an ideal setting this methodology would be appropriate, the field setting yields variable conditions that would tend to confound the data acquired. In order for the measurements to be representative of the field conditions present, the ISO-7503-1 approach is employed i.e. the 4π efficiency is divided into two components (the source efficiency and the instrument efficiency) generating a total efficiency indicative of the actual conditions encountered.

An additional purpose of this document is to determine the instrument conversion factors associated with the gamma scanning to be applied in the MDC calculations for these evolutions.

Instrument efficiencies e_i and source efficiencies e_s for alpha beta detection equipment under various field conditions, and instrument conversion factors (Ei), for gamma scanning detectors were determined and the results are provided herein.

2.0 Introduction

Before performing Final Status Surveys of building surfaces and land areas, the MDC must be calculated to establish the instrument sensitivity. One purpose of this basis document is to determine the efficiencies for the 100cm^2 gas proportional and the 2"x2" NaI (TI) detectors. Efficiencies for the other instrumentation, not covered in this basis document will be determined on an as needed basis. The 100 cm^2 gas proportional probe will be used to perform fixed-point measurements. A 2" x2" NaI (TI) detector will be used to perform gamma surveys (i.e., surface scans) of portions of land areas and supplemental structural scans as well as assessing the radiological conditions of systems. Although surface scans and fixed point measurements can be performed using the same instrumentation, the calculated MDCs will be quite different. MDC is dependent on many factors and may include but is not limited to:

- instrument efficiency
- background
- integration time
- surface type
- source to detector geometry
- source efficiency

A significant factor in determining an instrument MDC is the total efficiency, which is dependent on the instrument efficiency, the source efficiency and the type and energy of the radiation. MDC values are inversely affected by efficiency; as efficiencies increase, MDC values will decrease. Accounting for both the instrument and source components of the total efficiency provides for a more accurate assessment of surface activity present in the field.

3.0 Calibration Sources

For accurate measurement of surface activity it is desirable that the field instrumentation be calibrated with source standards similar to the type and energy of the anticipated contamination. The nuclides listed in Table 3.1 illustrate the nuclides determined to be found in soils and building surface areas at Enrico Fermi Unit 1 (EF1) as established by Technical Based Document NSEF-08-018 "Radionuclide Selection for DCGL Development". Instrument response varies with incident radiations and energies; therefore, instrumentation selection for field surveys must be modeled on the expected surface activity. For the purposes of this report, isotopes with max beta energies less than that of C-14 (0.158 MeV) will be considered difficult-to-detect (reference table 3.1). The detectability of radionuclides with max beta energies less than 0.158 MeV, utilizing gas proportional detectors, will be negligible at typical source to detector distances of approximately 1.27 cm (0.5 inches). The source to detector distance of 1.27 cm is the distance to the detector with the attached standoff. Table 3.1 provides a summary of the EF1 radionuclides and their detectability using Radiological Health Handbook data.

Table 3.1
Nuclides and Major Radiations: Approximate Energies

Nuclide	α Energy (Mev)	$E_{\beta max}$ (Mev)	Average E_β (Mev)	Photon Energy (Mev)	α Detectable w/Gas Proportional	β Detectable w/Gas Proportional	γ Detectable w/NaI 2"x2"
H-3		0.018	0.005				
C-14		0.158	0.049				
Na-22		1.393	1.393	1.369(100%) 2.754(99.9%) 3.866(.05%)		√	√
Fe-55				0.23 (.004%) bremsstrahlung			
Ni-59		1.072	1.072			√	
Co-60		0.314	0.094	1.173 (100%), 1.332 (100%)		√	√
Ni-63		0.066	0.017				
Sr-90		0.544 2.245 (Y90)	0.200 0.931			√	
Nb-94		0.50	0.156	0.702 (100%) 0.871 (100%)		√	√
Tc-99		0.295	0.085			√	
Ag-108m		1.65 (Ag-108)	0.624 (Ag-108)	0.434 (0.45%), 0.511(0.56%), 0.615 (0.18%), 0.632 (1.7%)			√
Sb-125		0.612	0.084	0.6,0.25,0.41, 0.46,0.68,0.77, 0.92,1.10,1.34		√	√
Cs-134		1.453	0.152	0.57(23%),0.605 (98%),0.796 (99%),1.038(1%) 1.168(1.9%), 1.365(3.4%)		√	√
Cs-137		1.175	0.195	0.662(85%) Ba-137m X-rays		√	√
Eu-152		1.840	0.288	0.122 (37%), 0.245(8%)0.344 (27%). 0.779 (114%)0.965(15 %),1.087(12%), 1.113(14%), 1.408(22%)		√	√
Eu-154		1.850(10%)	0.228	0.123(40%),0.72 3(20%),0.873(12 %),0.996(10%),1. 004(18%),1.274(35%)		√	√
Eu-155		0.247	0.044	0.087(32%) 0.105(20%)		√	
Pu-238	5.50(72%) 5.46(28%)			0.099(8E-3%) 0.150(1E-3%) 0.77(5E-5%)	√		
Pu239	5.16(88%) 5.11(11%)			0.039(.007%) 0.052(0.20%) 0.129(.005%)	√		
Pu-240	5.168(73%) 5.124(27%)				√		
Pu-241	4.90	0.021	0.005	0.145(1.6E-4%)			

Nuclide	α Energy (Mev)	$E_{\beta max}$ (Mev)	Average E_β (Mev)	Photon Energy (Mev)	α Detectable w/Gas Proportional	β Detectable w/Gas Proportional	γ Detectable w/NaI 2"x2"
	(.0019%) 4.85 (.0003%)						
Am241	5.49(85%) 5.44(13%)			0.060(36%) 0.101(0.04%)	√		
Cm-242	6.113(74%) 6.069(25%)				√		
Cm-243	6.06(6%) 5.99(6%) 5.79(73%) 5.74(11.5%)			0.209(4%) 0.228(12%) 0.278(14%)	√		

NUREG-1507 and ISO 7503-1 provide guidance for selecting calibration sources and their use in determining total efficiency. It is common practice to calibrate instrument efficiency for a single beta energy; however the energy of this reference source should not be significantly greater than the beta energy of the lowest energy to be measured.

Tc-99 (0.295 MeV max) and Th-230 (4.68 MeV at 76% and 4.62 MeV at 24%) have been selected as the beta and alpha calibration standards respectively, because their energies conservatively approximate the beta and alpha energies of the plant specific radionuclides.

4.0 Efficiency Determination

Typically, using the instrument 4π efficiency exclusively provides a good approximation of surface activity. However, using these means for calculating the efficiency often results in under estimation of activity levels in the field. Applying both the instrument 2π efficiency and the source efficiency components to determine the total efficiency allows for a more accurate measurement due to consideration of the actual characteristics of the source surfaces. ISO 7503-1 recommends that the total surface activity be calculated using:

$$A_S = \frac{R_{S+B} - R_B}{(e_i)(e_s)(W)}$$

where:
A_S is the total surface activity in dpm/cm^2,
R_{S+B} is the gross count rate of the measurement in cpm,
R_B is the background count rate in cpm,
e_i is the instrument or detector 2π efficiency
e_s is the efficiency of the source
W is the area of the detector window (cm^2)

Note that both the 2π surface emission rate and the source activity are usually stated on the certification sheet provided by the calibration source manufacturer and certified as National Institute of Standards and Technology (NIST) traceable. Table 4.1 depicts the average instrument efficiencies that have been determined during calibration using the 2π surface emission rate of the source.

Table 4.1
Instrument Efficiencies (e_i)

Source	Emission	Active Area of Source (cm^2)	Effective Area of Detector	100 cm^2 Gas Proportional e_i
Tc-99	β	15.2	100 cm^2	0.2662
Th-230	α	15.2	100 cm^2	0.2240

4.2 Source to Detector Distance Considerations

A major factor affecting instrument efficiency is source to detector distance. Consideration must be given to this distance when selecting accurate instrument efficiency. The distance from the source to the detector shall be as close as practicable to geometric conditions that exist in the field. A range of source to detector distances has been chosen, taking into account site specific survey conditions. In an effort to minimize the error associated with geometry, instrument efficiency correction factors have been determined for source to detector distances representative of those survey distances expected in the field. The results shown in Table 4.2 illustrate the imposing reduction in detector response with increased distance from the source as determined by empirical data referenced in NUREG-1507. Typically this source to detector distance will be 0.5 inches for fixed point measurements and 0.5 inches for scan surveys on flat surfaces, however they may differ for other surfaces. Table 4.2 makes provisions for the selection of source to detector distances for field survey conditions of up to 2 inches. If surface conditions dictate the placement of the detector at distances greater than 2 inches, instrument efficiencies will be determined on an as needed basis.

4.2.1 Methodology

The practical application of choosing the proper instrument efficiency may be determined by averaging the surface variation (peaks and valleys narrower than the length of the detector) and adding 0.5 inches, the spacing that should be maintained between the detector and the highest peaks of the surface. Select the source to detector distance from Table 4.2 that best reflects this pre-determined geometry.

Table 4.2
Source to Detector Distance Effects on
Instrument Efficiencies for α β Emitters

Source to Detector Distance (cm)	Instrument Efficiency e_i	
	Tc-99 Distributed	Th-230 Distributed
Contact	(1)(2π eff)	(1) (2π eff)
1.27 (0.5 in.)	(0.803) (2π eff)	(0.761) (2π eff)
2.54 (1 in.)	(0.701) (2π eff)	(0.579) (2π eff)
5.08 (2 in.)	(0.503) (2π eff)	(0.099) (2π eff)

4.3 Source (or Surface) Efficiency (e_s) Determination

Source efficiency (e_s), reflects the physical characteristics of the surface and any surface coatings. The source efficiency is the ratio between the number of particles emerging from surface and the total of particles released within the source. The source efficiency accounts for attenuation and backscatter. e_s, is nominally 0.5 (no self-absorption/attenuation, no backscatter) backscatter increases the value, self-absorption decreases the value. Source efficiencies may either be derived empirically or simply selected from the guidance contained in IS0 7503-1. IS0 7503-1 takes a conservative approach by recommending the use of factors to correct for alpha and beta self-absorption/attenuation when determining surface activity. However, this approach may prove to be too conservative for radionuclides with max beta energies that are marginally lower than 0.400 MeV, such as Co-60 with a β_{max} of 0.3 14 MeV. In this situation, it may be more appropriate to determine the source efficiency by considering the energies of other beta emitting radionuclides. Using this approach it is possible to determine weighted average source efficiency. For example, a source efficiency of 0.375 may be calculated based on a 50/50 mix of Co-60 and Cs-137. The source efficiencies for Co-60 and Cs-137 are 0.25 and 0.5 respectively, since the radionuclide fraction for Co-60 and Cs-137 is 50% for each, the weighted average source efficiency for the mix may be calculated in the following manner:

$$(.25)(.50) + (.50)(.50) = 0.375$$

Table 4.3 lists guidance on source efficiencies from IS0 7503-1.

Table 4.3
Source Efficiencies as listed in IS0 7503-1

	>.400 MeV_{max}	≤.400 MeV_{max}
Beta Emitters	$e_s = 0.50$	$e_s = 0.25$
Alpha Emitters	$e_s = 0.25$	$e_s = 0.25$

It should be noted that source efficiency is not typically addressed for gamma detectors as the value is effectively unity.

5.0 Applying Efficiency Corrections Based on the Effects of Field Conditions for Total Efficiency

The total efficiency for any given condition can now be calculated from the product of the instrument efficiency e_i and the source efficiency e_s.

$$e_{total} = (e_i)\,(e_s)$$

The following example illustrates the process of determining total efficiency. For this example we will assume the following:

1. Surface activity readings need to be made in the Reactor Building (RXB-01) on the concrete wall surfaces using the 2350-1 serial # 189090 and 43-68 gas proportional detector serial # PR 178074.
2. Data obtained from characterization results from the Reactor Building indicate the presence of beta emitters with the maximum energy greater than 0.400 MeV (100% Cs-137).
3. The source (activity on wall) to detector distance is 1.27 cm (0.5 in. detector stand-off). To calculate the total efficiency, e_{total}, refer to Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α/β Emitters" to obtain the appropriate correction factor.
4. Contamination on all surfaces is distributed relative to the effective detector area.
5. When performing fixed point measurements with gas proportional instrumentation the effective source to detector geometry is representative of the values listed in Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for *α/β Emitters*".
6. Corrections for temperature and pressure are not substantial.

In this example, the value for e_i is the product of 0.2622 (the 2π eff. for that inst./detector combination) and 0.803, the value depicted in Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α/β Emitters" corresponding to a 1.27 cm distance. The e_s value of 0.5 is chosen based on data obtained in Table 4.3 "Source Efficiencies as listed in ISO 7503-1". Therefore the total efficiency for this condition becomes:

$$E_{total} = (e_i)(e_s) = (0.2622)(0.803)(0.5) = 0.1053$$

6.0 Instrument Conversion Factor (E_i) (Instrument Efficiency for Scanning)

Separate modeling analysis (MicroShield®) was conducted using the common gamma emitters with a concentration of 1 pCi/g of uniformly distributed contamination throughout the volume. MicroShield® is a comprehensive photon/gamma ray shielding and dose assessment program, which is widely used throughout the radiological safety community. An activity concentration of 1 pCi/g for the nuclides was entered as the source term. The radial dimension of the cylindrical source was 28 cm, the depth was 15 cm, and the dose point above the surface was 10 cm with a soil density of 1.6 g/cm^3. The instrument efficiency when scanning, E_i is the product of the modeled exposure rate (MicroShield®) in $mRhr^{-1}/pCi/g$ and the energy response factor in cpm/mR/hr as derived from the energy response curve provided by Eberline Instruments. Table 6.1 demonstrates the derived efficiencies for the major gamma emitting isotopes listed in Table 3.1.

Table 6.1
Efficiency for Photon Emitting Isotopes

Isotope	E_i (cpm/pCi/g)
Na-22	625
Co-60	379
Nb-94	415
Ag-108m	633
Sb-125	192
Cs-134	499
Cs-137	191
Eu-152	342

When performing gamma scan measurements on soil surfaces the effective source to detector geometry is as close as reasonably possible (less than 3 inches).

7.0 Conclusion

Field conditions may significantly influence the usefulness of a survey instrument. When applying the instrument and source efficiencies in MDC calculations, field conditions must be considered. Tables have been constructed to assist in the selection of appropriate instrument and source efficiencies. Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α/β Emitters" lists correction factors for determining e_i at various source-to-detector distances for alpha and beta emitters. The appropriate e_i value should be applied, accounting for the field condition, e.g., the relation between the detector and the surface to be measured.

Source efficiencies should be selected from Table 4.3 "Source Efficiencies as listed in IS0 7503-1". This table lists conservative e_s values that correct for self-absorption and attenuation of surface activity. Table 5.1 "Energy Response and Efficiency for Photon Emitting Isotopes" lists E_i values that apply to scanning MDC calculations. The MicroShield® code was used to determine instrument efficiency.

Detector and source conditions equivalent to those modeled herein may directly apply to the results of this report.

8.0 References

Abelquist, E. (2001). "Decommissioning Health Physics." Institute of Physics Publishing

IS0 7503-1. (1988). "Evaluation of Surface Contamination - Part I: Beta Emitters and Alpha Emitters"

IS0 8769. (1988)."Reference Sources for the Calibration of Surface Contamination Monitors- Beta-emitters (maximum beta energy greater O.15MeV) and Alpha-emitters"

Munzer, J., Bunge, R. (1970)."Radiological Health Handbook." US Dept of Health, Education, Welfare

A. M. Huffert, et al. (1998). "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various contaminants and Field Conditions" NUREG-1507

Appendix A
MicroShield® Models and Calculations

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

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Run Date: August 27, 2008	By: ______
Run Time: 9:17:58 AM	Checked: ______
Duration : 00:00:00	

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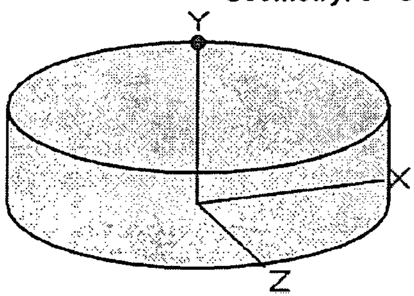
Description: SPA3 soil scan_28 cm radius 1 pCi/cm3 Na22
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Na-22	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.511	2.458e+03	6.699e-02	1.297e-01	1.315e-04	2.546e-04
1.2745	1.366e+03	1.221e-01	1.817e-01	2.141e-04	3.186e-04
TOTALS:	3.824e+03	1.890e-01	3.114e-01	3.455e-04	5.732e-04

Na22
E_i Calculation Sheet

Energy Mev	Energy kev	Exposure Rate (mR/hr/1 pCi/g)	Energy Response cpm/mR/hr	E_i (cpm/pCi/g)
0.511	511	2.55E-04	1700000	434
1.2745	1275	3.19E-04	600000	191
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
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				0
				0
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				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
			E_i Total	625

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : Case1
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Run Time : 9:36:57 AM
Duration : 00:00:00

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

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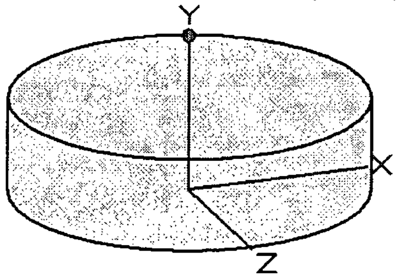
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm^3	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm^3	Bq/cm^3
Co-60	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.230e-01	9.055e-06	1.590e-05	1.748e-08	3.070e-08
1.1732	1.367e+03	1.098e-01	1.669e-01	1.962e-04	2.982e-04
1.3325	1.367e+03	1.293e-01	1.904e-01	2.244e-04	3.303e-04
TOTALS:	2.734e+03	2.391e-01	3.573e-01	4.205e-04	6.286e-04

Co-60
E_i Calculation Sheet

Energy Mev	Energy kev	Exposure Rate (mR/hr/1 pCi/g)	Energy Response cpm/mR/hr	E_i (cpm/pCi/g)
0.694	694	3.07E-08	1112600	0
1.173	1173	2.98E-04	660500	197
1.332	1332	3.30E-04	552200	182
			E_i Total	379

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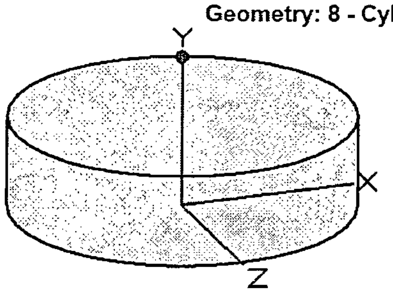
Detroit Edison Co.

Page : 1
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:06:35 AM
Duration : 00:00:00

File Ref: ____
Date: ____
By: ____
Checked: ____

Case Title: SPA3_Eff_Nb94
Description: SPA3 soil scan_28 cm radius 1 pCi/cm3 Nb94
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Nb-94	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0174	4.834e-01	8.762e-09	9.129e-09	4.729e-10	4.927e-10
0.0175	9.260e-01	1.719e-08	1.792e-08	9.104e-10	9.491e-10
0.0196	2.720e-01	7.924e-09	8.356e-09	2.925e-10	3.085e-10
0.7026	1.367e+03	5.643e-02	9.872e-02	1.088e-04	1.904e-04
0.8711	1.367e+03	7.464e-02	1.228e-01	1.405e-04	2.312e-04

Page : 2
DOS File : Case1
Run Date: August 27, 2008
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Duration : 00:00:00

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	2.736e+03	1.311e-01	2.216e-01	2.493e-04	4.216e-04

Nb94
E_i Calculation Sheet

Energy Mev	Energy kev	Exposure Rate (mR/hr/1 pCi/g)	Energy Response cpm/mR/hr	E_i (cpm/pCi/g)
0.0174	17	4.93E-10		0
0.0175	18	9.49E-10		0
0.0196	20	3.09E-10		0
0.7026	703	1.90E-04	1110400	211
0.8711	871	2.31E-04	884600	204
			E_i Total	415

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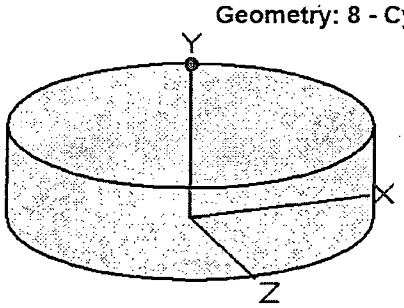
Page : 1
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:11:31 AM
Duration : 00:00:00

File Ref: ____
Date: ____
By: ____
Checked: ____

Case Title: SPA3_Eff_Ag108m
Description: SPA3 soil scan_28 cm radius 1 pCi/cm3 Ag108m
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Ag-108m	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.021	2.491e+02	9.534e-06	1.015e-05	2.824e-07	3.007e-07
0.0212	4.727e+02	1.862e-05	1.985e-05	5.389e-07	5.744e-07
0.022	7.024e+00	3.202e-07	3.434e-07	8.233e-09	8.831e-09
0.0222	1.330e+01	6.251e-07	6.714e-07	1.568e-08	1.685e-08
0.0238	1.501e+02	9.273e-06	1.010e-05	1.863e-07	2.029e-07
0.0249	4.289e+00	3.145e-07	3.464e-07	5.492e-09	6.050e-09

Page : 2
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:11:31 AM
Duration : 00:00:00

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0304	2.902e-04	4.431e-11	5.248e-11	4.230e-13	5.010e-13
0.0792	9.687e+01	2.008e-04	4.802e-04	3.190e-07	7.629e-07
0.4339	1.229e+03	2.705e-02	5.514e-02	5.294e-05	1.079e-04
0.6144	1.236e+03	4.282e-02	7.808e-02	8.347e-05	1.522e-04
0.7229	1.237e+03	5.300e-02	9.194e-02	1.019e-04	1.768e-04
TOTALS:	4.695e+03	1.231e-01	2.257e-01	2.397e-04	4.388e-04

Ag108m
E_i Calculation Sheet

Energy Mev	Energy kev	Exposure Rate (mR/hr/1 pCi/g)	Energy Response cpm/mR/hr	E_i (cpm/pCi/g)
0.021	21	3.01E-07	0	0
0.0212	21	5.74E-07	0	0
0.022	22	8.83E-09	0	0
0.0222	22	1.69E-08	0	0
0.0238	24	2.03E-07	0	0
0.0249	25	6.05E-09	0	0
0.0304	30	5.01E-13	0	0
0.0792	79	7.63E-07	10200000	8
0.4339	434	1.08E-04	2100000	227
0.6144	614	1.52E-04	1400000	213
0.7229	723	1.77E-04	1050000	186
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				0
				0
			E_i Total	633

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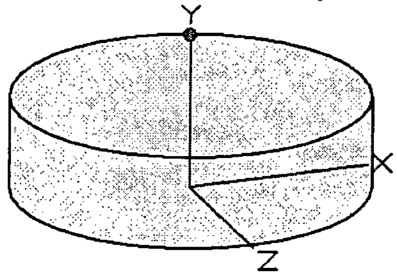
Page : 1
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:20:36 AM
Duration : 00:00:01

File Ref: ____
Date: ____
By: ____
Checked: ____

Case Title: SPA3_Eff_Sb125
Description: SPA3 soil scan_28 cm radius 1 pCi/cm3 Sb125
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Sb-125	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0272	1.748e+02	1.785e-05	2.020e-05	2.376e-07	2.689e-07
0.0275	3.262e+02	3.453e-05	3.922e-05	4.461e-07	5.067e-07
0.031	1.132e+02	1.857e-05	2.221e-05	1.670e-07	1.997e-07
0.0355	5.693e+01	1.492e-05	1.918e-05	9.090e-08	1.169e-07
0.1169	3.568e+00	1.380e-05	3.715e-05	2.146e-08	5.778e-08
0.159	9.531e-01	5.634e-06	1.499e-05	9.416e-09	2.505e-08

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DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:20:36 AM
Duration : 00:00:01

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.1726	2.478e+00	1.634e-05	4.295e-05	2.787e-08	7.326e-08
0.1763	9.422e+01	6.392e-04	1.674e-03	1.096e-06	2.870e-06
0.2041	4.410e+00	3.630e-05	9.230e-05	6.435e-08	1.636e-07
0.2081	3.324e+00	2.805e-05	7.103e-05	4.994e-08	1.264e-07
0.2279	1.796e+00	1.708e-05	4.229e-05	3.098e-08	7.670e-08
0.321	5.701e+00	8.474e-05	1.899e-04	1.620e-07	3.632e-07
0.3804	2.045e+01	3.792e-04	8.052e-04	7.364e-07	1.564e-06
0.408	2.486e+00	5.051e-05	1.049e-04	9.853e-08	2.047e-07
0.4279	4.009e+02	8.668e-03	1.774e-02	1.695e-05	3.470e-05
0.4435	4.130e+00	9.356e-05	1.894e-04	1.832e-07	3.709e-07
0.4634	1.415e+02	3.395e-03	6.781e-03	6.658e-06	1.330e-05
0.6006	2.430e+02	8.174e-03	1.501e-02	1.595e-05	2.930e-05
0.6066	6.864e+01	2.340e-03	4.283e-03	4.564e-06	8.355e-06
0.6359	1.548e+02	5.609e-03	1.012e-02	1.091e-05	1.967e-05
0.6714	2.478e+01	9.640e-04	1.710e-03	1.867e-06	3.311e-06
TOTALS:	1.848e+03	3.060e-02	5.901e-02	6.032e-05	1.156e-04

Sb125
E_i Calculation Sheet

Energy Mev	Energy kev	Exposure Rate (mR/hr/1 pCi/g)	Energy Response cpm/mR/hr	E_i (cpm/pCi/g)
0.0272	27	2.69E-07	0	0
0.0275	28	5.07E-07	0	0
0.031	31	2.00E-07	0	0
0.0355	36	1.17E-07	0	0
0.1169	117	5.78E-08	9000000	1
0.159	159	2.51E-08	7000000	0
0.1726	173	7.33E-08	6500000	0
0.1763	176	2.87E-06	6500000	19
0.2041	204	1.64E-07	5000000	1
0.2081	208	1.26E-07	500000	0
0.2279	228	7.67E-08	4800000	0
0.321	321	3.63E-07	2800000	1
0.3804	380	1.56E-06	2250000	4
0.408	408	2.05E-07	2000000	0
0.4279	428	3.47E-05	1800000	62
0.4435	444	3.71E-07	1800000	1
0.4634	463	1.33E-05	1700000	23
0.6006	601	2.93E-05	1400000	41
0.6066	607	8.36E-06	1400000	12
0.6359	636	1.97E-05	1200000	24
0.6714	671	3.31E-06	1100000	4
				0
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				0
				0
			E_i Total	192

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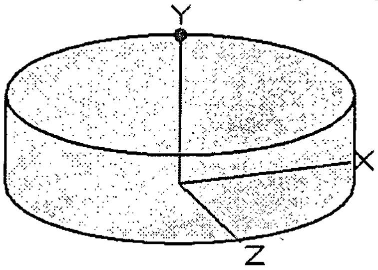
Detroit Edison Co.

Page : 1
DOS File : Case1
Run Date : August 27, 2008
Run Time: 9:25:52 AM
Duration : 00:00:00

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: SPA3_Eff_Cs134
Description: SPA3 soil scan_28 cm radius 1 pCi/cm3 Cs134
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Cs-134	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	2.931e+00	5.271e-07	6.386e-07	4.391e-09	5.320e-09
0.0322	5.407e+00	1.014e-06	1.236e-06	8.157e-09	9.943e-09
0.0364	1.968e+00	5.611e-07	7.321e-07	3.188e-09	4.160e-09
0.2769	4.839e-01	5.931e-06	1.391e-05	1.113e-08	2.610e-08
0.4753	1.996e+01	4.950e-04	9.808e-04	9.712e-07	1.924e-06
0.5632	1.146e+02	3.545e-03	6.648e-03	6.940e-06	1.302e-05

Page : 2
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:25:52 AM
Duration : 00:00:00

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.5693	2.109e+02	6.619e-03	1.237e-02	1.295e-05	2.421e-05
0.6047	1.334e+03	4.529e-02	8.300e-02	8.836e-05	1.619e-04
0.7958	1.167e+03	5.668e-02	9.564e-02	1.079e-04	1.820e-04
0.8019	1.193e+02	5.852e-03	9.853e-03	1.113e-05	1.874e-05
1.0386	1.367e+01	9.377e-04	1.472e-03	1.717e-06	2.696e-06
1.1679	2.461e+01	1.964e-03	2.990e-03	3.514e-06	5.349e-06
1.3652	4.156e+01	4.055e-03	5.936e-03	6.993e-06	1.024e-05
TOTALS:	3.057e+03	1.254e-01	2.189e-01	2.405e-04	4.202e-04

Cs134
E_i Calculation Sheet

Energy Mev	Energy kev	Exposure Rate (mR/hr/1 pCi/g)	Energy Response cpm/mR/hr	E_i (cpm/pCi/g)
0.0318	32	5.32E-09	0	0
0.0322	32	9.94E-09	0	0
0.0364	36	4.16E-09	0	0
0.2769	277	2.61E-08	3100000	0
0.4753	475	1.92E-06	1700000	3
0.5632	563	1.30E-05	1500000	20
0.5693	569	2.42E-05	1500000	36
0.6047	605	1.62E-04	1400000	227
0.7958	796	1.82E-04	1000000	182
0.8019	802	1.87E-05	1000000	19
1.0386	1039	2.70E-06	700000	2
1.1679	1168	5.35E-06	700000	4
1.3652	1365	1.02E-05	650000	7
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			E_i Total	499

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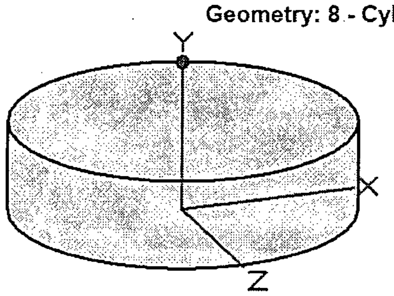
Detroit Edison Co.

Page : 1
DOS File : Case1
Run Date : August 27, 2008
Run Time : 9:29:43 AM
Duration : 00:00:00

File Ref: ____
Date: ____
By: ____
Checked: ____

Case Title: SPA3_Eff_Cs137
Description: SPA3 soil scan_28 cm radius 1 pCi/cm3 Cs137
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm^3	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm^3	Bq/cm^3
Ba-137m	3.4950e-008	1.2932e+003	9.4600e-007	3.5002e-002
Cs-137	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm^2/sec No Buildup	Fluence Rate MeV/cm^2/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	2.677e+01	4.815e-06	5.834e-06	4.011e-08	4.860e-08
0.0322	4.939e+01	9.260e-06	1.129e-05	7.452e-08	9.084e-08
0.0364	1.797e+01	5.126e-06	6.688e-06	2.912e-08	3.800e-08
0.6616	1.164e+03	4.442e-02	7.913e-02	8.611e-05	1.534e-04

Page : 2
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:29:43 AM
Duration : 00:00:00

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.258e+03	4.444e-02	7.915e-02	8.625e-05	1.536e-04

Cs137
E_i Calculation Sheet

Energy Mev	Energy kev	Exposure Rate (mR/hr/1 pCi/g)	Energy Response cpm/mR/hr	E_i (cpm/pCi/g)
0.0318	32	4.86E-08		0
0.0322	32	9.08E-08		0
0.0364	36	3.80E-08		0
0.6616	662	1.53E-04	1250000	191
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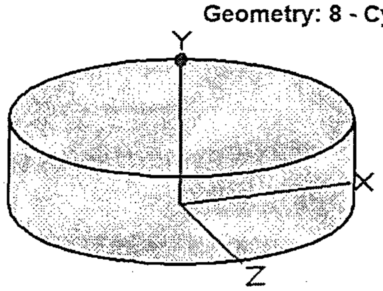
				0
			E_i Total	191

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:33:08 AM
Duration : 00:00:00

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: SPA3_Eff_Eu152
Description: SPA3 soil scan_28 cm radius 1 pCi/cm3 Eu152
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	15.0 cm	5.9 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Eu-152	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.04	8.088e+02	3.131e-04	4.331e-04	1.385e-06	1.916e-06
0.05	2.022e+02	1.507e-04	2.467e-04	4.014e-07	6.572e-07

Page : 2
DOS File : Case1
Run Date: August 27, 2008
Run Time: 9:33:08 AM
Duration : 00:00:00

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.1	3.887e+02	1.189e-03	3.118e-03	1.819e-06	4.770e-06
0.2	1.024e+02	8.207e-04	2.097e-03	1.448e-06	3.700e-06
0.3	3.696e+02	5.029e-03	1.151e-02	9.540e-06	2.184e-05
0.4	8.590e+01	1.701e-03	3.555e-03	3.314e-06	6.926e-06
0.5	7.711e+00	2.043e-04	3.984e-04	4.010e-07	7.819e-07
0.6	5.797e+01	1.948e-03	3.579e-03	3.802e-06	6.985e-06
0.8	2.434e+02	1.190e-02	2.005e-02	2.263e-05	3.813e-05
1.0	5.849e+02	3.820e-02	6.058e-02	7.042e-05	1.117e-04
1.5	3.171e+02	3.490e-02	4.999e-02	5.871e-05	8.411e-05
TOTALS:	3.169e+03	9.635e-02	1.556e-01	1.739e-04	2.815e-04

Eu-152
E_i Calculation Sheet

Energy Mev	Energy kev	*Exposure Rate* (mR/hr/1 pCi/g)	*Energy Response* cpm/mR/hr	E_i (cpm/pCi/g)
0.04	40	1.92E-06	3000000	6
0.05	50	6.57E-07	6500000	4
0.1	100	4.77E-06	10000000	48
0.2	200	3.70E-06	5200000	19
0.3	300	2.18E-05	3300000	72
0.4	400	6.93E-06	2300000	16
0.5	500	7.82E-07	1750000	1
0.6	600	6.99E-06	1400000	10
0.8	800	3.81E-05	950000	36
1	1000	1.12E-04	750000	84
1.5	1500	8.41E-05	550000	46
				0
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				0
				0
				0
				0
				0
				0
				0
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				0
				0
				0
				0
				0
				0
				0
				0
			E_i Total	342

Detroit Edison

Effects of asbestos encapsulant on survey instrument efficiencies

Martin C. Erickson

April 07, 2009

Approved by: ______________________ Date: 4-16-09
EFI Health Physicist

1. INTRODUCTION

During the course of preparing retired nuclear facilities for demolition and/or license termination, abatement of asbestos containing materials is necessary. Asbestos was utilized in many of the factories and power plants constructed from the 1920s to the 1970s for its excellent insulation and flame-resistant properties. The EPA warnings and regulations of the 1970s and beyond put an end to much of the industry.

There are stringent requirements set by federal, state, and local authorities regarding the methods for asbestos removal to include the release of the abatement area once the asbestos has been removed. The standard protocol for preparing an area post-abatement is employing an encapsulant over the area to prevent loose fibers from becoming airborne thus allowing the release of the area. In these bridging applications the encapsulant is applied full strength to a dry thickness of 6-10 mils. This methodology does have its drawbacks however, in that the coating may be present on surface areas surveyed for release. The presence of the coatings will affect the efficiencies of the instrumentation when beta measurements are necessitated and the source efficiencies will vary according to the number of coating applications.

Detection of beta particles depends on the energy of the beta particles emitted from materials being surveyed and the thickness of the detector window. The efficiency of the detector for beta particles is determined by exposing the detector to a known activity level of beta particles of a given energy and recording the resulting count rate (E_i). In order for the efficiency calibration to be accurate, the energy of the calibration source must be similar to the energy of the source to be measured in the field. Assuming that the calibration source is of appropriate energy, other adjustments may need to be made to the efficiency in order to accurately determine true source activity. These adjustments include source efficiency due to surface conditions (E_s) and beta attenuation caused by the asbestos encapsulant placed on the source.

The purpose of this document is to establish the adjustments to detection efficiency for Source Efficiency (E_s) due to the presence of coatings on surfaces being surveyed.

2. METHODOLOGY

The calibration source used for gas-flow proportional detectors is appropriate for the average energy of beta particles emitted from the surface of structures and components at Fermi 1. The E_s adjustment is made to E_i in order to calculate that the detector E_{total} has been properly determined. The need for adjustment of efficiency for surface coatings has been recognized and the method described in NUREG-1507 has been used where necessary to compensate for beta attenuation by surface coverings, however NUREG-1507 does not address the attenuation of asbestos encapsulant. It is therefore necessary to determine the attenuation of beta particles due to the presence of asbestos encapsulant. The process used is the methodology addressed in NUREG-1507 and is based on empirical data from two beta sources present at Fermi 1. The Ludlum 43-68 gas flow detectors with a physical probe area of 126 cm^2 (effective probe area of 100 cm^2, which accounts for the fraction of the probe covered by the protective screen) were used in this study.

Measurements were performed on each of the two sources using the same detector in the absence of the coatings and after the application of each layer. Shielded readings were gathered as well using an approximate 300 mg/cm^2 shield to assess the effect of the coating on the gamma emitters.

3. RESULTS and ANALYSIS

The 44 shielded readings taken yielded a mean value of 293 cpm and all readings were within two standard deviations of the mean value. Unshielded readings were taken on each area and the results of the values taken over coatings were compared with the readings taken without the coatings present. The mean fractional values were determined and are shown in Table 1.

Table 1: Mean fractional values for various layers of coatings

Reading	Mean Fractional Value
No Encapsulant	N/A
One Coat of Encapsulant	0.8994
Two Coats of Encapsulant	0.7448
Three Coats of Encapsulant	0.5917
Four Coats of Encapsulant	0.6804
Five Coats of Encapsulant	0.6836
Six Coats of Encapsulant	0.6159
Seven Coats of Encapsulant	0.5953
Eight Coats of Encapsulant	0.5605
Nine Coats of Encapsulant	0.5573
Ten Coats of Encapsulant	0.5285

Once the mean fractional value has been determined, the source efficiency based on the attenuation of the coatings can be determined. ISO 7503-1 takes a conservative approach by recommending the use of factors to correct for alpha and beta self-absorption/attenuation when determining surface activity. The guidance on source efficiencies from ISO 7503-1 for beta emitters > 0.400 MeV recommends a beta self-absorption/attenuation factor of 0.5. This factor is independent of attenuation due to additional factors such as the presence of coatings. Therefore, to account for the additional attenuation from the coatings, the source efficiency is corrected by multiplying the mean fractional value by the ISO 7503-1 value. The resulting measured source efficiency versus coating layer was fit to an exponential curve.

The results of the regression fit are provided in Table 2.

Table 2: Effects of Encapsulant Coatings on Source Efficiency

Surface Material	Source Efficiency	
	Measured[a]	Fit[b]
Detector Face[c]	N/A	N/A
Plus one coat encapsulant[d]	0.4497	0.3923
Plus two coats encapsulant	0.3724	0.3747

Plus three coats encapsulant	0.2959	0.3578
Plus four coats encapsulant	0.3402	0.3417
Plus five coats encapsulant	0.3418	0.3264
Plus six coats encapsulant	0.3079	0.3117
Plus seven coats encapsulant	0.2977	0.2977
Plus eight coats encapsulant	0.2802	0.2843
Plus nine coats encapsulant	0.2786	0.2715
Plus tencoats encapsulant	0.2643	0.2593
Regression Equation	$y = 0.4108e^{-0.046x}$	

[a] Source efficiency was determined by multiplying the ISO 7501-1 value for beta emitters > .400 Mev by the efficiency determined by empirical data from the mean values of the two sources monitored.
[b] The measured source efficiency versus encapsulant layer was fit to an exponential curve.
[c] Measurements performed with a Ludlum 43-68 gas proportional detector with a standard aluminized mylar window (0.8 mg/cm^2)
[d] Encapsulant is IPC Serpiflex® coating applied uniformly to a thickness of 0.006-0.010 inches

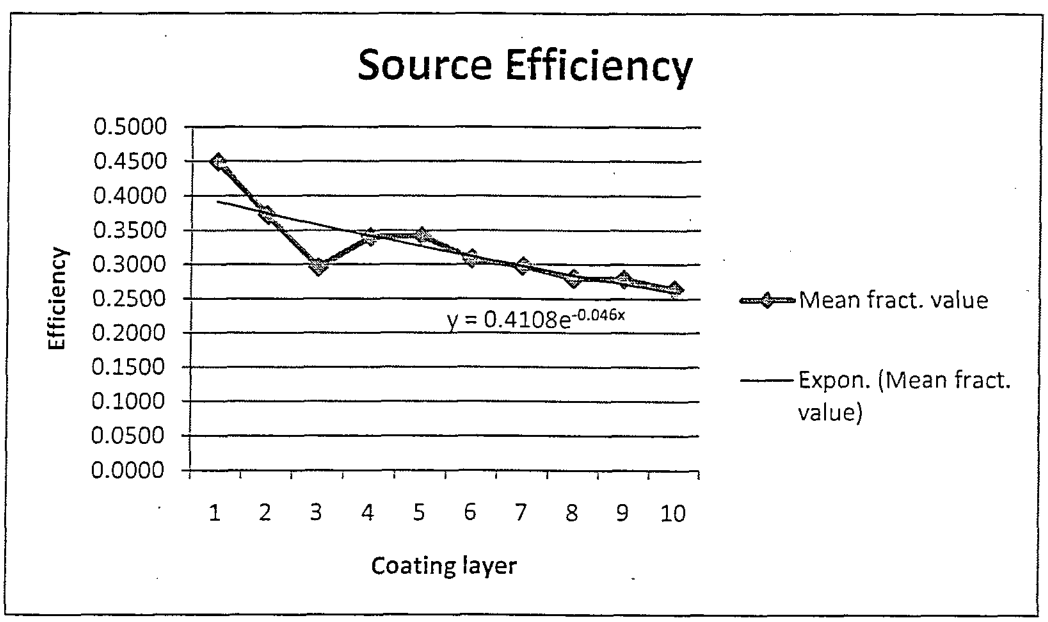

Figure 1: Graphical depiction of the measured source efficiency and the exponential fit

4. SUMMARY

When surveying areas of the site where asbestos encapsulant is present it is necessary to compensate for the attenuation provided by the encapsulant. To determine the appropriate 4π efficiency the fitted efficiency, based on the number of coats of encapsulant present, is used as the source efficiency.

REFERENCES

ISO 7503-1, "Evaluation of Surface Contamination-Part 1 : Beta Emitters and Alpha Emitters (first edition). (1988). Geneva: International Organization for Standardization.

NUREG 1507, Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. (1998). Nuclear Regulatory Commission.

Detroit Edison

Enrico Fermi Unit 1

Derived Concentration Guideline Levels for Embedded Piping
Revision 1

Martin C. Erickson

September 30, 2009

This document supersedes NSEF-09-0016

Approved by: D Lindsey Date: 10-1-09
EF1 Health Physicist

Contents

Tables

List of Figures

1. Introduction

Any embedded piping that was radiologically impacted by EF1 operations that is to remain in the facility after license termination must satisfy radiological criteria specified in NRC 10CFR20 Subpart E. The EF1 LTP has committed to a final status radiological survey that is in accordance with the guidance in the MARSSIM [USNRC 2001]. However, the MARSSIM does not address application of the 25 mrem/y radiological dose criterion to materials and equipment such as embedded piping[1]. As a result special criteria may be necessary to account for residual contamination on surfaces such as embedded pipes and site specific DCGLs for embedded piping will be developed through evaluation of doses to future occupants from these sources.

This report describes the approach used to calculate DCGLs for embedded piping that may remain in the facility. It presents proposed DCGL values for individual radionuclides as dpm/100 cm^2 per millirem/y. The following sections address:

- the assumptions and technical approach used to calculate the DCGLs,
- conceptual dose model and
- results – the DCGLs for individual radionuclides.

2. Approach to Development of DCGLs

The approach to development of DCGLs for embedded piping outlined here is similar to the approach followed by several other NRC licensed nuclear reactor facilities[2]. Doses to future building occupants are calculated from residual surface contamination on the inside surfaces of piping embedded in the structural concrete and concrete floors. It is noted that future building occupants could be exposed to radiation from residual contamination on building surfaces and possibly other sources such as volumetrically contaminated concrete in addition to that from embedded piping. Therefore, contributions to the 25 basic mrem/y dose criterions are allocated among the various sources in locations where multiple sources are assumed to be present. For derivation of DCGLs for embedded piping, the available NRC guidance recommends that the dose

[1] Subsequent to issuance of the MARSSIM, the NRC has issued general guidance for survey development of dose-based release criteria for embedded piping. See NUREG-1757, Appendix I and Appendix O [NRC 2003].

[2] Most NRC licensed power reactor facilities and several research and test reactors that have been decommissioned in the past decade or are currently under review by the NRC have used an approach that is similar to the approach outlined here. The methods used by, Trojan, Maine Yankee, Rancho Seco and the Plum Brook Reactor Facility were reviewed for this task. See the reference section for identification of the documents pertaining to each facility.

from special sources be limited to a small fraction of the 25 millirem/y criterion, e. g., a few millirem/y [USNRC 2003]. For EF1, one millirem/y is allocated to embedded piping DCGLs.

Other principal assumptions used in the development of embedded piping DCGLs are:

1. The dose is based on future routine occupancy associated with use of the facility as an academic research facility – consistent with non-residential occupancy scenario assumptions. The facility is used for activities that do not involve modifications; e.g., excavating or intruding into the floors where embedded piping is located. The maximum exposed individual is an adult who spends 2340 hours a year in an area of the facility that contains embedded piping[3]. While the scenario assumes no demolition, there may be an instance in future applications where demolition takes place. The exposure to personnel performing the demolition and packaging the piping would be minimal due to the use of excavation machinery as well as the duration of the exposure in addition to the added shielding afforded by the grout; therefore the occupancy scenario bounds the exposure for future demolition activities.

2. Embedded piping that remains will be filled with grout. The primary purpose of the grout is to "fix" any residual surface contamination on the inner surface of embedded piping. It will limit the exposure pathways to future building occupants to direct exposure from penetrating gamma radiation.

3. A conceptual dose model is used, wherein an individual is assumed to be in a location where on average he or she is continuously exposed to gamma radiation from the embedded pipes that remain. This is modeled by placing a dose receptor point one meter above a group of pipes representing the "maximum exposure" location.

Reviews of construction photos and drawings and walk-down of the facility were performed to verify piping layouts and dimensions. Several potential locations were considered for dose receptor locations. Shielding thickness and piping to dose point distances were confirmed for each of these.

The MicroShield® shielding code was used to perform the dose calculations [Grove 2005]. The dose rate to the receptor was calculated for each of the gamma emitting radionuclides individually. The MicroShield standard source geometry; cylindrical surface source with external slab shields and external dose point was used (Geometry 10). The residual contamination on the piping inner surface was modeled by assuming

[3] The value of 2340 hours building occupancy is the default value used in the RESRAD-BUILD computer dose modeling code for evaluation of doses under building occupancy scenarios. See RESRAD-BUILD Version 3 Users Manual, Table 3.1 [ANL 2003].

that the radionuclide source is uniformly deposited on a cylindrical surface. The pipe wall thickness (schedule 40 steel) is modeled by MicroShield as a cylindrical shield that surrounds the source. The concrete floor is treated as an external slab shield. The grout-filling in the piping is modeled as an inner cylindrical core. The source strength is set at 1 dpm/100-cm^2 (4.5E^{-09} μCi/cm^2).

To obtain the individual radionuclide DCGLs, the total dose rate to the receptor is first calculated as the sum of the doses (dose rates in mrem/y) from each of the individual pipe sources (pipe runs) in the conceptual model[4]. The annual dose rate is obtained as the product of the mrem/h total and 2340 exposure-hours per year. This is in units of mrem/y per dpm/100-cm^2. The DCGL is then obtained as the reciprocal of the annual dose rate in units of dpm/100-cm^2 per mrem/y.

3. Conceptual Dose Model and MicroShield Parameters

The conceptual dose model is comprised of an embedded pipe source in close proximity to a dose receptor point. The dose point is located one meter above the floor surface at a physically accessible location in the facility. The conceptual dose model represents a location which contains the maximum number of embedded piping runs that could contribute to the calculated dose received at a single dose point. Preliminary dose calculations were performed to determine which location in the Cutup/Decay Pool area would receive the greatest dose from contaminated embedded drain piping. It was concluded that the maximum dose receptor point is located at the southwest corner of the Cut-up Pool. Two sections of embedded 4 inch drains are closest in proximity at this location. A photo of the dose point location as it appears at the present time is shown in Figure 1. Figure 2 is a plan view of the pool area showing the dose point location in relation to the floor drain lines included in the conceptual dose model. A cross-section view of the conceptual model is shown in Figure 3.

The model includes two individual pipe runs that simulate the configuration of the pipes embedded in the floor southwest of the Cut-up Pool wall. The piping has diameters of four inches and is slightly over four feet long at the receptor location. The piping was modeled to be 10 feet in length to conservatively bound subsequent embedded piping. The MicroShield dose point x, y and z coordinates are shown as the distance in cm from an origin at the base of each cylindrical pipe source. The default source-receptor geometry in MicroShield is a vertical source cylinder whose length is parallel to and centered on the y axis. The origin is located at the "bottom" of the vertical source length. The x dimension extends in the positive direction perpendicular to the y axis. The total x distance to the receptor includes the pipe source radius, the pipe cladding thickness (if used), the pipe wall thickness, the thickness of any slab shields that are used and the 100 cm distance from the floor to the receptor. The floor concrete is modeled as a 1 ft. thick slab shield. The distance from the last shield to the dose point is identified as the "air gap". The z distance from the source to dose point is the perpendicular distance from the

[4] The MicroShield code does not have the capability to calculate doses from more than one discrete source element at a time. It does have the capability to calculate the dose at up to six receptor locations (from a single source) however.

x-y plane to the dose point. In the present application, the z distance is the horizontal off-set distance from the pipe center (y axis) to the dose point and is set at 9 inches. The y distance is set to one-half the length.

The MicroShield output report graphic is oriented to show the source and shield layout as it exists in EF1, i.e., with horizontal pipe source and slab shield. This aligns the source length parallel to and beneath the floor so the floor appears as a horizontal slab shield above the pipe source. In this orientation the x axis runs in the vertical direction.

The material properties used in the MicroShield calculations are shown in Table 1. The pipe fill is assumed to be low density Portland cement grout with a density of 1.8 g/cm^3 and the floor slab is assumed to be ordinary concrete with a density of 2.4 g/cm^3. The cylindrical source is assumed to be deposited in a thin layer (0.25 mm thick) of iron on the inner surface of the pipe. The pipe walls are modeled as iron (carbon steel) with density 7.86 g/cm^3.

Table 1: Material Properties

Material[1]	Thickness (cm)	Material	Density (g/cm^3)[2]
4 in. pipe grout fill	5.08 cm (radius)	concrete	1.8
Pipe inner wall clad[3]	0.025	iron	7.86
4 in. schedule 40 pipe wall[4]	0.60	iron	7.86
Floor slab shield	30.48	concrete	2.4
Air gap	100	air	0.001293 (STP)[5]

1. Pipe dimensions and materials (carbon steel, Schedule 40) are obtained from mechanical construction drawings.
2. Material densities for concrete and grout are typical values from the Engineering Compendium on Radiation Shielding, [Jaeger 1975]. The density of steel (iron) is the MicroShield default density.
3. The pipe source is modeled as a cylindrical surface source embedded in a thin corrosion layer of thickness 0.025 cm assumed to have the same density as iron. The inner wall clad was not used in the modeling to add additional conservatism to the data.
4. Wall thicknesses for schedule 40 steel piping are obtained from Glover, 2003.
5. Density of dry air at standard temperature and pressure.

4. Calculated Doses and DCGLs

The DCGL for each radionuclide is calculated as:

$$DCGL_k = \frac{1}{2340\sum_1^n D_i}, \text{ where:} \qquad \textbf{Equation (1)}$$

$DCGL_k$ = the DCGL for radionuclide k (dpm/100-cm^2 per mrem/y),
2340 = exposure time (h/y),
D_i = dose rate from radionuclide k from pipe source i (mrem/h per dpm/100-cm^2).
Dose rates from the north and south pipes are summed.

Calculated doses from each of the pipe sources in the conceptual dose model are shown in Table 2. These are reported in units of mrem/h per dpm/100-cm^2 for each of the radionuclides listed[5]. The total dose from each radionuclide (from all pipes) is tabulated in the last row of the table[6]. Table 3 presents the DCGL calculations and the DCGL values for each of the radionuclides. The first column shows the dose rate from all pipes for each radionuclide in mrem/h. The second column, the annual dose to the building occupant is obtained as the product of the dose rate in mrem/h and 2340 h/y occupancy time. The third column values, obtained as the reciprocal of the values in column 2, are the individual radionuclide DCGLs in dpm/100-cm2 per mrem/y. The table shows that the limiting radionuclide is Co-60 with a DCGL of 415,000 dpm/100-cm^2,

Table 2: Radionuclide Doses from Conceptual Model Pipe Sources

Pipe	Na-22	Co-60	Nb-94	Ag-108m	Sb-125	Cs-134	Cs-137	Eu-152	Eu-154	Eu-155
North	3.04E-10	5.14E-10	1.55E-10	9.86E-11	1.87E-11	1.30E-10	3.93E-11	1.70E-10	2.31E-10	4.54E-16
South	3.04E-10	5.14E-10	1.55E-10	9.86E-11	1.87E-11	1.30E-10	3.93E-11	1.70E-10	2.31E-10	4.54E-16
Total	6.08E-10	1.03E-09	3.10E-10	1.97E-10	3.74E-11	2.60E-10	7.86E-11	3.40E-10	4.62E-10	9.08E-16

Table 3: Summary of DCGL Calculations

Radionuclide	Dose from pipe (mrem/h)	Dose to Building Occupant (mrem/y per dpm/100 cm^2)	DCGL (dpm/100 cm^2 per mrem/y)
Na-22	6.08E-10	1.42E-06	7.03E+05
Co-60	1.03E-09	2.41E-06	4.15E+05
Nb-94	3.10E-10	7.25E-07	1.38E+06
Ag-108m	1.97E-10	4.61E-07	2.17E+06
Sb-125	3.74E-11	8.75E-08	1.14E+07
Cs-134	2.60E-10	6.08E-07	1.64E+06
Cs-137	7.86E-11	1.84E-07	5.44E+06
Eu-152	3.40E-10	7.96E-07	1.26E+06
Eu-154	4.62E-10	1.08E-06	9.25E+05
Eu-155	9.08E-16	2.12E-12	4.71E+11

5. Discussion

The DCGLs play an important role in the evaluation of embedded drain piping. The aspect of this is the effect of DCGLs in establishing survey methods.

5.1 Gross Activity DCGLs

Surveys of embedded piping are generally performed using count rate instruments with detectors inserted into the piping. These have been performed with

[5] The doses are obtained from the MicroShield case run reports in Appendix C.
[6] Gamma-emitting radionuclides are taken from EF1 TBD NSEF-08-018 " Radionuclide Development for DCGL Selection"

beta/gamma detectors, such as GM pancake-type detectors deployed to position directly on pipe inner surfaces and with NaI (Sodium Iodide) detectors. These detectors are usually calibrated using specially fabricated radionuclide sources; beta sources for GM detectors and gamma sources for NaI detectors. The most common survey techniques use detectors calibrated for gross activity measurements, hence the need for gross activity DCGLs.

Using the method recommended in the MARSSIM, the gross activity DCGL is calculated as:

$$DCGL_{GA} = \frac{1}{\left[\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \dots \frac{f_n}{DCGL_n}\right]}$$, where: **Equation 2**

f_1 = the activity fraction of radionuclide No. 1,
$DCGL_1$ = the DCGL for radionuclide No. 1,
f_2 = the activity fraction of radionuclide No. 2,
$DCGL_2$ = the DCGL for radionuclide No. 2,
f_n = the activity fraction of the "nth" radionuclide and
$DCGL_n$ = the DCGL for the "nth" radionuclide.

For the mix of radionuclides considered above, the most conservative assumption is to assume that the residual activity in embedded piping is comprised entirely of Co-60. This yields a gross activity DCGL equal to 415,000 dpm/100-cm^2. From previous survey results, it is observed that Co-60 activity fractions typically are less than 1% of the total activity. Hence, it is likely that Co-60 activity fractions in embedded piping will be considerably less than one and surveys can benefit from the higher gross activity DCGLs that can be justified. A calculation was performed to obtain the embedded gross activity DCGL as a function of Co-60 activity fraction. Two cases were evaluated:

1. The piping residual activity is assumed to consist of Co-60 and Cs-137,

2. The piping residual activity is assumed to consist of Co-60 and Na-22.

These two cases bound the range of gross activity DCGLs that may be expected. The results of this calculation are tabulated in Table 4. The gross activity DCGLs vs. Co-60 activity fractions are plotted in Figure 4. It is seen that the gross activity DCGL is most sensitive to the activity fraction when the Co-60 activity fraction is low, e.g., less than about 0.5. At higher activity fractions, the gross activity DCGL is dominated by the Co-60 DCGL.

Table 4: Gross Activity vs. Co-60 Activity Fraction

Co-60 Activity Fraction	Gross beta DCGL (dpm/100 cm^2)	
	Co-60 & Cs-137	Co-60 and Na-22
0.05	3.39E+06	6.79E+05
0.1	2.46E+06	6.57E+05
0.2	1.59E+06	6.17E+05
0.3	1.17E+06	5.82E+05
0.4	9.31E+05	5.50E+05
0.5	7.71E+05	5.22E+05
0.6	6.58E+05	4.96E+05
0.7	5.74E+05	4.73E+05
0.8	5.09E+05	4.52E+05
0.9	4.57E+05	4.33E+05
1.0	4.15E+05	4.15E+05

6. Conclusion

The approach to development of DCGLs for EF1 embedded piping is based on doses to future building occupants calculated from residual surface contamination on the inside surfaces of piping embedded in the structural concrete and concrete floors. The conceptual dose model chosen represents a location which contains the maximum number of embedded piping runs that could contribute to the calculated dose received at a single dose point within EF1. The model was further modified by extending the length of the piping to further provide conservatism to the conceptual model. The total dose was summed from each source for each gamma emitting radionuclide and the corresponding DCGL was then calculated for each nuclide. These data provided the basis for determining the gross activity for different fractions of radionuclide mixes.

7. References

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Glover 2003 Thomas J. Glover, Concrete Sawing and Drilling Association, *Pocket Ref(erence)*, Sequoia Publishing, 3rd Ed. 2003.

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Appendix A Figures

Figure 1 Recent Photo Showing Dose Receptor Location

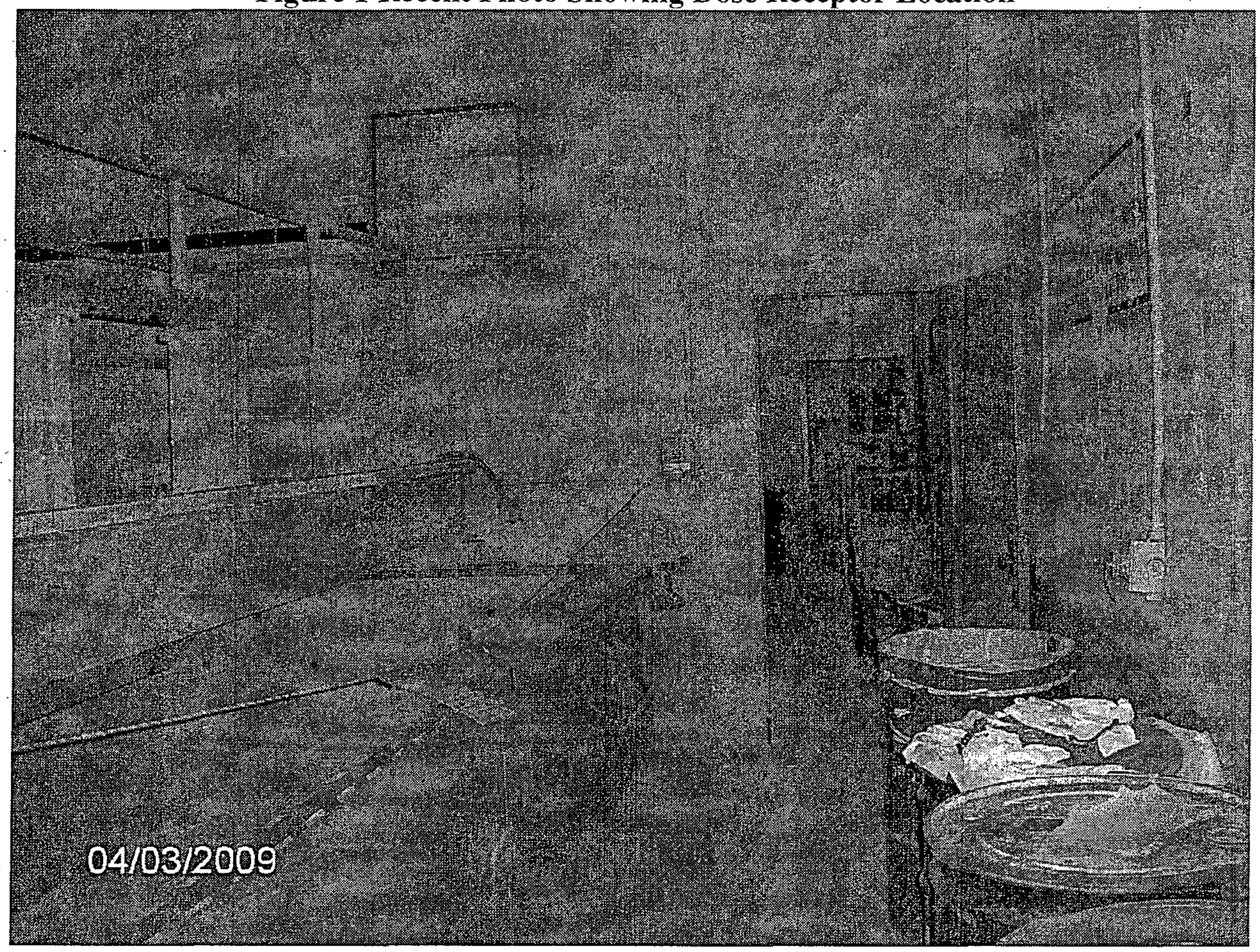


Figure 2 Cross Section View of Conceptual Dose Model Piping Arrangement

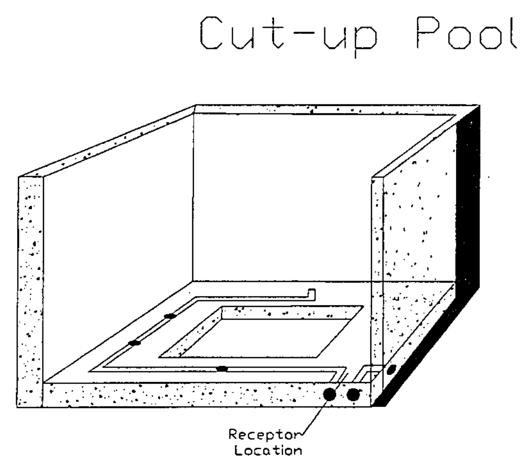


Figure 3 Cross Section view of Conceptual Dose Model Piping Arrangement

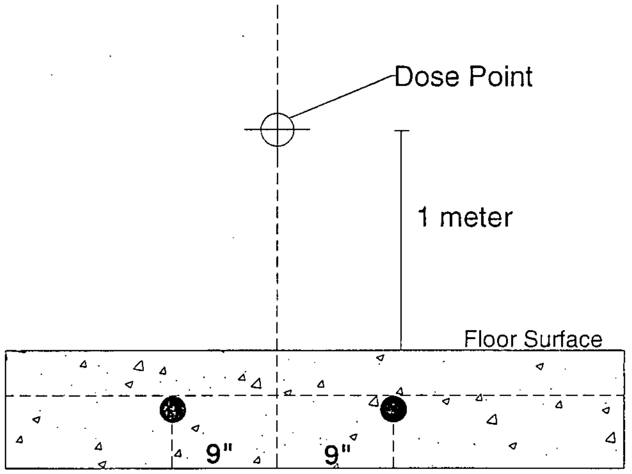
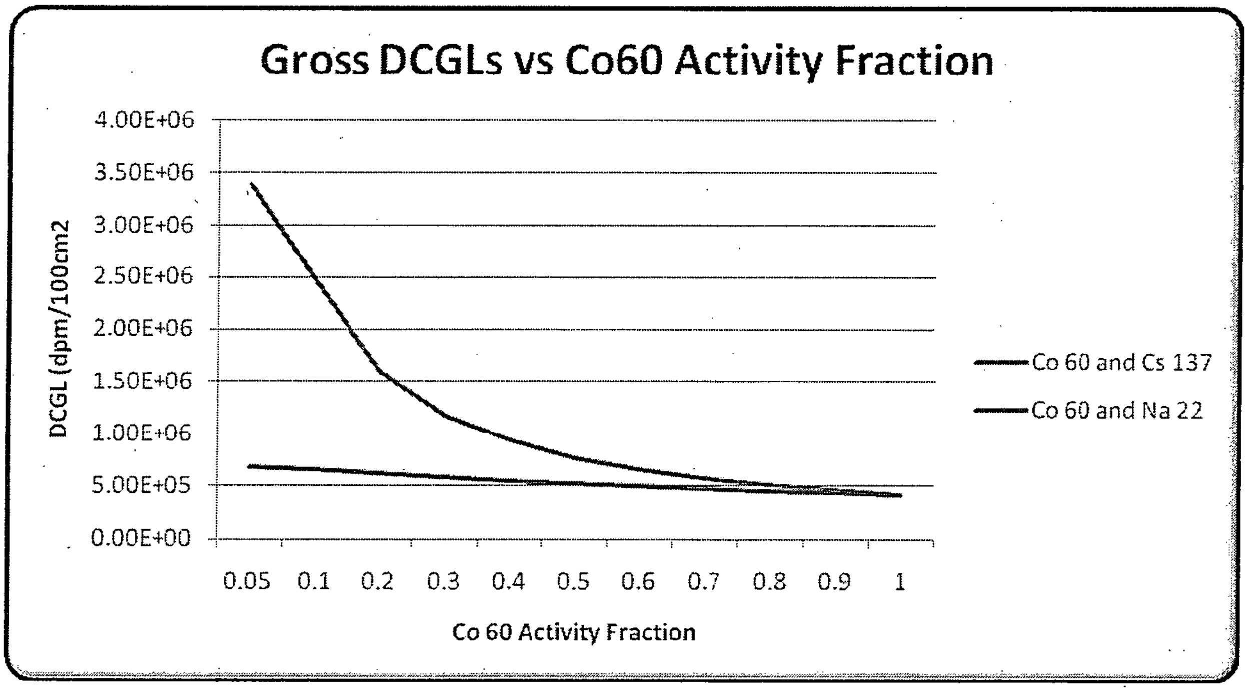


Figure 4 Gross DCGL Vs. Co-60 Activity Fraction



Appendix B Dose Modeling Sensitivity Analysis

Prior to calculating the doses needed to obtain DCGLs, preliminary dose calculations were performed with the MicroShield code. These were to confirm that appropriate values were selected for the user selected MicroShield parameters. In addition several cases were run to evaluate the assumptions used to develop the conceptual pipe model layout. The sensitivity analysis case runs are included in Appendix C and the results are tabulated in Table xxx MicroShield Case Run Reports for Sensitivity Analysis. All the sensitivity case runs were made with the same source geometry, Geometry 10, cylindrical surface source, (4 inch diameter, radius 5.08 cm) with external dose point and with a Co-60 source of unit concentration (1 dpm/100-cm2 or 4.5E-09 μCi/cm2).

The principal user selected parameters evaluated were:

- the number of integration steps
- the material used in the dose build calculation.

Experience has shown that 20 to 30 integration steps are sufficient for cases where the source-to-dose point distance is large relative to the source radius (larger than the radius). Cases were run with integration steps of 10, 20, 30 & 40 (the number of axial and circumferential steps were set equal). It was found that 20 integration steps were appropriate. The calculated dose did not vary significantly, but achieved a maximum at 20 steps.

Cases were run to test the medium used for calculation of the dose "buildup". Test runs were made using the following materials as buildup materials: 1) cylindrical core (concrete; density 1.8), 2) the pipe wall shield (iron; density 7.86) and 3) the concrete floor slab shield (concrete; density 2.4). No difference was seen in the buildup dose between the cylindrical core and the concrete slab shield. However, both of these materials produced higher buildup dose rates than the pipe wall shield. The floor slab shield was selected as the buildup medium.

Cases were run to evaluate the conceptual model parameters:

- length of pipe source
- off-set distance from pipe source to dose receptor (z coordinate).

Cases were run for pipe lengths of 1, 3, 5, 7, 10 and15 ft. No increase in the dose rate was seen as the length was increased above 10 ft; so 10 ft was selected as the default length to represent a conservative based modeling concept. It was found that at 5 ft offset distance the dose rate was decreased to7% of the base case (9 in. z offset). From this scenario, it can be concluded that pipe runs located at z coordinate distances greater than five feet from the dose point can be excluded from the conceptual dose model.

MicroShield Case Run Reports for Sensitivity Analysis

Run Date	Case Title	Description	File Name	Result (mrem/h)
4/3/09	10 Integration steps	10 Integration steps sensitivity	10int	3.22E-10
4/3/09	20 integration steps	20 integration steps sensitivity	20int	3.22E-10
4/3/09	30 integration steps	30 integration steps sensitivity	30int	3.21E-10
4/3/09	40 integration steps	40 integration steps sensitivity	40int	3.21E-10
4/3/09	Cylindrical core BU	Cylindrical core buildup	ccbu	3.22E-10
4/3/09	Pipe wall shield BU	Pipe wall shield buildup	pwsbu	2.72E-10
4/3/09	Ct floor slab BU	Concrete floor slab buildup	cfsbu	3.22E-10
4/3/09	10 foot pipe	10 foot pipe sensitivity	10ftp	3.35E-10
4/3/09	15 foot pipe	15 foot pipe sensitivity	15ftp	3.35E-10
4/3/09	1 foot pipe	1 foot pipe sensitivity	1ftp	1.04E-10
4/3/09	3 foot pipe	3 foot pipe sensitivity	3ftp	2.68E-10
4/3/09	5 foot pipe	5 foot pipe sensitivity	5ftp	3.23E-10
4/3/09	7 foot pipe	7 foot pipe sensitivity	7ftp	3.33E-10
4/3/09	Pipe 0.025 iron clad	Pipe & 0.025 iron clad	clad	3.35E-10
4/3/09	Pipe no iron clad	Pipe no iron clad sensitivity	noclad	3.38E-10
4/3/09	9" z offset	9" z offset sensitivity	9inz	3.38E-10
4/3/09	12" z offset	12" z offset sensitivity	10inz	3.17E-10
4/3/09	18" z offset	18" z offset sensitivity	18inz	2.66E-10
4/3/09	24" z offset	24" z offset sensitivity	24inz	2.1E-10
4/3/09	36" z offset	36" z offset sensitivity	36inz	1.14E-10
4/3/09	48" z offset	48" z offset sensitivity	48inz	5.32E-11
4/3/09	60" z offset	60" z offset sensitivity	60inz	2.28E-11

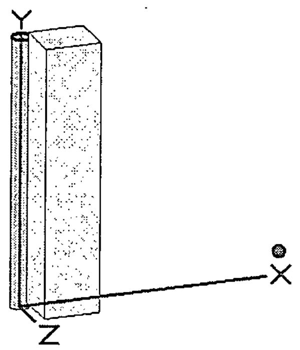
Appendix C Microshield Case Run Reports

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 10INT.MS5
Run Date : April 6, 2009
Run Time: 1:20:42 PM
Duration : 00:00:00

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: 10 Integration
Description: 10 integration steps
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	150.0 cm	4 ft 11.1 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	2.1545e-011	7.9717e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	10
Circumferential	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.300e-04	1.740e-13	2.888e-12	3.359e-16	5.577e-15
1.1732	7.972e-01	8.808e-09	7.645e-08	1.574e-11	1.366e-10
1.3325	7.972e-01	1.422e-08	1.068e-07	2.467e-11	1.853e-10

Page : 2
DOS File : 10INT.MS5
Run Date : April 6, 2009
Run Time: 1:20:42 PM
Duration : 00:00:00

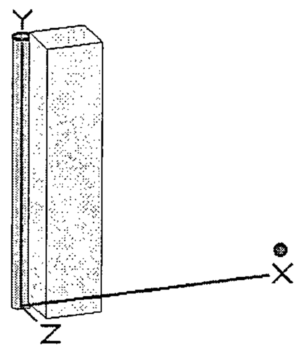
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.594e+00	2.303e-08	1.833e-07	4.041e-11	3.219e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 20INT.MS5
Run Date : April 6, 2009
Run Time: 1:25:31 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: 20 Integration
Description: 20 integration steps
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	150.0 cm	4 ft 11.1 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	2.1545e-011	7.9717e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.300e-04	1.738e-13	2.886e-12	3.356e-16	5.572e-15
1.1732	7.972e-01	8.802e-09	7.644e-08	1.573e-11	1.366e-10
1.3325	7.972e-01	1.421e-08	1.068e-07	2.465e-11	1.853e-10

Page : 2
DOS File : 20INT.MS5
Run Date : April 6, 2009
Run Time: 1:25:31 PM
Duration : 00:00:01

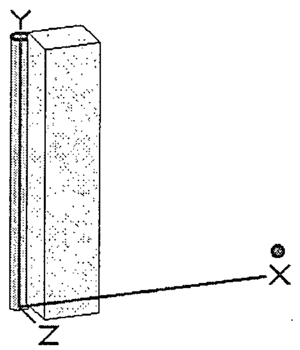
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.594e+00	2.301e-08	1.832e-07	4.038e-11	3.219e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 30INT.MS5
Run Date : April 6, 2009
Run Time: 1:26:51 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: 30 Integration
Description: 30 integration steps
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	150.0 cm	4 ft 11.1 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	2.1545e-011	7.9717e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	30
Circumferential	30

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.300e-04	1.736e-13	2.881e-12	3.351e-16	5.562e-15
1.1732	7.972e-01	8.786e-09	7.629e-08	1.570e-11	1.363e-10
1.3325	7.972e-01	1.418e-08	1.066e-07	2.461e-11	1.849e-10

Page : 2
DOS File : 30INT.MS5
Run Date : April 6, 2009
Run Time: 1:26:51 PM
Duration : 00:00:01

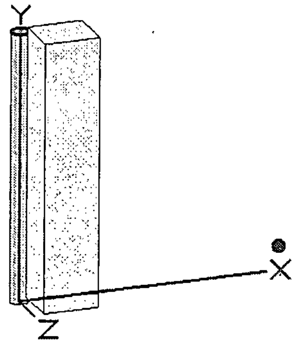
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.594e+00	2.297e-08	1.829e-07	4.031e-11	3.213e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 40INT.MS5
Run Date : April 6, 2009
Run Time: 1:28:57 PM
Duration : 00:00:03

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 40 Integration
Description: 40 integration steps
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	150.0 cm	4 ft 11.1 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	2.1545e-011	7.9717e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	40
Circumferential	40

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.300e-04	1.736e-13	2.881e-12	3.351e-16	5.562e-15
1.1732	7.972e-01	8.786e-09	7.629e-08	1.570e-11	1.363e-10
1.3325	7.972e-01	1.418e-08	1.066e-07	2.461e-11	1.849e-10

Page : 2
DOS File : 40INT.MS5
Run Date : April 6, 2009
Run Time: 1:28:57 PM
Duration : 00:00:03

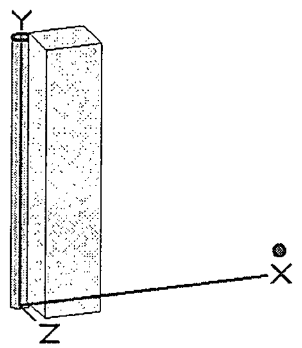
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.594e+00	2.297e-08	1.829e-07	4.031e-11	3.213e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : CCBU.MS5
Run Date : April 6, 2009
Run Time: 1:33:45 PM
Duration : 00:00:01

File Ref: ______________
Date: ______________
By: ______________
Checked: ______________

Case Title: Cylindrical core BU
Description: cylindrical core buildup
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	150.0 cm	4 ft 11.1 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	2.1545e-011	7.9717e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Cyl. Core

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.300e-04	1.738e-13	2.886e-12	3.356e-16	5.572e-15
1.1732	7.972e-01	8.802e-09	7.644e-08	1.573e-11	1.366e-10
1.3325	7.972e-01	1.421e-08	1.068e-07	2.465e-11	1.853e-10

Page : 2
DOS File : CCBU.MS5
Run Date : April 6, 2009
Run Time: 1:33:45 PM
Duration : 00:00:01

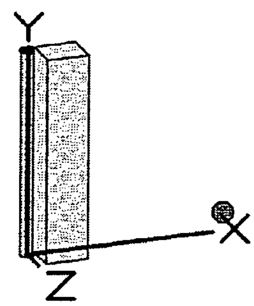
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.594e+00	2.301e-08	1.832e-07	4.038e-11	3.219e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : PWSBU.MS5
Run Date : April 7, 2009
Run Time: 9:48:54 AM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Pipe wall shield BU
Description: Pipe wall shield buildup
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	150.0 cm	4 ft 11.1 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	2.1545e-011	7.9717e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Transition

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.300e-04	1.738e-13	1.987e-12	3.356e-16	3.837e-15
1.1732	7.972e-01	8.802e-09	6.360e-08	1.573e-11	1.137e-10
1.3325	7.972e-01	1.421e-08	9.145e-08	2.465e-11	1.587e-10

Page : 2
DOS File : PWSBU.MS5
Run Date : April 7, 2009
Run Time: 9:48:54 AM
Duration : 00:00:01

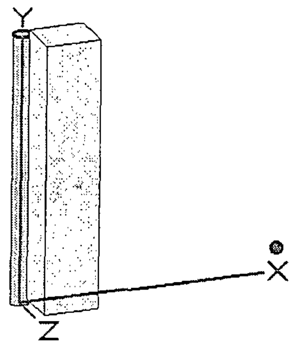
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.594e+00	2.301e-08	1.551e-07	4.038e-11	2.723e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : CFSBU.MS5
Run Date : April 6, 2009
Run Time: 1:34:26 PM
Duration : 00:00:01

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: Ct floor slab BU
Description: concrete floor slab buildup
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	150.0 cm	4 ft 11.1 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	2.1545e-011	7.9717e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.300e-04	1.738e-13	2.886e-12	3.356e-16	5.572e-15
1.1732	7.972e-01	8.802e-09	7.644e-08	1.573e-11	1.366e-10
1.3325	7.972e-01	1.421e-08	1.068e-07	2.465e-11	1.853e-10

Page : 2
DOS File : CFSBU.MS5
Run Date : April 6, 2009
Run Time: 1:34:26 PM
Duration : 00:00:01

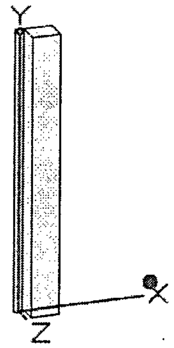
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.594e+00	2.301e-08	1.832e-07	4.038e-11	3.219e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 10FTP.MS5
Run Date: April 6, 2009
Run Time: 1:19:07 PM
Duration : 00:00:01

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: 10 foot pipe
Description: 10 foot pipe sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	1.760e-13	2.946e-12	3.397e-16	5.688e-15
1.1732	1.620e+00	9.010e-09	7.922e-08	1.610e-11	1.416e-10
1.3325	1.620e+00	1.460e-08	1.112e-07	2.533e-11	1.930e-10

Page : 2
DOS File : 10FTP.MS5
Run Date: April 6, 2009
Run Time: 1:19:07 PM
Duration : 00:00:01

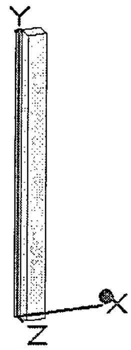
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	3.240e+00	2.361e-08	1.904e-07	4.143e-11	3.345e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 15FTP.MS5
Run Date : April 6, 2009
Run Time: 1:23:23 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 15 foot pipe
Description: 15 foot pipe sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	457.2 cm	15 ft
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	6.5669e-011	2.4298e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	3.963e-04	1.760e-13	2.946e-12	3.397e-16	5.688e-15
1.1732	2.430e+00	9.011e-09	7.923e-08	1.610e-11	1.416e-10
1.3325	2.430e+00	1.460e-08	1.112e-07	2.533e-11	1.930e-10

Page : 2
DOS File : 15FTP.MS5
Run Date : April 6, 2009
Run Time: 1:23:23 PM
Duration : 00:00:01

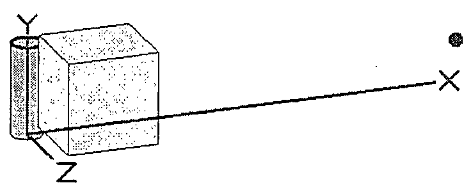
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	4.860e+00	2.361e-08	1.905e-07	4.143e-11	3.346e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 1FTP.MS5
Run Date : April 6, 2009
Run Time: 1:24:49 PM
Duration : 00:00:01

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: 1 foot pipe
Description: 1 foot pipe sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	30.48 cm	1 ft
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-012	1.6198e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-05	6.372e-14	9.996e-13	1.230e-16	1.930e-15
1.1732	1.620e-01	3.031e-09	2.499e-08	5.416e-12	4.465e-11
1.3325	1.620e-01	4.819e-09	3.442e-08	8.361e-12	5.971e-11

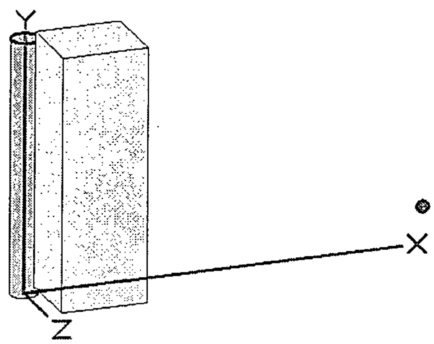
Page : 2
DOS File : 1FTP.MS5
Run Date : April 6, 2009
Run Time: 1:24:49 PM
Duration : 00:00:01

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	3.240e-01	7.850e-09	5.941e-08	1.378e-11	1.044e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page	: 1	File Ref:	
DOS File	: 3FTP.MS5	Date:	
Run Date	: April 6, 2009	By:	
Run Time	: 1:28:18 PM	Checked:	
Duration	: 00:00:01		

Case Title: 3 foot pipe
Description: 3 foot pipe sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	91.44 cm	3 ft
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	1.3134e-011	4.8595e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	7.927e-05	1.544e-13	2.492e-12	2.981e-16	4.811e-15
1.1732	4.860e-01	7.570e-09	6.391e-08	1.353e-11	1.142e-10
1.3325	4.860e-01	1.212e-08	8.856e-08	2.103e-11	1.536e-10

Page : 2
DOS File : 3FTP.MS5
Run Date : April 6, 2009
Run Time: 1:28:18 PM
Duration : 00:00:01

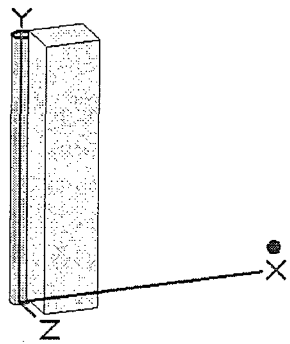
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	9.720e-01	1.969e-08	1.525e-07	3.455e-11	2.679e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 5FTP.MS5
Run Date : April 6, 2009
Run Time: 1:30:18 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: 5 foot pipe
Description: 5 foot pipe sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	152.4 cm	5 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	2.1890e-011	8.0992e-001	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.321e-04	1.740e-13	2.891e-12	3.360e-16	5.582e-15
1.1732	8.099e-01	8.819e-09	7.664e-08	1.576e-11	1.370e-10
1.3325	8.099e-01	1.424e-08	1.071e-07	2.471e-11	1.858e-10

Page : 2
DOS File : 5FTP.MS5
Run Date : April 6, 2009
Run Time: 1:30:18 PM
Duration : 00:00:01

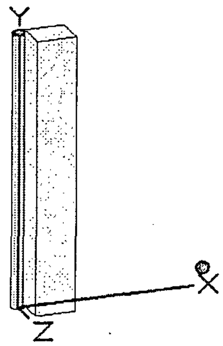
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.620e+00	2.306e-08	1.838e-07	4.047e-11	3.228e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 7FTP.MS5
Run Date : April 6, 2009
Run Time: 1:32:00 PM
Duration : 00:00:01

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: 7 foot pipe
Description: 7 foot pipe sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	213.36 cm	7 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	3.0646e-011	1.1339e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	1.850e-04	1.758e-13	2.941e-12	3.395e-16	5.679e-15
1.1732	1.134e+00	8.991e-09	7.890e-08	1.607e-11	1.410e-10
1.3325	1.134e+00	1.456e-08	1.107e-07	2.526e-11	1.920e-10

Page : 2
DOS File : 7FTP.MS5
Run Date : April 6, 2009
Run Time: 1:32:00 PM
Duration : 00:00:01

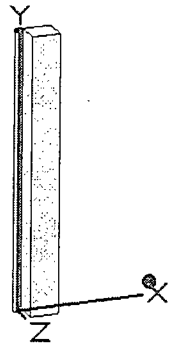
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	2.268e+00	2.355e-08	1.896e-07	4.133e-11	3.330e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : CLAD.MS5
Run Date : April 6, 2009
Run Time: 1:35:06 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: pipe &.025 iron clad
Description: pipe & 0.25 iron clad sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122
Wall Clad	.025 cm	Iron	7.86

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	1.760e-13	2.946e-12	3.397e-16	5.688e-15
1.1732	1.620e+00	9.010e-09	7.922e-08	1.610e-11	1.416e-10
1.3325	1.620e+00	1.460e-08	1.112e-07	2.533e-11	1.930e-10

Page : 2
DOS File : CLAD.MS5
Run Date : April 6, 2009
Run Time: 1:35:06 PM
Duration : 00:00:01

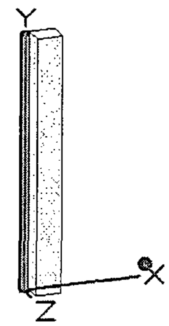
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	3.240e+00	2.361e-08	1.904e-07	4.143e-11	3.345e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : NOCLAD.MS5
Run Date : April 6, 2009
Run Time: 1:55:27 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: pipe &.no iron clad
Description: pipe & no iron clad sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

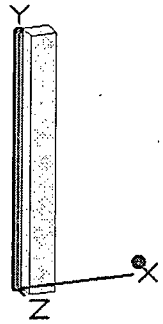
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	1.786e-13	2.981e-12	3.448e-16	5.756e-15
1.1732	1.620e+00	9.115e-09	7.996e-08	1.629e-11	1.429e-10
1.3325	1.620e+00	1.476e-08	1.122e-07	2.561e-11	1.947e-10
TOTALS:	3.240e+00	2.388e-08	1.922e-07	4.190e-11	3.376e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 9INZ.MS5
Run Date : April 6, 2009
Run Time: 1:32:48 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 9" z offset
Description: 9" z offset sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	22.86 cm
	4 ft 5.5 in	8.7 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

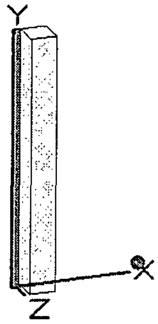
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	1.786e-13	2.981e-12	3.448e-16	5.756e-15
1.1732	1.620e+00	9.115e-09	7.996e-08	1.629e-11	1.429e-10
1.3325	1.620e+00	1.476e-08	1.122e-07	2.561e-11	1.947e-10
TOTALS:	3.240e+00	2.388e-08	1.922e-07	4.190e-11	3.376e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 12INZ.MS5
Run Date : April 6, 2009
Run Time: 1:22:40 PM
Duration : 00:00:01

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: 12" z offset
Description: 12" z offset sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	30.48 cm
	4 ft 5.5 in	8.7 in	1 ft

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

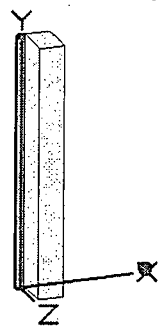
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	1.633e-13	2.764e-12	3.153e-16	5.336e-15
1.1732	1.620e+00	8.460e-09	7.502e-08	1.512e-11	1.341e-10
1.3325	1.620e+00	1.374e-08	1.055e-07	2.384e-11	1.831e-10
TOTALS:	3.240e+00	2.220e-08	1.806e-07	3.896e-11	3.172e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 18INZ.MS5
Run Date : April 6, 2009
Run Time : 1:24:03 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 18" z offset
Description: 18" z offset sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	45.72 cm
	4 ft 5.5 in	8.7 in	1 ft 6.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

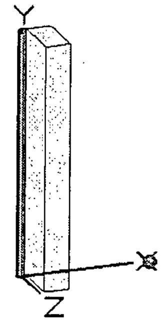
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	1.270e-13	2.231e-12	2.452e-16	4.308e-15
1.1732	1.620e+00	6.854e-09	6.260e-08	1.225e-11	1.119e-10
1.3325	1.620e+00	1.124e-08	8.875e-08	1.949e-11	1.540e-10
TOTALS:	3.240e+00	1.809e-08	1.514e-07	3.174e-11	2.659e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 24INZ.MS5
Run Date : April 6, 2009
Run Time: 1:26:08 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 24" z offset
Description: 24" z offset sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	60.96 cm
	4 ft 5.5 in	8.7 in	2 ft

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

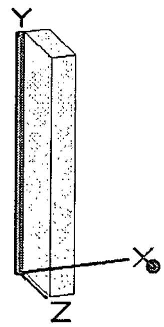
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	9.069e-14	1.675e-12	1.751e-16	3.233e-15
1.1732	1.620e+00	5.172e-09	4.912e-08	9.242e-12	8.779e-11
1.3325	1.620e+00	8.583e-09	7.036e-08	1.489e-11	1.221e-10
TOTALS:	3.240e+00	1.375e-08	1.195e-07	2.413e-11	2.099e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 36INZ.MS5
Run Date : April 6, 2009
Run Time : 1:27:34 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 36" z offset
Description: 36" z offset sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	91.44 cm
	4 ft 5.5 in	8.7 in	3 ft

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

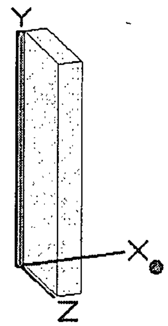
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	3.788e-14	7.949e-13	7.313e-17	1.535e-15
1.1732	1.620e+00	2.506e-09	2.630e-08	4.478e-12	4.700e-11
1.3325	1.620e+00	4.297e-09	3.872e-08	7.454e-12	6.717e-11
TOTALS:	3.240e+00	6.802e-09	6.502e-08	1.193e-11	1.142e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 48INZ.MS5
Run Date : April 6, 2009
Run Time: 1:29:37 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 48" z offset
Description: 48" z offset sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	121.92 cm
	4 ft 5.5 in	8.7 in	4 ft

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

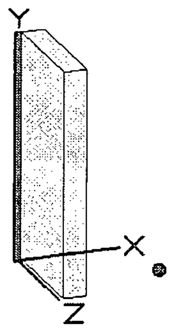
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	1.274e-14	3.103e-13	2.459e-17	5.991e-16
1.1732	1.620e+00	1.016e-09	1.201e-08	1.816e-12	2.146e-11
1.3325	1.620e+00	1.816e-09	1.830e-08	3.151e-12	3.174e-11
TOTALS:	3.240e+00	2.833e-09	3.031e-08	4.968e-12	5.320e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : 60INZ.MS5
Run Date : April 6, 2009
Run Time: 1:30:57 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: 60" z offset
Description: 60" z offset sensitivity
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	136 cm	22 cm	152.4 cm
	4 ft 5.5 in	8.7 in	5 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	3.793e-15	1.080e-13	7.322e-18	2.085e-16
1.1732	1.620e+00	3.749e-10	5.019e-09	6.699e-13	8.969e-12
1.3325	1.620e+00	7.021e-10	7.953e-09	1.218e-12	1.380e-11
TOTALS:	3.240e+00	1.077e-09	1.297e-08	1.888e-12	2.277e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page	: 1	File Ref:	
DOS File	: EF1NA22N.MS5	Date:	
Run Date	: April 6, 2009	By:	
Run Time	: 1:51:12 PM	Checked:	
Duration	: 00:00:01		

Case Title: Embedded Pipe DCGL
Description: North drain Na22
Geometry: 10 - Cylinder Surface - External Dose Point

Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Na-22	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

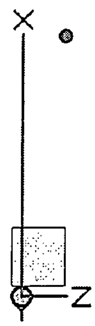
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.511	2.912e+00	7.726e-10	1.932e-08	1.516e-12	3.792e-11
1.2745	1.619e+00	1.882e-08	1.518e-07	3.300e-11	2.662e-10
TOTALS:	4.531e+00	1.959e-08	1.711e-07	3.451e-11	3.042e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1NA22.MS5
Run Date : April 6, 2009
Run Time: 1:50:13 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: South drain Na-22
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Na-22	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

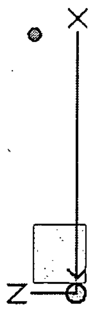
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.511	2.912e+00	7.726e-10	1.932e-08	1.516e-12	3.792e-11
1.2745	1.619e+00	1.882e-08	1.518e-07	3.300e-11	2.662e-10
TOTALS:	4.531e+00	1.959e-08	1.711e-07	3.451e-11	3.042e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1CO60N.MS5
Run Date : April 6, 2009
Run Time: 1:39:25 PM
Duration : 00:00:01

File Ref: ___
Date: ___
By: ___
Checked: ___

Case Title: Embedded Pipe DCGL
Description: North drain Co60
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

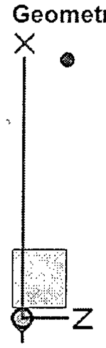
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	2.639e-13	4.479e-12	5.095e-16	8.647e-15
1.1732	1.620e+00	1.370e-08	1.216e-07	2.449e-11	2.173e-10
1.3325	1.620e+00	2.227e-08	1.709e-07	3.863e-11	2.966e-10
TOTALS:	3.240e+00	3.597e-08	2.925e-07	6.312e-11	5.138e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1CO60.MS5
Run Date : April 6, 2009
Run Time: 1:38:24 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Embedded Pipe DCGL
Description: South drain Co-60
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Co-60	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

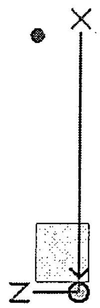
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.642e-04	2.639e-13	4.479e-12	5.095e-16	8.647e-15
1.1732	1.620e+00	1.370e-08	1.216e-07	2.449e-11	2.173e-10
1.3325	1.620e+00	2.227e-08	1.709e-07	3.863e-11	2.966e-10
TOTALS:	3.240e+00	3.597e-08	2.925e-07	6.312e-11	5.138e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1NB94N.MS5
Run Date : April 6, 2009
Run Time: 1:52:59 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: North drain Nb94
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Nb-94	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0174	5.728e-04	3.363e-262	3.354e-37	1.815e-263	1.811e-38
0.0175	1.097e-03	1.154e-257	6.487e-37	6.111e-259	3.436e-38
0.0196	3.223e-04	6.245e-190	2.279e-37	2.305e-191	8.413e-39
0.7026	1.620e+00	1.707e-09	2.851e-08	3.291e-12	5.497e-11
0.8711	1.620e+00	4.176e-09	5.317e-08	7.858e-12	1.001e-10

Page : 2
DOS File : EF1NB94N.MS5
Run Date : April 6, 2009
Run Time: 1:52:59 PM
Duration : 00:00:01

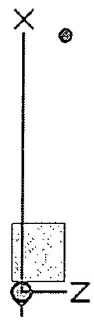
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	3.242e+00	5.882e-09	8.168e-08	1.115e-11	1.550e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1NB94.MS5
Run Date : April 6, 2009
Run Time: 1:52:02 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: South drain Nb94
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Nb-94	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0174	5.728e-04	3.363e-262	3.354e-37	1.815e-263	1.811e-38
0.0175	1.097e-03	1.154e-257	6.487e-37	6.111e-259	3.436e-38
0.0196	3.223e-04	6.245e-190	2.279e-37	2.305e-191	8.413e-39
0.7026	1.620e+00	1.707e-09	2.851e-08	3.291e-12	5.497e-11
0.8711	1.620e+00	4.176e-09	5.317e-08	7.858e-12	1.001e-10

Page : 2
DOS File : EF1NB94.MS5
Run Date : April 6, 2009
Run Time: 1:52:02 PM
Duration : 00:00:01

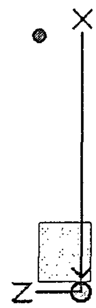
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	3.242e+00	5.882e-09	8.168e-08	1.115e-11	1.550e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1AGN.MS5
Run Date : April 6, 2009
Run Time : 1:37:24 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: North drain Ag108m
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Ag-108m	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.021	2.952e-01	4.192e-155	2.324e-34	1.242e-156	6.884e-36
0.0212	5.602e-01	8.445e-152	4.460e-34	2.444e-153	1.291e-35
0.022	8.324e-03	2.839e-139	7.029e-36	7.300e-141	1.807e-37
0.0222	1.576e-02	3.341e-136	1.348e-35	8.383e-138	3.382e-37
0.0238	1.779e-01	1.779e-112	1.712e-34	3.574e-114	3.439e-36

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DOS File : EF1AGN.MS5
Run Date : April 6, 2009
Run Time: 1:37:24 PM
Duration : 00:00:01

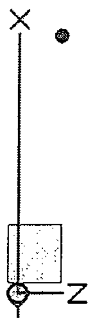
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0249	5.083e-03	6.587e-102	5.308e-36	1.150e-103	9.270e-38
0.0304	3.439e-07	2.812e-68	5.756e-40	2.684e-70	5.495e-42
0.0792	1.148e-01	1.783e-17	5.418e-16	2.833e-20	8.607e-19
0.4339	1.456e+00	1.851e-10	5.668e-09	3.623e-13	1.109e-11
0.6144	1.464e+00	8.692e-10	1.721e-08	1.694e-12	3.355e-11
0.7229	1.466e+00	1.742e-09	2.807e-08	3.350e-12	5.398e-11
TOTALS:	5.563e+00	2.796e-09	5.095e-08	5.407e-12	9.862e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1AG108.MS5
Run Date : April 6, 2009
Run Time: 1:36:16 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: South drain AG108m
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Ag-108m	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.021	2.952e-01	4.192e-155	2.324e-34	1.242e-156	6.884e-36
0.0212	5.602e-01	8.445e-152	4.460e-34	2.444e-153	1.291e-35
0.022	8.324e-03	2.839e-139	7.029e-36	7.300e-141	1.807e-37
0.0222	1.576e-02	3.341e-136	1.348e-35	8.383e-138	3.382e-37
0.0238	1.779e-01	1.779e-112	1.712e-34	3.574e-114	3.439e-36

Page : 2
DOS File : EF1AG108.MS5
Run Date : April 6, 2009
Run Time: 1:36:16 PM
Duration : 00:00:01

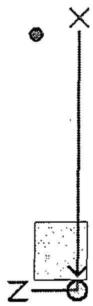
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0249	5.083e-03	6.587e-102	5.308e-36	1.150e-103	9.270e-38
0.0304	3.439e-07	2.812e-68	5.756e-40	2.684e-70	5.495e-42
0.0792	1.148e-01	1.783e-17	5.418e-16	2.833e-20	8.607e-19
0.4339	1.456e+00	1.851e-10	5.668e-09	3.623e-13	1.109e-11
0.6144	1.464e+00	8.692e-10	1.721e-08	1.694e-12	3.355e-11
0.7229	1.466e+00	1.742e-09	2.807e-08	3.350e-12	5.398e-11
TOTALS:	5.563e+00	2.796e-09	5.095e-08	5.407e-12	9.862e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1SBN.MS5
Run Date : April 6, 2009
Run Time: 1:54:46 PM
Duration : 00:00:01

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: Embedded Pipe DCGL
Description: North drain Sb125
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Sb-125	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0272	2.072e-01	9.146e-81	2.599e-34	1.217e-82	3.459e-36
0.0275	3.865e-01	1.306e-78	4.960e-34	1.687e-80	6.408e-36
0.031	1.342e-01	6.126e-60	2.387e-34	5.509e-62	2.146e-36
0.0355	6.746e-02	1.713e-45	1.896e-34	1.043e-47	1.155e-36
0.117	4.228e-03	2.226e-16	1.239e-14	3.462e-19	1.927e-17

Page : 2
DOS File : EF1SBN.MS5
Run Date: April 6, 2009
Run Time: 1:54:46 PM
Duration : 00:00:01

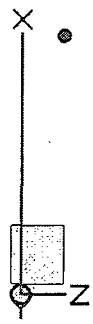
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.159	1.129e-03	7.281e-16	4.613e-14	1.217e-18	7.709e-17
0.1726	2.936e-03	3.241e-15	2.056e-13	5.527e-18	3.507e-16
0.1763	1.116e-01	1.408e-13	8.920e-12	2.414e-16	1.529e-14
0.2041	5.226e-03	1.570e-14	9.574e-13	2.783e-17	1.697e-15
0.2081	3.939e-03	1.318e-14	7.974e-13	2.347e-17	1.420e-15
0.2279	2.128e-03	1.172e-14	6.756e-13	2.126e-17	1.225e-15
0.321	6.756e-03	2.095e-13	9.028e-12	4.007e-16	1.727e-14
0.3804	2.423e-02	1.680e-12	6.011e-11	3.262e-15	1.167e-13
0.408	2.946e-03	2.824e-13	9.312e-12	5.509e-16	1.817e-14
0.4279	4.751e-01	5.667e-11	1.765e-09	1.108e-13	3.451e-12
0.4435	4.894e-03	6.872e-13	2.049e-11	1.346e-15	4.013e-14
0.4634	1.677e-01	2.872e-11	8.114e-10	5.633e-14	1.591e-12
0.6006	2.879e-01	1.549e-10	3.158e-09	3.024e-13	6.163e-12
0.6066	8.134e-02	4.571e-11	9.199e-10	8.917e-14	1.794e-12
0.6359	1.834e-01	1.262e-10	2.393e-09	2.455e-13	4.653e-12
0.6714	2.936e-02	2.550e-11	4.512e-10	4.938e-14	8.737e-13
TOTALS:	2.190e+00	4.408e-10	9.608e-09	8.594e-13	1.874e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1SB125.MS5
Run Date : April 6, 2009
Run Time: 1:53:50 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Embedded Pipe DCGL
Description: South drain SB125
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Sb-125	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0272	2.072e-01	9.146e-81	2.599e-34	1.217e-82	3.459e-36
0.0275	3.865e-01	1.306e-78	4.960e-34	1.687e-80	6.408e-36
0.031	1.342e-01	6.126e-60	2.387e-34	5.509e-62	2.146e-36
0.0355	6.746e-02	1.713e-45	1.896e-34	1.043e-47	1.155e-36
0.117	4.228e-03	2.226e-16	1.239e-14	3.462e-19	1.927e-17

Page : 2
DOS File : EF1SB125.MS5
Run Date : April 6, 2009
Run Time: 1:53:50 PM
Duration : 00:00:01

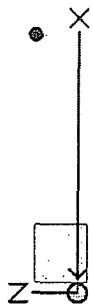
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.159	1.129e-03	7.281e-16	4.613e-14	1.217e-18	7.709e-17
0.1726	2.936e-03	3.241e-15	2.056e-13	5.527e-18	3.507e-16
0.1763	1.116e-01	1.408e-13	8.920e-12	2.414e-16	1.529e-14
0.2041	5.226e-03	1.570e-14	9.574e-13	2.783e-17	1.697e-15
0.2081	3.939e-03	1.318e-14	7.974e-13	2.347e-17	1.420e-15
0.2279	2.128e-03	1.172e-14	6.756e-13	2.126e-17	1.225e-15
0.321	6.756e-03	2.095e-13	9.028e-12	4.007e-16	1.727e-14
0.3804	2.423e-02	1.680e-12	6.011e-11	3.262e-15	1.167e-13
0.408	2.946e-03	2.824e-13	9.312e-12	5.509e-16	1.817e-14
0.4279	4.751e-01	5.667e-11	1.765e-09	1.108e-13	3.451e-12
0.4435	4.894e-03	6.872e-13	2.049e-11	1.346e-15	4.013e-14
0.4634	1.677e-01	2.872e-11	8.114e-10	5.633e-14	1.591e-12
0.6006	2.879e-01	1.549e-10	3.158e-09	3.024e-13	6.163e-12
0.6066	8.134e-02	4.571e-11	9.199e-10	8.917e-14	1.794e-12
0.6359	1.834e-01	1.262e-10	2.393e-09	2.455e-13	4.653e-12
0.6714	2.936e-02	2.550e-11	4.512e-10	4.938e-14	8.737e-13
TOTALS:	2.190e+00	4.408e-10	9.608e-09	8.594e-13	1.874e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1CS34N.MS5
Run Date : April 6, 2009
Run Time: 1:42:19 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Embedded Pipe DCGL
Description: North drain Cs134
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Cs-134	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	3.473e-03	3.208e-58	6.709e-36	2.672e-60	5.589e-38
0.0322	6.407e-03	1.543e-56	1.286e-35	1.242e-58	1.035e-37
0.0364	2.332e-03	8.587e-45	7.169e-36	4.879e-47	4.073e-38
0.2769	5.734e-04	8.617e-15	4.282e-13	1.616e-17	8.032e-16
0.4753	2.365e-02	4.543e-12	1.244e-10	8.914e-15	2.440e-13

Page : 2
DOS File : EF1CS34N.MS5
Run Date : April 6, 2009
Run Time: 1:42:19 PM
Duration : 00:00:01

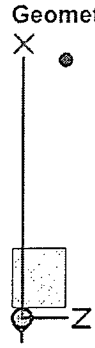
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.5632	1.357e-01	5.526e-11	1.222e-09	1.082e-13	2.393e-12
0.5693	2.499e-01	1.066e-10	2.326e-09	2.087e-13	4.553e-12
0.6047	1.581e+00	8.763e-10	1.771e-08	1.710e-12	3.454e-11
0.7958	1.383e+00	2.457e-09	3.506e-08	4.676e-12	6.673e-11
0.8019	1.414e-01	2.592e-10	3.664e-09	4.930e-13	6.968e-12
1.0386	1.620e-02	8.491e-11	8.703e-10	1.555e-13	1.594e-12
1.1679	2.916e-02	2.424e-10	2.162e-09	4.336e-13	3.867e-12
1.3652	4.924e-02	7.410e-10	5.538e-09	1.278e-12	9.551e-12
TOTALS:	3.622e+00	4.827e-09	6.868e-08	9.072e-12	1.304e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1CS134.MS5
Run Date : April 6, 2009
Run Time : 1:40:24 PM
Duration : 00:00:02

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Embedded Pipe DCGL
Description: South drain Cs134
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Cs-134	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	3.473e-03	3.208e-58	6.709e-36	2.672e-60	5.589e-38
0.0322	6.407e-03	1.543e-56	1.286e-35	1.242e-58	1.035e-37
0.0364	2.332e-03	8.587e-45	7.169e-36	4.879e-47	4.073e-38
0.2769	5.734e-04	8.617e-15	4.282e-13	1.616e-17	8.032e-16
0.4753	2.365e-02	4.543e-12	1.244e-10	8.914e-15	2.440e-13

Page : 2
DOS File : EF1CS134.MS5
Run Date : April 6, 2009
Run Time: 1:40:24 PM
Duration : 00:00:02

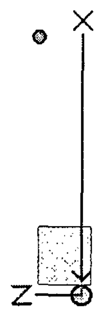
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.5632	1.357e-01	5.526e-11	1.222e-09	1.082e-13	2.393e-12
0.5693	2.499e-01	1.066e-10	2.326e-09	2.087e-13	4.553e-12
0.6047	1.581e+00	8.763e-10	1.771e-08	1.710e-12	3.454e-11
0.7958	1.383e+00	2.457e-09	3.506e-08	4.676e-12	6.673e-11
0.8019	1.414e-01	2.592e-10	3.664e-09	4.930e-13	6.968e-12
1.0386	1.620e-02	8.491e-11	8.703e-10	1.555e-13	1.594e-12
1.1679	2.916e-02	2.424e-10	2.162e-09	4.336e-13	3.867e-12
1.3652	4.924e-02	7.410e-10	5.538e-09	1.278e-12	9.551e-12
TOTALS:	3.622e+00	4.827e-09	6.868e-08	9.072e-12	1.304e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1CS37N.MS5
Run Date : April 6, 2009
Run Time: 1:43:21 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Embedded Pipe DCGL
Description: North drain Cs137
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Ba-137m	4.1415e-011	1.5324e+000	4.2570e-009	1.5751e-004
Cs-137	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	3.172e-02	2.931e-57	6.129e-35	2.441e-59	5.106e-37
0.0322	5.853e-02	1.410e-55	1.175e-34	1.135e-57	9.458e-37
0.0364	2.130e-02	7.845e-44	6.549e-35	4.457e-46	3.721e-37
0.6616	1.379e+00	1.125e-09	2.028e-08	2.181e-12	3.932e-11

Page : 2
DOS File : EF1CS37N.MS5
Run Date : April 6, 2009
Run Time : 1:43:21 PM
Duration : 00:00:01

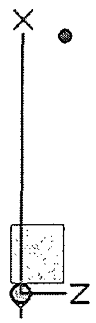
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.490e+00	1.125e-09	2.028e-08	2.181e-12	3.932e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1CS137.MS5
Run Date : April 6, 2009
Run Time: 1:41:24 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: South drain Cs137
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Ba-137m	4.1415e-011	1.5324e+000	4.2570e-009	1.5751e-004
Cs-137	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	3.172e-02	2.931e-57	6.129e-35	2.441e-59	5.106e-37
0.0322	5.853e-02	1.410e-55	1.175e-34	1.135e-57	9.458e-37
0.0364	2.130e-02	7.845e-44	6.549e-35	4.457e-46	3.721e-37
0.6616	1.379e+00	1.125e-09	2.028e-08	2.181e-12	3.932e-11

Page : 2
DOS File : EF1CS137.MS5
Run Date : April 6, 2009
Run Time: 1:41:24 PM
Duration : 00:00:01

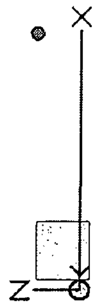
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
TOTALS:	1.490e+00	1.125e-09	2.028e-08	2.181e-12	3.932e-11

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1EU52N.MS5
Run Date : April 6, 2009
Run Time: 1:47:21 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: North drain Eu152
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Eu-152	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.04	9.584e-01	2.196e-35	4.121e-33	9.713e-38	1.823e-35

Page : 2
DOS File : EF1EU52N.MS5
Run Date : April 6, 2009
Run Time: 1:47:21 PM
Duration : 00:00:01

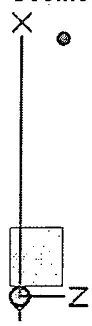
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.05	2.397e-01	1.031e-25	9.388e-25	2.747e-28	2.501e-27
0.1	4.606e-01	3.976e-15	1.860e-13	6.083e-18	2.846e-16
0.2	1.214e-01	3.245e-13	1.995e-11	5.727e-16	3.521e-14
0.3	4.380e-01	9.778e-12	4.509e-10	1.855e-14	8.553e-13
0.4	1.018e-01	8.906e-12	3.006e-10	1.735e-14	5.858e-13
0.5	9.137e-03	2.201e-12	5.655e-11	4.319e-15	1.110e-13
0.6	6.869e-02	3.681e-11	7.512e-10	7.185e-14	1.466e-12
0.8	2.884e-01	5.235e-10	7.421e-09	9.957e-13	1.412e-11
1.0	6.931e-01	3.123e-09	3.352e-08	5.757e-12	6.179e-11
1.5	3.758e-01	7.983e-09	5.395e-08	1.343e-11	9.076e-11
TOTALS:	3.755e+00	1.169e-08	9.647e-08	2.030e-11	1.697e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1EU152.MS5
Run Date : April 6, 2009
Run Time: 1:44:14 PM
Duration : 00:00:01

File Ref: ___________
Date: ___________
By: ___________
Checked: ___________

Case Title: Embedded Pipe DCGL
Description: South drain Eu152
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Eu-152	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.04	9.584e-01	2.196e-35	4.121e-33	9.713e-38	1.823e-35

Page : 2
DOS File : EF1EU152.MS5
Run Date : April 6, 2009
Run Time: 1:44:14 PM
Duration : 00:00:01

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.05	2.397e-01	1.031e-25	9.388e-25	2.747e-28	2.501e-27
0.1	4.606e-01	3.976e-15	1.860e-13	6.083e-18	2.846e-16
0.2	1.214e-01	3.245e-13	1.995e-11	5.727e-16	3.521e-14
0.3	4.380e-01	9.778e-12	4.509e-10	1.855e-14	8.553e-13
0.4	1.018e-01	8.906e-12	3.006e-10	1.735e-14	5.858e-13
0.5	9.137e-03	2.201e-12	5.655e-11	4.319e-15	1.110e-13
0.6	6.869e-02	3.681e-11	7.512e-10	7.185e-14	1.466e-12
0.8	2.884e-01	5.235e-10	7.421e-09	9.957e-13	1.412e-11
1.0	6.931e-01	3.123e-09	3.352e-08	5.757e-12	6.179e-11
1.5	3.758e-01	7.983e-09	5.395e-08	1.343e-11	9.076e-11
TOTALS:	3.755e+00	1.169e-08	9.647e-08	2.030e-11	1.697e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1EU54N.MS5
Run Date : April 6, 2009
Run Time: 1:48:26 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Embedded Pipe DCGL
Description: North drain Eu154
Geometry: 10 - Cylinder Surface - External Dose Point

Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Eu-154	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.04	3.297e-01	7.554e-36	1.418e-33	3.341e-38	6.269e-36

Page : 2
DOS File : EF1EU54N.MS5
Run Date : April 6, 2009
Run Time: 1:48:26 PM
Duration : 00:00:01

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.05	8.374e-02	3.603e-26	3.280e-25	9.599e-29	8.738e-28
0.1	6.555e-01	5.659e-15	2.647e-13	8.657e-18	4.050e-16
0.2	1.106e-01	2.957e-13	1.818e-11	5.220e-16	3.209e-14
0.4	1.156e-02	1.011e-12	3.413e-11	1.970e-15	6.650e-14
0.5	3.507e-03	8.447e-13	2.171e-11	1.658e-15	4.261e-14
0.6	1.307e-01	7.002e-11	1.429e-09	1.367e-13	2.789e-12
0.8	6.317e-01	1.147e-09	1.625e-08	2.181e-12	3.092e-11
1.0	4.983e-01	2.246e-09	2.410e-08	4.139e-12	4.442e-11
1.5	6.321e-01	1.343e-08	9.074e-08	2.259e-11	1.527e-10
TOTALS:	3.087e+00	1.689e-08	1.326e-07	2.905e-11	2.309e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1EU154.MS5
Run Date : April 6, 2009
Run Time: 1:45:39 PM
Duration : 00:00:01

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: Embedded Pipe DCGL
Description: South drain Eu154
Geometry: 10 - Cylinder Surface - External Dose Point

Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Eu-154	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.04	3.297e-01	7.554e-36	1.418e-33	3.341e-38	6.269e-36

Page : 2
DOS File : EF1EU154.MS5
Run Date : April 6, 2009
Run Time: 1:45:39 PM
Duration : 00:00:01

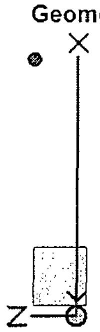
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.05	8.374e-02	3.603e-26	3.280e-25	9.599e-29	8.738e-28
0.1	6.555e-01	5.659e-15	2.647e-13	8.657e-18	4.050e-16
0.2	1.106e-01	2.957e-13	1.818e-11	5.220e-16	3.209e-14
0.4	1.156e-02	1.011e-12	3.413e-11	1.970e-15	6.650e-14
0.5	3.507e-03	8.447e-13	2.171e-11	1.658e-15	4.261e-14
0.6	1.307e-01	7.002e-11	1.429e-09	1.367e-13	2.789e-12
0.8	6.317e-01	1.147e-09	1.625e-08	2.181e-12	3.092e-11
1.0	4.983e-01	2.246e-09	2.410e-08	4.139e-12	4.442e-11
1.5	6.321e-01	1.343e-08	9.074e-08	2.259e-11	1.527e-10
TOTALS:	3.087e+00	1.689e-08	1.326e-07	2.905e-11	2.309e-10

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1EU55N.MS5
Run Date : April 6, 2009
Run Time: 1:49:24 PM
Duration : 00:00:01

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Embedded Pipe DCGL
Description: North drain Eu155
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Eu-155	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0265	5.155e-03	1.589e-87	6.110e-36	2.288e-89	8.796e-38
0.0423	1.048e-01	4.158e-33	2.008e-32	1.599e-35	7.721e-35
0.043	1.888e-01	5.134e-32	2.576e-31	1.899e-34	9.526e-34
0.0453	2.092e-02	1.613e-30	9.876e-30	5.286e-33	3.236e-32
0.0487	7.458e-02	4.064e-27	3.331e-26	1.141e-29	9.349e-29

Page : 2
DOS File : EF1EU55N.MS5
Run Date : April 6, 2009
Run Time: 1:49:24 PM
Duration : 00:00:01

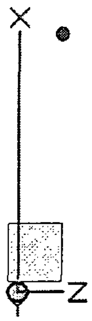
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.06	1.802e-02	3.691e-22	5.997e-21	7.329e-25	1.191e-23
0.0693	2.989e-03	1.382e-20	3.160e-19	2.372e-23	5.422e-22
0.0861	2.453e-03	2.037e-18	7.328e-17	3.155e-21	1.135e-19
0.0865	5.005e-01	4.602e-16	1.674e-14	7.120e-19	2.590e-17
0.1053	3.349e-01	5.567e-15	2.789e-13	8.540e-18	4.279e-16
TOTALS:	1.253e+00	6.029e-15	2.957e-13	9.256e-18	4.539e-16

MicroShield v5.05 (5.05-00566)
Detroit Edison Co.

Page : 1
DOS File : EF1EU155.MS5
Run Date : April 6, 2009
Run Time: 1:46:26 PM
Duration : 00:00:01

File Ref: ______________
Date: ______________
By: ______________
Checked: ______________

Case Title: Embedded Pipe DCGL
Description: South drain Eu155
Geometry: 10 - Cylinder Surface - External Dose Point



Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	5.08 cm	2.0 in

Dose Points

	X	Y	Z
# 1	135.6 cm	152.4 cm	22.86 cm
	4 ft 5.4 in	5 ft 0.0 in	9.0 in

Shields

Shield Name	Dimension	Material	Density
Cyl. Core	5.08 cm²	Concrete	1.8
Transition	.6 cm	Iron	7.86
Shield 2	30.48 cm	Concrete	2.4
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm²	Bq/cm²
Eu-155	4.3780e-011	1.6198e+000	4.5000e-009	1.6650e-004

Buildup
The material reference is : Shield 2

Integration Parameters

Y Direction (axial)	20
Circumferential	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0265	5.155e-03	1.589e-87	6.110e-36	2.288e-89	8.796e-38
0.0423	1.048e-01	4.158e-33	2.008e-32	1.599e-35	7.721e-35
0.043	1.888e-01	5.134e-32	2.576e-31	1.899e-34	9.526e-34
0.0453	2.092e-02	1.613e-30	9.876e-30	5.286e-33	3.236e-32
0.0487	7.458e-02	4.064e-27	3.331e-26	1.141e-29	9.349e-29

Page : 2
DOS File : EF1EU155.MS5
Run Date : April 6, 2009
Run Time: 1:46:26 PM
Duration : 00:00:01

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.06	1.802e-02	3.691e-22	5.997e-21	7.329e-25	1.191e-23
0.0693	2.989e-03	1.382e-20	3.160e-19	2.372e-23	5.422e-22
0.0861	2.453e-03	2.037e-18	7.328e-17	3.155e-21	1.135e-19
0.0865	5.005e-01	4.602e-16	1.674e-14	7.120e-19	2.590e-17
0.1053	3.349e-01	5.567e-15	2.789e-13	8.540e-18	4.279e-16
TOTALS:	1.253e+00	6.029e-15	2.957e-13	9.256e-18	4.539e-16

etroit
Edison

Fermi 2
6400 North Dixie Highway
Newport, Michigan 48166
(313) 586-4000

Nuclear
Operations

September 25, 1987
NRC-87-0174

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

References: 1) Enrico Fermi Atomic Power Plant, Unit 1
Docket No 50-16
NRC License No. DPR-9

2) Letter Detroit Edison to NRC, "Amendment Request for Extension of 'Possession Only' License for Fermi 1," NE-85-0714, dated May 17, 1985

3) Letter NRC to Detroit Edison, "Request for Additional Information - Enrico Fermi Atomic Power Plant, Unit No. 1," dated December 2, 1986

4) Letter Detroit Edison to NRC, "Submittal of Environmental Information for Fermi 1," NRC-87-0051, dated May 5, 1987

Subject: Transmittal of "Supplemental Environmental Information Enrico Fermi Atomic Power Plant, Unit 1"

Enclosed are five (5) copies of the subject report; the remaining thirty-three (33) copies will be sent under separate cover.

The supplemental environmental information for Fermi 1 is submitted in response to the request in Reference 2 for information that satisfies the requirements of 10 CFR 51.20(b)(5) and 10 CFR 51.45(b).

The information provided should enable the Commission to prepare an environmental assessment and to respond to the request to amend the Fermi 1 "Possession Only" License No. DPR-9. The request was to extend the expiration date for 40 years to ultimately expire in March 2025.

In accordance with present definitions, Fermi 1 is in a SAFSTOR condition. A comprehensive cleanup and decontamination effort took place from 1972 to 1975 that resulted in dismantling and shipping the radioactive fuel and blanket subassemblies and mechanical components offsite, decontaminating plant areas, sealing contaminated areas, deactivating the ventilation systems, and establishing a restricted area boundary with security controls. Surveillances in accordance with Technical Specifications and maintenance have been conducted on a continuing basis since 1975.

The proposed action to continue the SAFSTOR of Fermi 1 for 40 years will not cause a significant environmental impact, will result in a reduction of dose rate and personnel exposure at the time of final action, and will continue to minimize the risk to the health and safety of the public.

Should you have any further questions, please call E. F. Madsen at (313) 586-4205.

Sincerely,

W. S. Orser, Vice President
Nuclear Operations and
Plant Manager
Fermi 1 Custodian

Enclosure

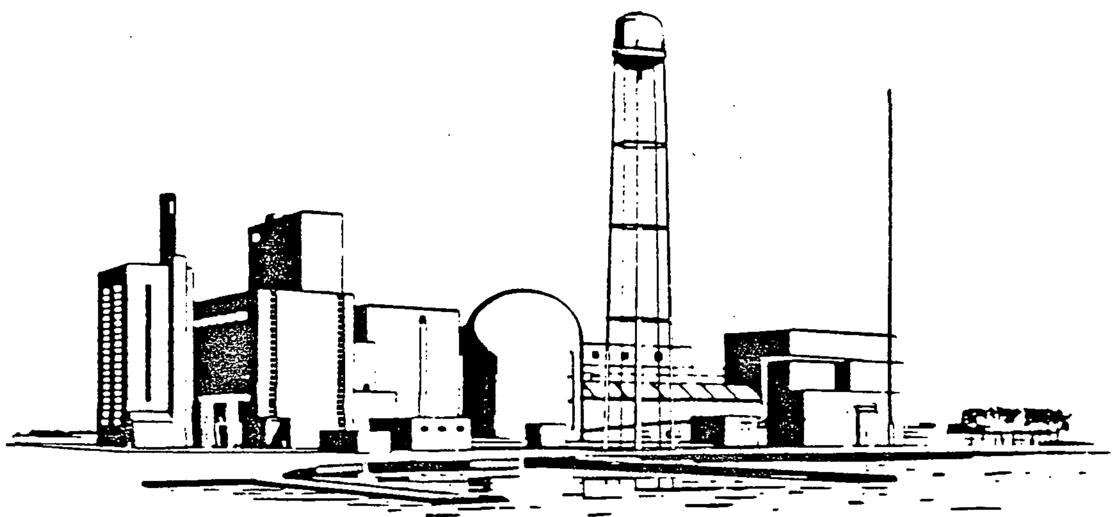
cc: H. N. Berkow
R. C. Callen (MPSC)
P. B. Erickson
W. G. Rogers
J. J. Stefano
USNRC Region III

bcc: F. E. Agosti
P. Anthony
C. Borr (WPSC, Inc.)
L. P. Bregni
J. Calhoun (ICC)
S. G. Catola
J. M. DuBay
N. M. Ewbank
J. H. Flynn
S. R. Frost
J. Green (ICC)
E. P. Griffing
D. Hahn (Michigan Dept./Public Health)
H. Heffner
D. Hoffman (Excel)
R. S. Lenart
L. Lessor (ICC)
S. Levy (ICC)
E. F. Madsen
P. A. Marquardt
R. A. May
M. E. Miles (ICC)
J. V. Neely (ICC)
G. D. Ohlemacher
W. S. Orser
G. R. Overbeck
E. Preston, Jr.
T. Randazzo
S. Savage (NUS)
D. Shen (GE)
F. J. Svetkovich
B. R. Sylvia
G. M. Trahey
W. M. Tucker

Approval Control
Secretary's Office (2412 WCB)
NRR Chron File
RACTS Coordinator
Author

U.S. Nuclear Regulatory Commissi
Docket No. 50
NRC License No. DPF

Supplemental Environmental Information
Enrico Fermi Atomic Power Plant, Unit 1



Detroit
Edison

SUMMARY

This report provides supplemental environmental information on the decommissioned Enrico Fermi Atomic Power Plant, Unit 1, located on an 1120-acre site approximately 30 miles southwest of Detroit on Lake Erie, in Lagoona Beach, Frenchtown Township, Michigan. The site is shared with Fermi 2, a 3294 Mw(t) General Electric boiling water reactor licensed to operate at 100% of rated power.

Fermi 1 was a 200 Mw(t), sodium-cooled, fast breeder reactor that operated at essentially atmospheric pressure. Fermi 1 received a low-power operating license in May 1963 and was last operated at power September 1972. At the request of the AEC, Power Reactor Development Company decided to decommission the facility in November 1972. The decommissioning effort was initiated in October 1972 with the dismantling and shipping of the radioactive fuel and blanket subassemblies offsite. The effort was completed in 1975 when mechanical components had been shipped offsite, plant areas decontaminated, contaminated areas sealed, a restricted area boundry established, and surveillances began in accordance with Technical Specifications.

The proposed action to continue the SAFSTOR of Fermi 1 for 40 years will not cause a significant environmental impact and will result in a reduction of dose rate and personnel exposure at the time of final action and will minimize the risk to the health and safety of the public.

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1.0 INTRODUCTION

On May 17, 1985, Detroit Edison submitted to the NRC an application to amend the Possession Only license (License No. DPR-9) for the Enrico Fermi Atomic Power Plant, Unit 1 (Fermi 1) to reflect an extension of 40 years to expire in March 2025 (Reference 1). In addition to the request for additional information (Reference 2) there has been correspondence (References 3, 4, 5, 6, and 7) and a meeting with the NRC staff concerning the request to provide environmental information pursuant to 10CFR51.45(b). This document is in response to Reference 7 and addresses the environmental aspects of the current status of the decommissioned Fermi 1.

Fermi 1 was a 200 Mw(t), sodium-cooled, fast breeder reactor that operated essentially at atmospheric pressure. The plant was developed under the AEC Power Demonstration Program and was constructed, owned, and operated by Power Reactor Development Co. (PRDC). PRDC was assisted by Atomic Power Development Associates, Inc. (APDA), who carried out the research and development, the conceptial design, and operated a facility to test the vital components of the reactor. Both of these companies consisted of member companies who financed the project with some aid from the AEC. A chronological history of the Fermi 1 project is presented in Table 1.1. Many of the details surrounding this history can be found in **FERMI 1, New Age for Nuclear** Power published in 1979 by the American Nuclear Society.

The Fermi 1 decommissioning was ordered via a letter directive from the AEC, L. Manning Muntzing, issued March 31, 1972 that stated

> ...an itemization of estimated costs to place the reactor in the proposed decommissioned condition (including costs to package, transport, and reprocess fuel and costs for burial of the axial and radial blankets), and a statement of the assumptions made in arriving at these costs to maintain the reactor in a proposed decommissioned condition. These estimated costs should be based on a proposed plan for decommissioning and maintenance of the plant in perpetuity.

The final plans for decommissioning Fermi 1 were submitted to the AEC in September 1973. Since there were no guidelines available from the AEC associated with the decommissioning of a sodium-cooled reactor, studies were conducted by the AEC and PRDC to determine the disposition of the irradiated blanket elements and radioactive primary system sodium.

The primary objective of the decommissioning was to perform the activities within the funds allocated such that the health and safety of the public was protected at all times. Decommissioning was accomplished through the provisions of 10CFR50.59 and a series of Technical Specification changes and is documented in detail in two reports issued by PRDC (Reference 8). The major retirement activities and plan for maintenance of the plant in perpetuity are summarized as

- Return of leased enriched uranium to AEC, Savannah River Plant.
- Offsite disposition of blanket subassemblies.
- Offsite disposition of radioactive and non-radioactive sodium.
- Passivation of residual sodium.
- Disposal of contaminated equipment and materials.
- Fencing facility
- Surveillance (Technical Specifications).
- Retention of legal and other significant documents.
- Establishment of administrative controls for authorized entry into restricted areas, preparation of reports, and general custodial functions.

The present status of Fermi 1 is described in Appendix 1.

Table 1.1 - CHRONOLOGICAL HISTORY OF THE FERMI 1 PROJECT

1950, October 30	Formation of Dow Chemical-Detroit Edison Study Group.
1954, August 30	Atomic Energy Act of 1954 became law.
1955, January 16	AEC Power Demonstration Program initiated.
1955, March 10	Incorporation of APDA.
1955, March 30	Filed proposal to develop a fast breeder reactor under AEC Demonstration Program.
1955, August 8	Proposal to AEC accepted during First Geneva Conference.
1955, August 30	Incorporation of PRDC.
1956, January 6	PRDC filed application for construction permit to erect a fast breeder reactor at Lagoona Beach, Michigan.
1956, April 30	Grade and fill work started at site.
1956, August 4	AEC issued construction permit to PRDC.
1956, August 8	Groundbreaking ceremony.
1956, August 31	UAW, IUE, and UPA filed petition for intervention before AEC; case docketed as F-16.
1958, December 10	AEC issued order confirming previously issued construction permit.
1959, July 25	AFL-CIO appealed to U.S. Court of Appeals asking that construction permit be set aside.
1960, June 10	Court of Appeals by 2-1 decision set aside AEC construction permit on grounds of illegal departure from statutes and regulations.
1960, August 12	PRDC filed petition for certiorari with Supreme Court asking that it reverse the decision of Court of Appeals.
1961, June 12	U.S. Supreme Court reversed Court of Appeals and confirmed AEC construction permit.
1963, May 10	AEC issued 1-Mw operating license, subject to final inspection by Division of Compliance.
1963, August 23	First criticality of Fermi and start of low-power tests.

1964, March 12	Application filed with AEC for license to operate up to 200 Mw (t).
1965, December 17	Operating license issued to PRDC by AEC DRL. (License No. DPR-9)
1966, July 8	First 100-Mw(t) operation.
1966, October 5	Fuel melting incident; plant became inoperative for 3 years and 9 months.
1970, February 10,	PRDC granted permission to load fuel and resume operations up to 200Mw(t).
1970, July 18	Criticality achieved.
1970, October 16	Reactor power level of 200 Mw(t) reached.
1970, November	Proposal to AEC for oxide core.
1970, December	Master plan for continued operation using oxide core; beginning of attempt to fund $50 million program.
1971, November 20 to December 1	10-day high-power operation logging 1660 Mwd(t).
1972, June 9	AEC ordered PRDC to show cause: (1) why its request for extension of expiration date of Provisional Operating License DPR-9 should not be denied, and (2) why PRDC should not suspend operation at Fermi, submit a dismantling plan, and prepare to implement it.
1972, August 28	AEC determined that PRDC was not financially qualified to warrant extension of its license and set the matter for a hearing.
1972, Sept. 15-22	Last plant operation at low power for operator licensing examinations.
1972, November 27	Decision by PRDC Executive Committtee to decommission.
1973, September 24	Submission to AEC of retirement plan.
1973, November	AEC approval of decommissioning plan.
1974, March	Retirement of the Enrico Fermi Atomic Power Plant, Report NP-20087 (PRDC)
1975, October	Retirement of the Enrico Fermi Atomic Power Plant, Report NP-20047, Supplement 1 (PRDC)

1975, December 31	Decommissioning completed and PRDC dissolved.
1976, January 3	Transfer of License No. DPR-9; possession only from PRDC to Detroit Edison.
1984, November	Completion of shipment of primary sodium to ANL, Scovile, Idaho.
1985, May 17	Amendment request for extension of the Possession only license for Fermi 1 for 40 years to expire March 2025.

2.0 DECOMMISSIONING OF FERMI 1

2.1 DESCRIPTION OF THE PLANT

2.1.1 General Description

Fermi 1 is located on an 1120 acre site approximately 30 miles southwest of Detroit on Lake Erie, in Lagoona Beach, Frenchtown Township, Michigan (Figure 2.1). The site is shared with Fermi 2, a 3294 Mw(t) General Electric boiling water reactor rated at 1093 Mw(e) net. Fermi 2 is presently licensed to operate at 100% of rated power, but is temporarily restricted to levels below 50% (Figure 2.2).

Fermi 1 was a fast breeder, sodium-cooled reactor, operated at essentially atmospheric pressure. The plant was designed for a maximum capability of 430 Mw(t); however, the maximum reactor power with the first core loading (Core A) was 200 Mw(t). The plant was composed of the reactor containment building, which housed the reactor and the primary coolant system; the steam generator building; the control building; and the turbine house. Some distance from this building complex there was a fuel and repair building, in which fresh and spent fuel was stored and processed; a waste gas building, in which waste gas was processed and from which inert gas was supplied and recirculated; a sodium building in which sodium was cold-trapped and stored; and a combined health physics building and chemistry laboratory (Figures 2.3 and 2.4). A brief description of the plant facilities pertinent to the understanding of the approved plan for decommissioning the facility is presented in the following paragraphs.

2.1.2 Reactor Vessel and Associated Structures

The stainless steel reactor vessel is composed of four parts: the lower reactor vessel, the transfer rotor container, the upper reactor vessel, and the rotating shield plug container. The cylindrical lower reactor vessel, which contained the core and blanket is 114 inches in diameter and has a dished ellipital head. The transfer rotor container, used for fuel storage and transfer, is attached to the lower reactor vessel. The upper reactor vessel, which is eccentric with the lower vessel, is also cylindrical and is 174 inches in diameter. The upper portion of the vessel is sealed at the top by the rotating shield plug, which supports the control mechanism, the fuel holddown mechanism (HDM), and the offset handling mechanism (OHM). The plug container is an extension of the upper reactor vessel and is stepped to maintain the biological shielding effectiveness of the rotating plug.

The vessel as a whole contained the reactor and the primary sodium coolant which flowed upward through the core and blanket. Sodium coolant for the core and inner radial blanket entered the lower vessel through three equispaced nozzles 14 inches in diameter; sodium coolant for the outer blanket entered the lower reactor vessel through three equispaced nozzles 6 inches indiameter. Sodium from the core and blanket discharged into a common pool and left the upper reactor vessel through three equispaced nozzles 30 inches in diameter.

The reactor vessel was surrounded by a graphite neutron shield located in a nitrogen atmosphere inside the primary shield tank. The graphite consisted of an inner 6-inch layer of 5% borated graphite next to the reactor vessel wall, a layer of heat insulation, a region of unborated graphite, and a 6-inch layer of borated graphite which lined the inside of the primary shield tank.

The upper portion of the primary shield tank served as a biological shield and was integral in purpose and shielding effectiveness with the rotating shield plug and the biological shield function of the operating floor.

2.1.3 Core and Blanket Components

The reactor was an assembly of 870 removable and, to a certain extent, interchangeable subassembly units located on a square lattice spacing. The core subassemblies contained the upper and lower axial blankets and occupied a roughly cylindrical region in the center of the lattice. The entire core region was about 31 inches in diameter and 31 inches high, while the axial blanket regions were each 17 inches high.

The subassembly lattice positions immediately surrounding the core region comprised the inner radial blanket (IRB) region; the 499 subassembly lattice positions surrounding the IRB comprised the outer radial blanket region (ORB). Surrounding the ORB region were 198 lattice positions used for steel subassemblies that provided thermal and irradiation shielding for the reactor vessel. Together the core and blanket regions approximated a cylinder 80 inches in diameter and 70 inches high.

The active fuel region of each core subassembly was made up of 140 zirconium-clad uranium 10 w/o-molybdenum alloy pins enriched to 25.6 w/o in uranium-235. The upper and lower axial blanket regions in each core subassembly contaianed 16 stainless steel clad 3 w/o molybdenum alloy rods containing uranium depleted to 0.35 w/o uranium-235. The radial blanket rods were similar to the axial blanket rods, except they were 71.5 inches long instead of 17 inches long; each radial blanket subassembly contained 25 blanket rods.

2.1.4 Fuel and Repair Building

The Fuel and Repair Building (FARB) contained process cells, water-filled decay and cut-up pools, a new fuel handling and storage area, a central control room, a 75-ton crane, and a transport car access area for the performance of fuel handling functions; space was provided for a repair and cleaning facility for maintenance of contaminated equipment. The building is located approximately 100 feet north of the Reactor Building and is connected to the Reactor Building by a covered transport car track. The substructure of the FARB consists of heavy reinforced concrete walls and rests on bedrock. The superstructure consists of two different types of construction. The walls above the operating floor in the new fuel receiving and storage area and the irradiated fuel decay and cut-up pool areas are reinforced concrete. All other superstructure walls consist of structural steel with corrugated asbestos siding.

2.1.5 Sodium Service System

The cold trap system was contained in a separate substructure room diagonally adjacent to the transfer tank room. The sodium lines and equipment were shrouded in a welded carbon steel secondary structure which was inerted with nitrogen. The piping outside the walled areas was in the repair pit area and was contained in a concrete vault with a removable cover slab.

2.1.6 Heat Removal Systems

The heat removal systems consisted of three primary and three secondary coolant loops. The sodium pumps, one per loop, were all single-stage centrifugal mechanical pumps. Heat was removed from the reactor core and blanket by the primary sodium coolant, transferred to the secondary sodium coolant by three parallel intermediate heat exchangers located in the reactor building, and finally transferred to water and steam in three once-through steam generators located in the Steam Generator Building.

2.1.7 Waste Gas Disposal System

The waste gas system disposed of waste gases from the plant by a process which included storage until the gases decayed to a suitable level, dilution below the maximum permissible concentration in air, and dispersion into the atmosphere through a stack. The waste gas disposal building is immediately west of and adjacent to the inert gas building. Piping, valves, and mechanical equipment were housed in chambers below grade; the holdup tanks are housed above grade in shielded cells of the building.

2.1.8 Liquid Waste Disposal System

Like the waste gas disposal system, the liquid waste disposal system was designed for 430 Mw(t) reactor operation and 6 a/o fuel burnup. It provided for substantial holdup capacity, permitting discontinuous discharge if necessary. The major sources of liquid waste were effluents from subassembly cleaning, miscellaneous decontamination operations, and laboratory sinks. After process and decay when necessary, wastes were diluted and discharged to the lagoon from which they reached Lake Erie via Swan Creek.

The liquid waste disposal system is located in the FARB. Its major components are three liquid waste surge tanks, a liquid waste test tank, a liquid waste dump tank, ion exchange units, a liquid waste metering pump, and the associated piping and valving.

2.1.9 Turbine and Electrical Systems

Steam produced in the three steam generators located within the Steam Generator Building passed to the adjacent turbine house and was used to operate the turbine. The turbine was a tandem-compound, single-flow machine having a guaranteed gross capability of 150 Mw(e). Four stages of feedwater heating were used. The main condenser was a single-flow, divided-water-box, welded steel unit. Four feedwater heaters, a drain cooler, and a reheated drain cooler were included in the cycle. Three feedwater pumps were provided, two of which were capable of pumping the flow required for the ultimate 430 Mw(t) conditions.

2.2 DECOMMISSIONING ACTIVITIES

Although the decommissioning plan was not formally approved by the AEC until November 1973, a year after initial submittal, decommissioning activities were initiated in October 1972 with the removal and cleaning of the reactor fuel. Activities were essentially completed in October 1975 with the exception of shipping the primary sodium to the Clinch River project which was accomplished in November 1984. In December 1975, the corporate existence of PRDC was terminated and in January 1976 Detroit Edison became the legal custodian of the Fermi 1 plant site.

2.2.1 Disposal of Fuel and Blanket Subassemblies

Fuel for the Fermi reactor was defined as the 25.6% enriched uranium/molybdenum alloy pins contained in the mid-portion of the fuel subassemblies. This material contained approximately 4000 kilograms of uranium, which was assigned to the project under an AEC lease agreement. Under terms of the agreement, the uranium was to be returned to the AEC in the form of UF_6 meeting diffusion plant purity specifications, if a private commercial company in the U.S. could do the work; if no company were available, the AEC would accept the irradiated materials under the spent fuels chemical processing and conversion provisions of the Atomic Energy Act of 1954, using specified hypothetical plant costs. The AEC agreed to accept the material at its Savannah River Project (SRP).

Two shipping casks were designed, fabricated, and licensed for Fermi fuel. The cask cavity was licensed to accommodate four complete subassemblies, two defective subassemblies in canisters, or eight cut fuel segments.

Subassembly cutting and cask loading were accomplished on a 24-hour day, 6-day week basis. The casks were loaded manually through the top with the cask upright on the floor of the pool. The cask lid was set in place prior to lifting the cask out of the pool. After the cask was loaded, it was set in a tray adjacent to the pool assembly, leak checked, and decontaminated. Decontamination of the cask was done by washing with soap and water and wiping with paper towels; it was not difficult because exterior surfaces were smooth and nonporous.

During these operations, the spread of contamination was readily controlled and limited to the cut-up pool area, where lab coats and shoe covers were required. The activity of the pool water was typically 5×10^{-5} uCi/cm^3; this was principally ^{60}Co and ^{137}Cs from the surface of the subassemblies.

The shipments were scheduled so that one cask would be at the SRP being unloaded, while the other cask was at the site being loaded. Loading or unloading, including decontamination, required approximately 24 hours; transportation time between the site and the SRP was 18 to 24 hours. The first shipment of fuel from the site was made on February 6, 1973; 14 weeks later, on May 15, 1973, the last shipment from Batelle Memorial Institute arrived at the SRP.

Disposal of all blanket subassemblies, some of which were purposely segmented, was accomplished by shipment to the Idaho Chemical Processing Plant (ICPP). This involved 962 subassemblies or segments containing a total of 6524 grams of ^{239}Pu, which were shipped in 14 cask loadings between December 17, 1974 and April 18, 1975. Of the 962 subassemblies or segments, 318 were uncut outer radial blankets, 168 were cut outer radial blankets, 73 were cut inner radial blankets, 202 were upper axial blankets, 132 were cut lower axial blankets, and 69 were uncut lower axial blankets. The term "cut" indicates that the nozzle was removed from the subassembly.

2.2.2 Materials Removed

Nonradioactive secondary sodium was sold and shipped to Fike Chemical Company, Nitro, West Virginia and processed into sodium methylate. The primary cold trap and hot trap, including miscellaneous piping, were shipped to Beatty, Nevada for burial. Other miscellaneous radioactive or contaminated items were buried, including dummy subassemblies, oscillator rods, neutron sources, special reactor and pool handling tools, etc. Whenever possible, miscellaneous hardware, such as pool racks, were decontaminated and sold as scrap. When this was not possible, they were shipped for burial.

2.2.3 Decontamination and Sealing of Contaminated Areas

Each item slated for disposal was rinsed to remove loose surface contamination and surveyed for contamination level. In general, items with radiation or contamination levels above the maximum permissible concentration (MPC) were logged and sealed for offsite disposal at Morehead, Kentucky, while all items with radiation or contamination levels below MPC were sold as scrap.

A significant effort was exerted in decontaminating the FARB decay and cut-up pools. After all equipment was removed from the decay pool, the pool walls were scrubbed with a detergent and soapy water. The final wash consisted of a 10% nitric acid solution and a demineralized water rinse. Protective clothing worn by personnel consisted of plastic coveralls, rubber gloves, plastic shoe covers, and respirators. Personnel exposure was monitored by health physics technicians at all times.

Subsequent to the final cleaning and drying, a 20-mil-thick layer of Cooks Spray Booth Shield White strippable paint was applied in several coats to all surfaces of both pool walls, floor, and tunnel. Approximately 50 gallons of paint were applied using hand rollers. Personnel wore coveralls and oxygen breathing masks and worked from a hanging cage. Additional air horns were provided for ventilation during the painting process.

After shipping all the radioactive material that was economically recoverable off site and decontaminating to the extent practicable, the only remaining major decommissioning task was sealing the reactor building, the primary sodium system, and the secondary sodium system. Therefore, it was decided to seal the reactor vessel within the primary shield tank and to seal the outlying components directly, using the reactor building as an isolation structure against personnel access to the primary system.

The reactor building superstructure is of a design conducive to long life with little maintenance. It was decided that since the primary system would be completely sealed and there was no other source of radiation or contamination in the building, closure would constitute only the prevention of personnel access to radiation areas. The building itself would be permitted to breathe. No sealing of building penetrations were made, except as related to closure of the radioactive primary sodium system, service system, and cover gas system. These systems were then sealed and maintained at slightly positive inert gas pressure to prevent the entrance of water or moisture and to minimize dispersal of any remaining radioactive material.

After removal of the sodium, the primary system was cooled. A gastight system was then established consisting of the primary sodium system plus the primary shield tank, the machinery dome, and the primary and secondary sodium service systems extending out to welded pipe caps. This system was filled with nitrogen and passivated with carbon dioxide, which reacts with residual sodium to form an inert solid compound Na_2CO_3. Nitrogen and CO_2 gas is maintanined under positive pressure within the sealed system by use of a N_2 and CO_2 bottle gas system. The retired reactor vessel contains 7 safety rods, 1 control rod, 10 lower guide tubes, 1 neutron source, 4 dummy subassemblies, and 198 stainless-steel thermal shield bars, but no fuel or blanket subassemblies.

The sodium service system piping was cut in the cold trap room and in the Reactor Building and caps were welded onto the pipes where they connect to the primary system. Sodium service piping between the Reactor Building and the cold trap room was closed by valves at one end and by welded caps at the other end, wherever they were cut. The insides of the pipes are contaminated with a very thin layer of sodium. One of the tunnel lines contains sodium; this line was sealed with a welded cap in the lower Reactor Building.

The auxilialry fuel storage facility was sealed after 100 pounds of CO_2 were added to passivate any residual sodium that may have dripped from the fuel storage pots.

The FARB transfer and overflow tanks were drained, sealed, and passivated with CO_2, then opened to the air atmosphere of the tank room. The forced circulation cold trap system associated with the transfer tank has been completely removed, disassembled, and shipped for burial. The cold trap room is vacant except for sections of service piping.

Access to the tunnel between the Reactor Building and the cold trap room can only be obtained by removing a welded cover. Access to the tunnel from the cold trap room is closed off by a concrete barrier. Radiation levels in the tunnel have not been measured, but contamination levels in December 1973 were less than 100 d/min/100 cm^2.

The liquid waste and sump pump system has been deactivated, but left intact so any potential groundwater leakage can be pumped from the sumps to the FARB liquid waste storage tanks for later controlled discharge. Radiation and surface contamination levels in the 1973-1975 period are shown in Table 2.1; activation sources in the reactor vessel in 1973 are shown in Table 2.2.

2.2.4 Restricted Area Boundary

The Fermi 1 boundary was revised to exclude many nonradioactive areas such as the Office and Turbine Building. The new boundary (Figure 2.5) is marked by a 7-foot-high chain-link fence and building walls that enclose the FARB, the Reactor Building, the Sodium Storage Building, and the cold trap room. The cold trap room contains some contaminated piping. The health physics building has been dismantled.

2.2.5 Surveillance

Surveillances are maintained for Fermi 1 pursuant to Section I.8, Reporting Requirements of the Technical Specifications, Amendment 8 to Provisional Operating License No. DPR-9. Surveillance data is available on an annual basis as submitted to the Commission from the year ending June 30, 1975 through June 30, 1987 as Reports EF-121 through EF-133.

2.3 DECOMMISSIONING COSTS

The decommissioning activities for Fermi 1 were influenced by the following factors:

- o Detroit Edison's use of the Fermi 1 turbine steam supplied from an oil-fired boiler for peaking power. (Presently retired on Economic Reserve)
- o Detroit Edison's construction of an 1100 Mw(e) boiling water reactor adjacent to Fermi 1.
- o The $4 million retirement fund held in reserve by PRDC.

The major decommissioning activities and plan for maintenance of the plant in perpetuity formed the framework for the decommissioning program. The final decommissioning costs are shown in Table 2.3. The monies over and above the $4 million were obtained from member company contributions and revenue from salvage sales.

Table 2.1 RADIATION AND SURFACE CONTAMINATION LEVELS

Location	RADIATION LEVELS mR/h Max	Avg	CONTAMINATION LEVEL d/m/ft^2 Max	Avg	Date
Fuel and Repair Bldg.					
Repair Pit	1	0.02	150	<100	11/19/75
Decontamination Facility	0.03	0.01	400	<100	11/19/75
Dry Loading Tunnel	6	0.4	250	<100	7/14/75
Steam Cleaning Chamber	10	2	140,000	44,000	2/8/74
Decay Pool and Room	20[1]	0.03	18,000[1]	<100	12/1/75
Cutup Pool and Room	40[2]	0.03	2,200[2]	150	12/1/75
Mechanical Equipt. Room	2	0.1	2,800[3]	<100	1/14/76
Control & Receiving Room	0.3	0.01	183	<100	11/21/75
Cask Car Maintenance Pit	0.3	0.01	<100	<100	11/19/75
Fan Room	1	0.01	110	<100	11/19/75
Unloading Pit	0.03	0.02	<100	<100	11/25/75

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1 20 mR/h on decay pool tunnel to cutup pool wall support beam. Whole pool is covered with strippable paint; 18,000 dpm is on remnants of chain for bridge grapple inside bridge trolley cabinet that is sealed and labeled.

2 40 mR is due to material trapped under alignment pads on bottom of cutup pool. Pads are sealed with metal putty and whole pool is covered with strippable paint; 2200 dpm is on boom crane that is sealed in plastic and labeled.

3 8300 dpm is on liquid waste pump that was decontaminated and covered with plastic.

Table 2.1 **RADIATION AND SURFACE CONTAMINATION LEVELS (Cont.)**

Location	RADIATION LEVELS mR/h Max	RADIATION LEVELS mR/h Avg	CONTAMINATION LEVEL d/m/ft^2 Max	CONTAMINATION LEVEL d/m/ft^2 Avg	Date
Lower Fuel Vault	0.02	0.01	<100	<100	11/19/75
Upper Fuel Vault	0.3	0.01	<100	<100	11/21/75
Transfer Tank Room	7	0.5	<100	<100	2/6/74
Pool Sump[1]	0.03	0.02	<100	<100	11/18/75
Hot Sump Pit[2]	120	2	800	170	11/4/75
Clean Shop	0.02	0.01	<100	<100	11/24/75
Cold-Trap Room	0.03	0.02	126	<100	11/6/75
North Waste Tank Room	100	3	<100	<100	11/19/75
South Waste Tank Room	60	1	<100	<100	11/19/75
Reactor Building					
Biological Shield Wall - Annulus	0.05	0.02	<100	<100	11/18/75
Below-Floor Area	2	0.2	<100	<100	10/8/75
Outside Auxiliary Fuel Storage Facility	0.1	0.1	<100	<100	5/7/74
Operating Floor	30	7	200	<100	10/8/75
Machinery Dome	1.5	1	105	<100	4/24/75
Secondary Shield Wall Cavity	15	0.1	<100	<100	10/8/75

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1 Above waterline. Does not include below waterline.

2 Does not include sump below waterline.

Table 2.1 RADIATION AND SURFACE CONTAMINATION LEVELS (Cont.)

Location	RADIATION LEVELS mR/h Max	Avg	CONTAMINATION LEVEL d/m/ft^2 Max	Avg	Date
Reactor Building Anti-contaimination Bldg.	0.05	0.03	<100	<100	11/7/75
Cask Car Trestleway	0.2	0.05	<100	<100	9/14/77
Waste Gas Compressor Rm	0.02	0.01	<100	<100	11/17/75
Waste Gas Valve Room	0.02	0.02	<100	<100	11/17/75
Primary Sodium Cold-. trap Room	3	0.05	108	<100	11/5/75
Primary Sodium Storage Room	6	3	<100	<100	11/5/75
Primary Sodium Service System Valve Room	0.3	0.01	<100	<100	11/17/75
East Sodium Gallery	0.02	0.02	<100	<100	10/9/75
West Sodium Gallery	0.02	0.02	<100	<100	10/9/75
Fission Products Detector Building	0.03	0.02	<100	<100	5/16/74
Inert Gas Tunnel	0.1	0.02	<100	<100	11/26/75
Vent Building	0.03	0.02	<100	<100	11/17/75
Vent Building Equipt.Pit	0.02	0.01	<100	<100	11/17/75
Health Physics Building					
Office and Lab	0.05	0.02	<100	<100	11/12/75
Locker Room	0.03	0.02	<100	<100	11/12/75
First Aid Rooms	0.02	0.02	<100	<100	10/17/75
Chem Lab	0.02	0.02	<100	<100	11/12/75

Table 2.2 **CALCULATED STAINLESS-STEEL ACTIVATION IN REACTOR VESSEL (NEGLECTING BLANKET SUBASSEMBLIES) - June 1, 1973**

Component	Activation Source, Ci				
	^{63}Ni	^{55}Fe	^{58}Co	^{60}Co	Total
Control & safety rod channels	2	99	22	19	142
Holddown mechanism	5	206	6	228	439
Shield bars	22	796	12	105	935
Thermal shield	22	796	1	97	916
Holddown column	*	22	*	3	25
Safety rods	*	3	*	3	6
Rotating plug	*	1	*	1	2
Support plates	24	860	*	965	1849
Support structure	7	259	*	35	301
Support structure Shielding	8	269	*	35	312
Flow baffles	*	10	*	2	12
Conical flow guide	*	1	*	1	2
Lower reactor head Shielding	4	152	*	18	174
Transfer rotor	*	1	*	1	2
OHM	1	44	*	6	51
Reactor Vessel	-	-	-	-	-
Total	96	3515	35	1519	5168

* Less than 1 Ci.

Table 2.3 FINAL DECOMMISSIONING COST

1.	**Core Fuel Processing** Includes transferring subassemblies from reactor and other storage areas to FARB, steam cleaning, underwater segmenting, loading in casks and shipping to Savannah River; also includes material and fabrication cost of No. 2 shipping cask and modifications to No. 1 cask.	$ 418,000
2.	**AEC Core Fuel Processing** Includes basic processing and conversion charges, processing and conversion losses, and use charges during the processing period.	1,783,000
3.	**Blanket Subassembly Processing** Includes transferring subassemblies from reactor and other storage areas to FARB, steam cleaning, and storage in cutup pool.	67,000
4.	**Blanket Subassembly Processing for Disposal at Idaho** Includes licensing and rental of two casks, design and purchase of special basket and container assemblies, round-trip shipping charges, and cutting and disposing of some nozzles.	386,000
5.	**AEC (ERDA) Blanket Subassembly Processing Payment** Blanket accepted by ERDA under Reprocessing provisions of 33CFR30.	1,594,000
6.	**Sodium and Cold Trap Disposal** Includes transferring primary sodium from all systems to storage tanks, constructing a sodium-barreling facility, and dismantling and removing the primary cold trap for shipment to Beatty, Nevada. Includes $75,000 allocated to the trust fund to barrel and ship primary sodium to PMC in 1981 - 1985.	250,000
7.	**Sodium Piping and Contaminated Equipment Disposal** Includes cutting and sealing pipes and equipment, decontaminating equipment, and packaging solid waste for burial.	480,000
8.	**Plant and Administrative Expenses** Includes plant and administrative expenses, nuclear insurance, property tax, regulatory charges, and AEC use charges. Amount is reduced by $376,000 of interest received on invested funds during the decommissioning period.	1,999,700

Table 2.3 FINAL DECOMMISSIONING COST (Cont.)

	Total Cost of Decommissioning	$6,977,700
9.	**Provision for Surveillance**	187,288[1]
	Total Cost of Decommissioning including Surveillance Fund	$7,164,988

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1 In addition to this amount, it was anticipated that the fund would increase over the next 10 years due to premium funds from the NELIA insurance.

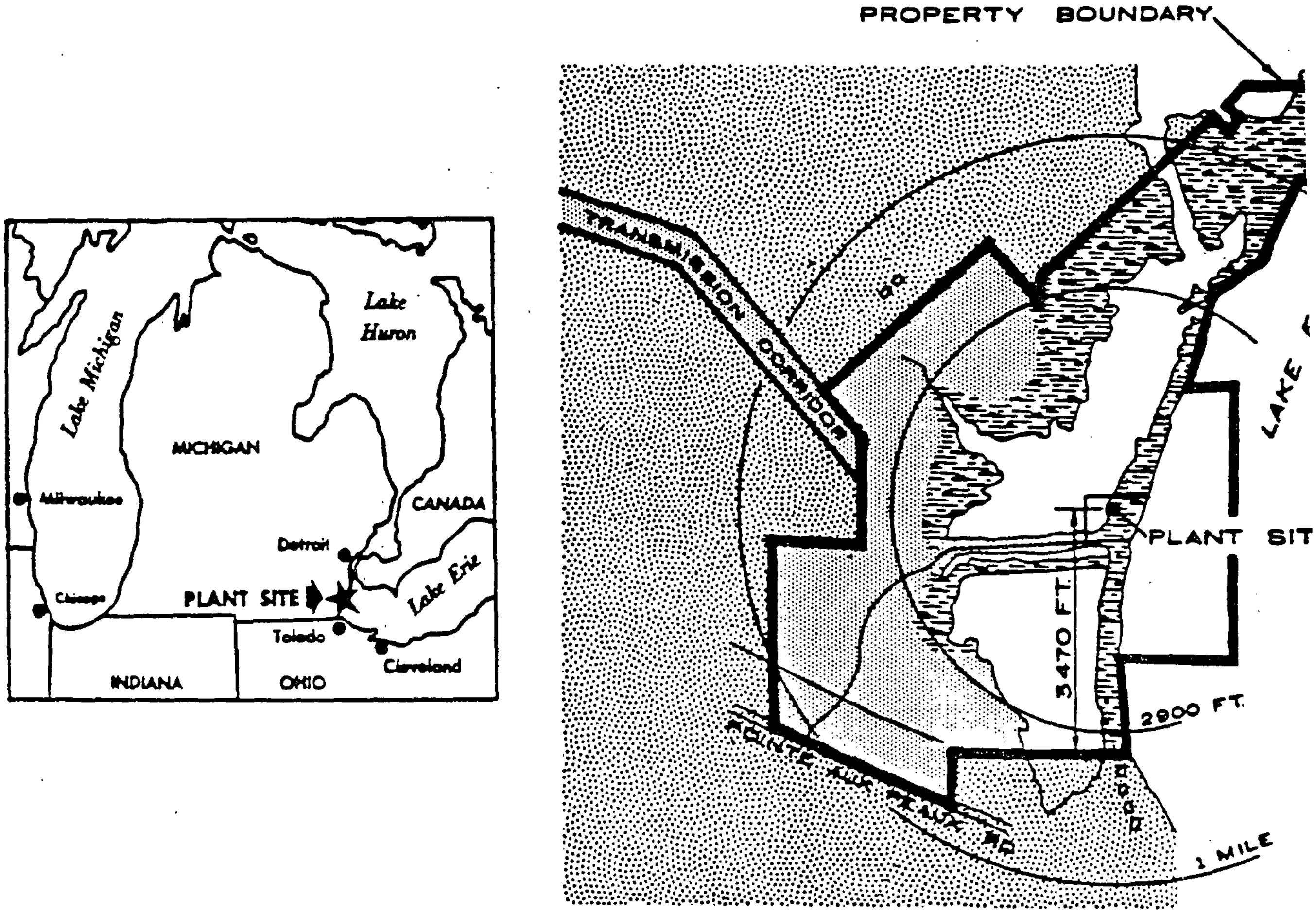


FIGURE 2.1 PLANT LOCATION

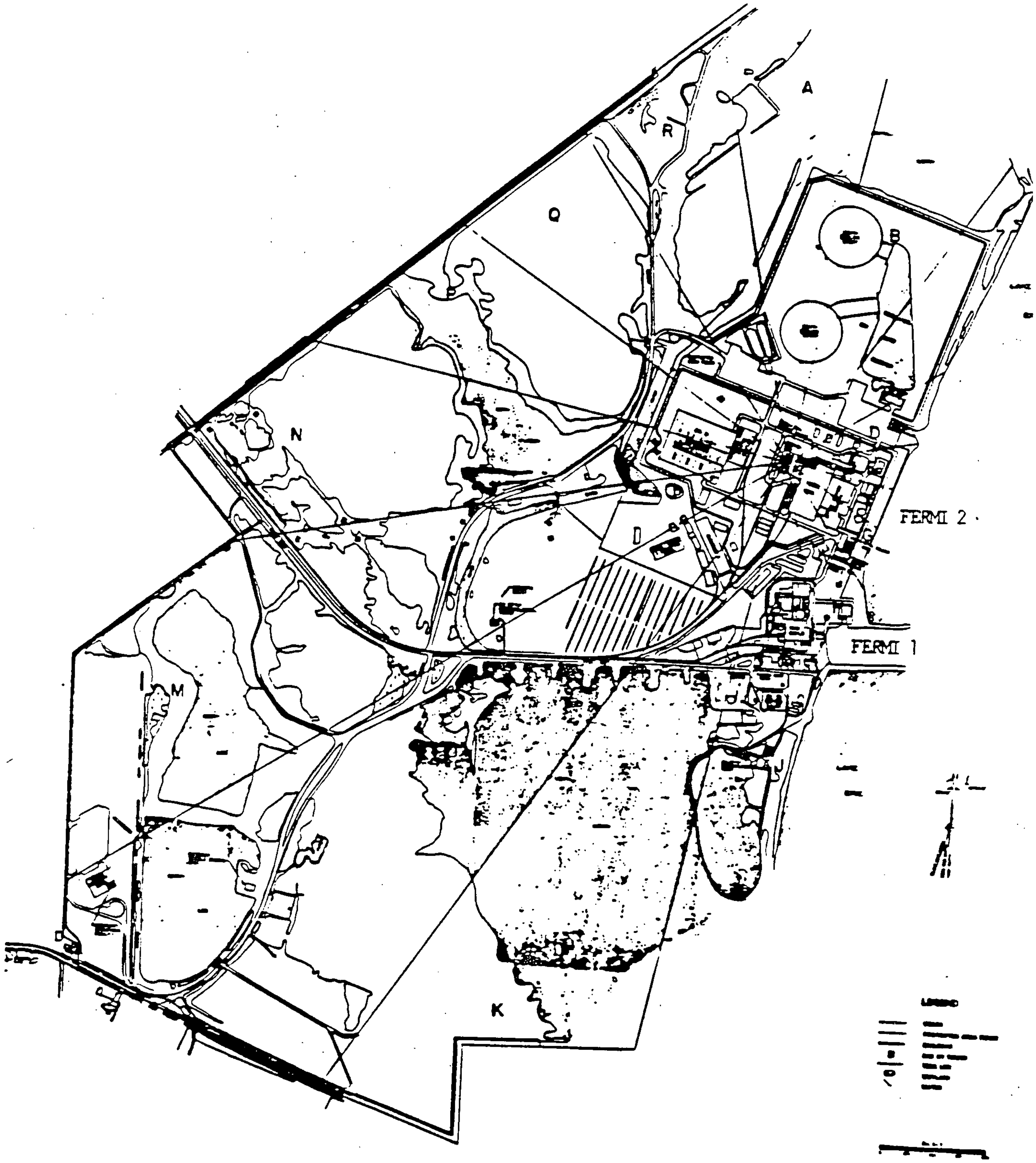


FIGURE 2.2 FERMI SITE

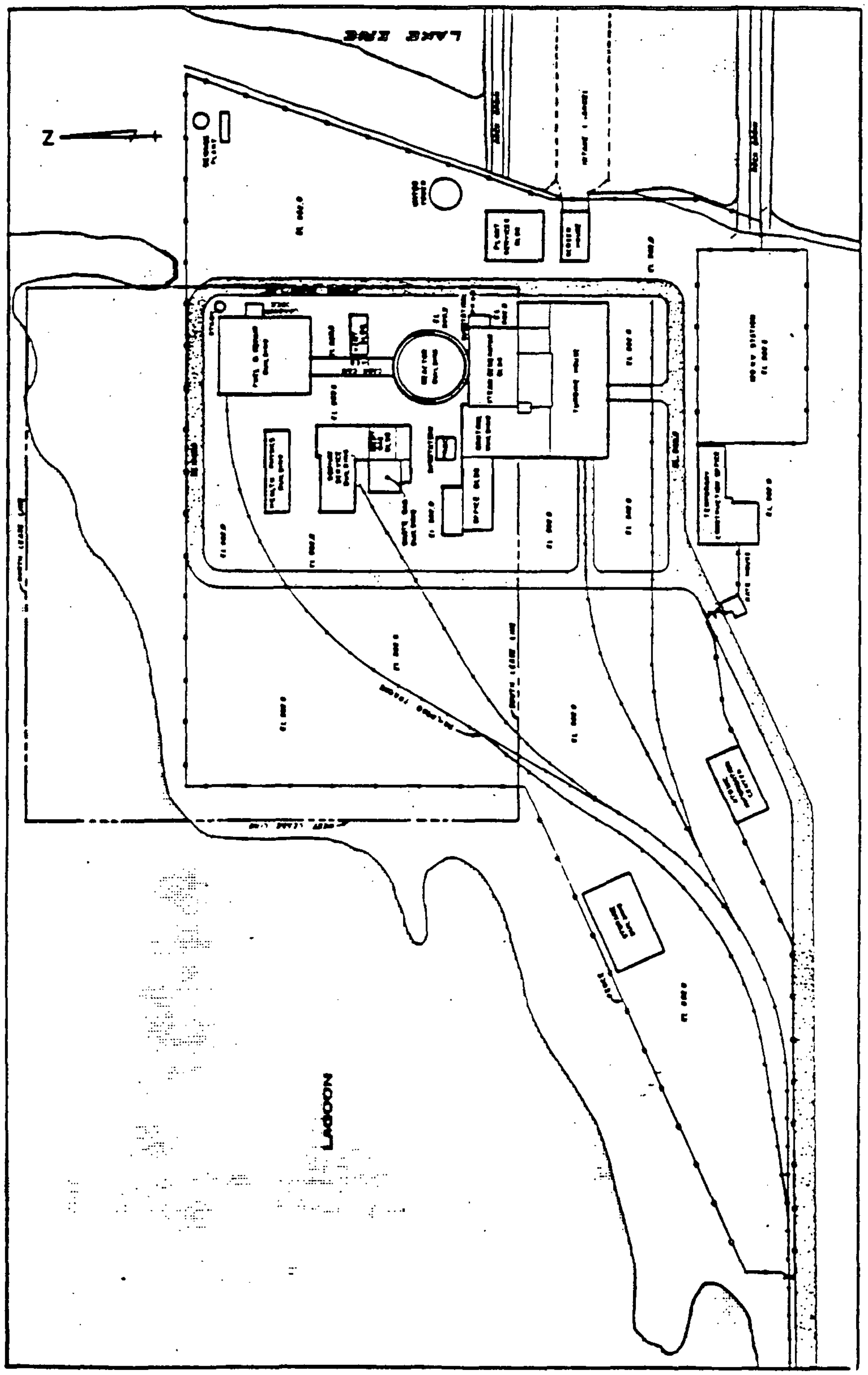


FIGURE 2.3 PLOT PLAN OF FERMI 1 PLANT SITE

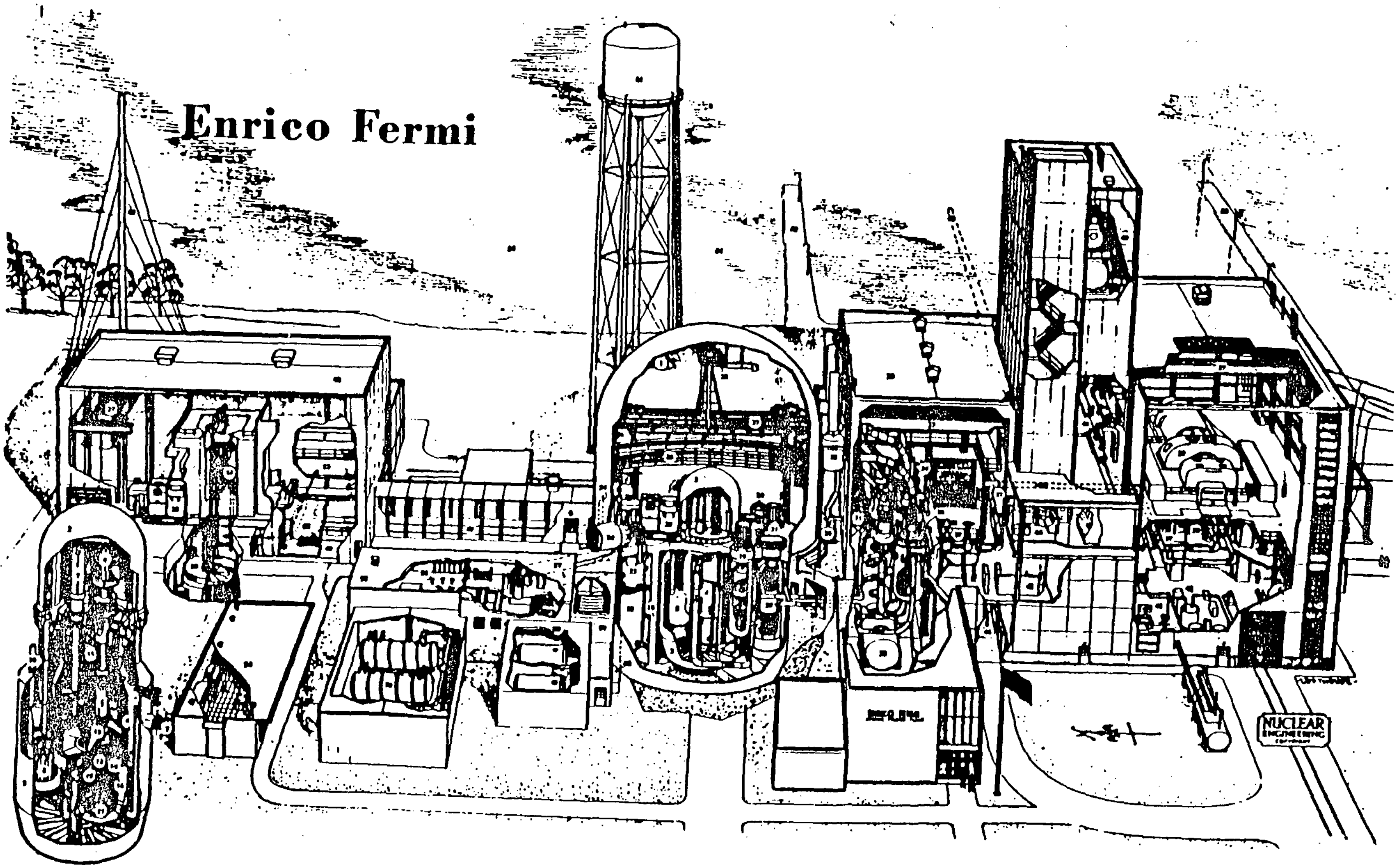
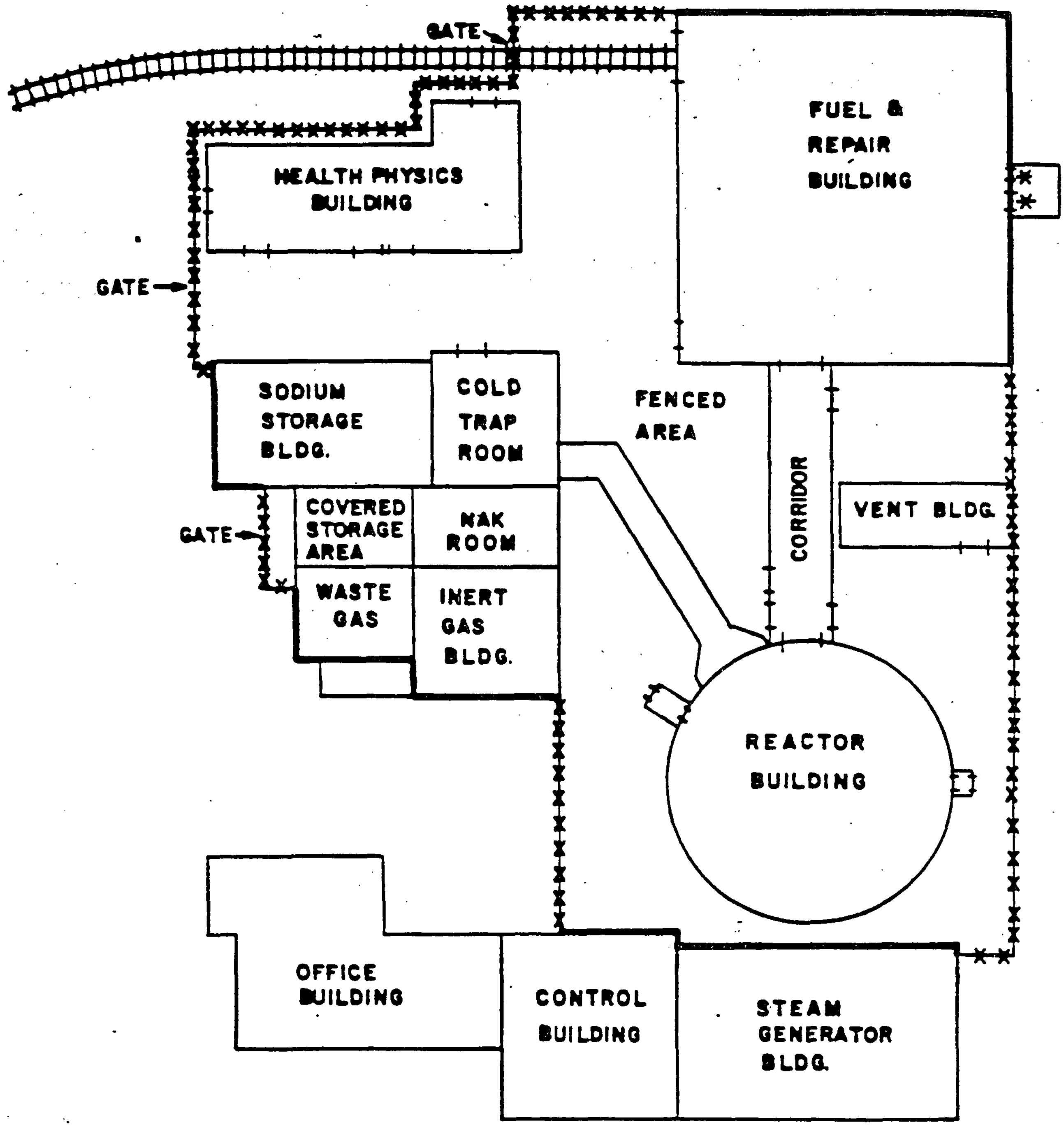


FIGURE 2.4 FERMI 1 FACILITY LAYOUT

1. GASTIGHT BUILDING
2. MACHINERY DOME
3. PRIMARY SHIELD TANK
4. REACTOR VESSEL
5. TRANSFER ROTOR
6. COOLANT OUTLET
7. COOLANT INLET
8. CONTROL ROD MECHANISM
9. OFFSET HANDLING MECHANISM
10. TRANSFER TUBE
11. ROTATING SHIELD PLUG
12. HOLD-DOWN ASSEMBLY
13. CORE
14. RADIAL BLANKET
15. AXIAL BLANKET
16. THERMAL SHIELD
18. SECONDARY SHIELD WALL
19. PRIMARY SODIUM
20. INTERMEDIATE HEAT EXCHANGERS
21. THROTTLE VALVES
22. PRIMARY SODIUM OVERFLOW TANK
23. OVERFLOW PUMPS
24. AIRLOCKS
25. CASK CAR (IN TWO POSITIONS)
26. CABLE GALLERIES
27. OVERHEAD CRANES
28. ATMOSPHERE CONDITIONING
29. SECONDARY SODIUM PIPING
30. STEAM GENERATING BUILDING
31. SECONDARY SODIUM PUMPS
32. STEAM GENERATORS
33. SODIUM STORAGE TANKS
35. SODIUM SEPARATOR UNITS
36. FEEDWATER DUMP TANK
37. MAIN STEAM LINE
38. MAIN STEAM STOP VALVES
39. TURBO-GENERATOR
40. STORAGE AND DE-AERATORS
41. L. P. HEATERS
42. WATER TREATMENT
43. WORKSHOP
44. MAIN CONTROL ROOM
45. REACTOR SIMULATOR
46. SWITCH ROOM
47. COVERED CAR TRACK
48. FUEL HANDLING BUILDING
49. REPAIR PIT
50. TRANSFER TANK ROTOR
52. CUT-UP POOL
53. DECAY POOL
54. HEALTH PHYSICS LABORATORY
55. SODIUM SERVICE BUILDING
56. SODIUM CONTROL ROOM
57. SODIUM TUNNEL
58. WASTE GAS BUILDING AND DECAY TANKS
59. INERT GAS BUILDING
60. INERT GAS TUNNEL
61. POTABLE WATER STORAGE TANK
62. PIERS
63. WATER INTAKE CHANNEL
64. LAKE ERIE
65. STACK



* THESE DOORS TO BE LOCKED OR PERMANENTLY CLOSED.

HEALTH PHYSICS BUILDING HAS BEEN DISMANTLED

FIGURE 2.5 FERMI 1 RESTRICTED AREA BOUNDRY

3.0 ENVIRONMENTAL ASSESSMENT

The proposed action to continue the SAFSTOR of Fermi 1 for 40 years will not cause a significant environmental impact. The Fermi 1 decommissioning effort was completed in 1975. Since this involved dismantling and shipping the radioactive fuel, blanket assemblies, and mechanical components offsite, any impact due to decommissioning has already occurred.

On April 29, 1969, Detroit Edison filed an application with the AEC for a permit to construct Fermi 2; Construction Permit No. CPR-87 was issued on September 26, 1972 following reviews by the AEC staff, Advisory Committee on Reactor Safeguards, and public hearings dealing with environmental matters before an Atomic Safety and Licensing Board. The staff's conclusions were issued as a Final Environmental Statement (CP-FES) in July 1972. On April 4, 1975, Detroit docketed the Environmental Report (ER-OL) in support of the application for an operating license. In August 1981, the NRC issued the "Final Environmental Statement Related to the Operation of Enrico Fermi Atomic Power Plant, Unit No. 2", NUREG-0769. The OL-FES presents assessments that supplement those described in the CP-FES. The report is written in accordance with 10CFR51 which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

As discussed in Section 2.1 and shown in Figure 2.2, Fermi 1 shares the 1120-acre site with Fermi 2. The environmental information presented in this section is based on relevant information and studies presented in the Fermi 2 ER-OL, Updated Final Safety Analysis Report (UFSAR), and the NRC's OL-FES. The environmental information is applicable since much of the data was collected at the time of decommissioning or after Fermi 1 was decommissioned and in a SAFSTOR status.

3.1 NON-RADIOLOGICAL IMPACTS

The regional demography and land use, water use, site ecology, geology and meteorology have not changed significantly since described in Section 2 of the Fermi 2 ER-OL and UFSAR. Tables 3.1 and 3.2 represent the most recent population data around the site.

3.1.1 Socioeconomic and Cultural Resources

The personnel required for maintenance of the facility in SAFSTOR consists of a 12-person Site Committee who inspect the facility annually, a 3-person Audit Subcommittee who audits the facility twice a year, one technician who carries out the surveillance program, and an operator responsible for periodic rounds. All of these individuals are employed by Edison in other capacities and in some cases, at locations other than the Fermi site. Because of the small number involved and their status as Edison employes, there is virtually no impact on the community and traffic patterns.

3.1.2 Land Use

The SAFSTOR of the facility will not affect land use onsite or offsite. There are no plans for either construction or dismantling any portion of the facility over the next 40 years. Periodic maintenance to the facility will be done as required to maintain the SAFSTOR status.

3.1.3 Hydrology

The hydrology of the site and its environs has not changed significantly since the Fermi 2 ER-OL and UFSAR. It is not anticipated there will be any significant changes over the next 40 years.

3.1.4 Water Use

While in the SAFSTOR status, Fermi 1 has no requirement for water; thus the water use on the site is directly attributable to the operation of Fermi 2. Non-contaminated liquid waste collected in sump systems is essentially the intrustion of underground or rain water. These sumps discharge to the plant drain system which drains to Lake Erie. The State of Michigan NPDES Permit No. MI 0001830 (Expires March 31, 1990) covers the discharge of waste waters from the Fermi 1 facility.

3.1.5 Aquatic and Terrestrial Resources

The aquatic and terrestrial ecology of the site and its environs is presented in the Fermi 2 ER-OL and further discussed in the NRC OL-FES. Since there is no water requirement for the facility and no construction or dismantling activities anticipated, there will be no impact on the aquatic or terrestrial resources.

3.1.6 Unavoidable Impacts

Fermi 1 will occupy a small restricted area of the present site over the SAFSTOR period. Within that restricted area, Fermi 2 has a thermoluminescent dosimeter (TLD) calibration facility inside the concrete shield walls of the Fuel and Repair Building.

The unrestricted portions of the Fermi 1 facility are effectively used by Fermi 2:

- The Office and Turbine Buildings house training, medical, and storage facilities.
- The water plant supplies the potable water for Fermi 2.
- The general service water intake structure for Fermi 2 is located on the Fermi 1 intake canal.

3.1.7 Local Short-Term Uses Versus Long-Term Productivity

The site is presently being used for production of electricity by Fermi 2 and there are no plans for the next 40 years other than electrical power generation.

3.1.8 Commitment of Resources

The 40 years of SAFSTOR will not involve commitment of a significant amount of resources. It can be reasonably assumed that there will be less volume of radioactive waste to dispose of at the end of SAFSTOR due to the additonal period of decay. Immediate dismantling would require offsite shipment of radioactive material and a larger burial area at a waste disposal site.

3.2 RADIOLOGICAL IMPACTS

Tables 2.1 and 2.2 present activation sources in the Reactor Vessel and radiation and contamination levels, respectively, at the time of decommissioning. On July 23, 1986 Edison submitted supplemental information in response to NRC questions (References 2 and 3). Relevant information has been included in this section; for the detailed data, see Reference 3.

The radiological impacts of 40 years of SAFSTOR consist of:

- The occupational radiation exposure of workers involved in maintenance and surveillance.
- The environmental impacts of releases of liquid and gaseous effluents.
- The impact of postulated accidents.

3.2.1 Occupational Radiation Exposure

Specific measures for the maintenance and control of radiation exposures and releases of radioactive materials to unrestricted areas are contained in the manual "Decommissioned Enrico Fermi Unit-1 Reactor and Associated Building and Equipment-Administrative and Surveillance Procedures". This manual is reviewed annually by the Fermi 1 Site Review Committee. Any revisions to the manual are reported in the Annual Report to the NRC.

Every six months the Audit Subcommittee performs an inspection and review of records and evaluates compliance with commitments for periods of surveillance.

The Plant Manager of Fermi 2 is the Custodian for Fermi 1 during its SAFSTOR status. Two Custodial Delegates are appointed or reaffirmed at the annual Review Committee meeting to act on behalf of the Custodian.

An ALARA program is maintained by Fermi 1 Administrative Procedures and the implementation of Fermi 2 procedures that are applicable for radiation protection of personnel entering or working in a Radiation Controlled Area (RCA). A list of these procedures is found in Reference 3.

The following controls and surveillances are carried out at Fermi 1. In some instances the requirements of the Technical Specifications are exceeded; these controls may at any time be revised to reflect the surveillance frequencies required by the Technical Specifications.

1. All access points to the Restricted Area are kept locked. Access to the secondary reactor shell is also controlled with a padlock. Only two keys are available for the locks; one key is kept in the Plant Manager's safe and the other in the critical key cabinet in the Fermi 1 Control Room. Unescorted access to the restricted area must be approved by the Custodian or his delegate.

2. Thermoluminscent Dosimeters (TLD) and Direct Reading Dosimeters (DRD) are supplied for all persons who have been granted permission for unescorted access. Visitors are properly escorted and are issued DRDs.

3. Periodic test and commitment compliance activities are initiated by surveillance work orders issued by the Custodial Delegate.

4 The following weekly tests are performed:

   o General walk-through and inspection of the restricted area.

   o Continuity test of the water intrusion alarm circuits. (Detectors are in the containment building lower level sump, the waste water sump, and the biological shield annulus around the Reactor Building).

- o Observation of the CO_2 cover gas pressure over the essentially empty sodium storage tanks. (Small remnants of sodium remain in the pipes, tanks, pumps, and reactor.)

- o Cover gas (CO_2) pressure in the reactor is checked and recorded in the Reactor Building.

5. The following monthly surveillances are performed:

   - o The volume of liquid in the liquid waste tanks is checked and recorded. (Intrusion of rain water into the FARB caused one tank to fill, this was corrected over three years ago by the placement of a concrete apron on the West Side of the FARB).

   - o Detailed inspection of restricted area is made and potential problems are reported to the Custodial Delegate.

   - o Water levels in all active sumps are checked.

6. The following quarterly surveillances are performed:

   - o Radiation and Smear Survey of FARB rooms.

   - o Radiation and Smear Survey of Reactor Building.

7. The following semi-annual and annual surveillances are performed:

   - o Twenty radiological environmental sample analyses of raw surface water and sediment around the plant environs and raw city water are performed by an outside contractor.

   - o Physical tests (wet compress application) are performed of the water intrusion alarms at the detectors.
   - o Hi/Lo pressure alarms for the reactor cover gas are tested.

   - o Reactor carbon dioxide cover gas pressure relief valve is tested annually.

3.2.1.1 Personnel Exposure

Table 3.3 represents the personnel exposure experience from 1973 through 1985. This covers three distinct periods in the history of Fermi 1:

- 1973 - 1975: Exposure experience involved all plant personnel for removal of all highly radioactive material and equipment and area decontamination and sealing.

- 1976 - 1981: Surveillance and routine maintenance activities.

- 1982 - 1985: Preliminary evaluations and planning were made in 1982 for the disposition of the primary sodium stored in Fermi 1. Drumming operations were performed in 1983 and the sodium was shipped to Idaho Falls in 1984.

In 1985, Fermi 2 established a direct reading dosimeter calibration facility in the machine shop located in the FARB. This area was selected because of the low background radiation and access control maintained over the area. Most of the exposure for 1985 was the result of activity in this facility doing work for Fermi 2.

Maintenance, repair, and surveillance operations over the next 40 years will average about 0.034 person-rem per year or a total of 0.14 person-rem. Fermi 2 dosimetry calibration activities in the FARB could result in personnel exposures as high as 0.20 person-rem per year not directly attributable to Fermi 1 SAFSTOR.

3.2.1.2 Radionuclide Inventory

Activation analyses were performed on various Fermi 1 components to determine the 1986 radionuclide inventory and project the inventory at the end of the 40 year SAFSTOR period. Reference 3 provides the details for Table 3.4, a summary of the results of analyzing the reactor vessel, primary shield tank, biological shield (concrete), reactor vessel internals, sodium residuals, and liquid waste samples.

The 40 year SAFSTOR will result in the following estimated reductions:

- 85% reduction in activity.

- 90% reduction in liquid waste activity.

- 89% to 90% reduction in exposure.

3.2.1.3 Radiological Surveys

In 1986, radiological surveys were performed to assess exposure rates and contamination levels within the Fermi 1 Radiological Controlled Area. Areas surveyed included:

- Fuel and Repair Building

- Reactor Building
- Cask Car Trestle Shed
- Ventilation Building
- Outside Areas within the RCA
- Primary & Secondary Sodium & Steam Tunnels
- Sodium Service Building

The results are shown in Table 3.5. No significant removable contamination was detected in any of the surveyed areas at Fermi 1. The only detectable removable contamination was found in a few spots in the decay and cutup pools which ranged from 1500-4000 dpm/100cm^2. All other beta and gamma contamination levels were less than 1000 dpm/100 cm^2, the minimum detectable level for the purpose of this survey. Alpha contamination levels were all less than 20 dpm/100 cm^2 which represents the alpha contamination minimum detectable level.

Presently, the following areas located within the Fermi 1 restricted area are within the release criteria defined as "...5 micro rem per hour at one meter for reactor generated, gamma emmiting isotopes", (Reference 9).

- FARB
  - First Floor and Mezzanine
  - Machine pit
- Cask Car Trestle Shed
- Operations Floor in Reactor Building
- Second Floor of Sodium Building
- All Outdoor Areas

It is estimated that over the SAFSTOR period, the decay and cutup pool rooms and Reactor Building basement will be at unrestricted dose rate criteria; the bottom of the decay pool will be at or near unrestricted criteria.

3.2.1.4 Isotopic Analysis

Isotopic analyses were performed at selected locations with enough activity to provide significant data. The inplace analyses were performed with a Quantum Technology transportable gamma spectroscopy system. Selected locations were those areas in which the general radiation level was higher than normal background.

Only Cesium-137, Cobalt-60 and Sodium-22 were found. The measured activities, present dose rate at the point of measurement, forty year dose rate, forty year dose rate corrected for gamma energy profile change, and percent reduction over the forty year span are shown in Table 3.6.

3.2.2 Radioactive Waste Management

o **Gaseous Wastes**

There will be no radioactive gaseous wastes released from Fermi 1 over the SAFSTOR period.

o **Liquid Wastes**

Liquid wastes at Fermi 2 are contained within the waste tanks in the FARB. All potentially contaminated drains and sumps collect in the hot sump in the FARB and discharge to the waste tanks. Liquid quantities in these tanks are monitored and recorded. If there is a need to discharge the liquid from the tanks, the water will be processed using an approved portable liquid radwaste processing system until it is acceptable for discharge in accordance with the Technical Specifications.

3.2.3 Postulated Accidents

There are three postulated accidents that could occur during SAFSTOR. These are described in the following sections.

3.2.3.1 Liquid Releases

It is assumed that two liquid waste tanks in the Fuel and Repair Building rupture. The tanks contain a total of 7550 gallons of radioactive radwaste that analyzed 6 mCi of ^{60}Co and 6 mCi of ^{137}Cs.

Scenario A: Airborne Release

ASSUMPTIONS:

- Tanks rupture/malfunction and radioactive inventory is spilled on floor.
- 25% of the inventory is assumed to be released through a vent to the environment.
- Release occurs over a 2-hour period and individual is exposed for the entire time at the exclusion area boundry (EAB).
- Dose factors from Regulatory Guide 1.109 and ICRP Publication 30
- X/Q = 1.55xE-5 sec/m^3 (Fermi 2 UFSAR, Chapter 15, Table 15A-2)

2-hour, 50 th percentile value at Fermi 2 exclusion area boundry (EAB) of 915 meters NW. This distance is conservative since the Fermi 1 EAB is approximately 1211 meters NW.

- Maximum Permissible Concentration (MCP) from 10CFR20, Appendix B, Table II.

RESULTS: Scenario A

Liquid Water Tank Source - Airborne Release

Nuclide	Concentration uCI/ml In Tank	At EAB	MPC (air)	C/MPC*
Cobalt-60	2.10E-4	3.23E-12	1E-8	3.23E-4
Cesium-137	2.10E-4	3.23E-12	2E-9	1.62E-3

* C/MPC = ratio of EAB concentration to MPC

2-Hour Dose Rate at EAB, mrem

	Adult	Child
Whole Body	3.27E-4	1.11E-4
Lung*	4.46E-3	5.29E-3

* Lung is most critical organ.

Scenario B: Liquid Release to Lake Erie

ASSUMPTIONS:

- The liquid radwaste tanks are located in the subbasement of the FARB. In the unlikely event of an earthquake, minor cracking of the structure could occur. The tanks could also undergo stress cracking and leaking to allow fluid flow between the interior of the structure and the surrounding earth. Initially, liquid would be retained within the structure and diluted by inflowing ground water from the dolomite aquifer. There would also be a slow inflow of ground water and the water level inside the structure would rise until it attained the elevation of the piezometric level of the ground water. At that time the radioactive liquid may be diluted by as much as 10:1; however, no credit is taken for dilution via the influx of water.

- Tanks are approximately 450 ft. from the Lake Erie shoreline.

- Flow rate within the aquifer is 0.24 ft/day.

- Delay time in traveling from the tank to Lake ERie is 1875 days plus 40 days to move upward through till and lake bottom sediments, (Fermi 2 UFSAR, Section 15.7.3.2).

- Dilution factor of 77 at Monroe City Water intake 3200 meters south of Fermi 2 (Fermi 2 UFSAR, Appendix 11A).

- Decay with delay time is assumed.

- Individual consumed water, fish, and invertebrates for 24-hour period.

- Dose factors from Regulatory Guide 1.109.

- MPC from 10CFR20, Appendix B, Table II.

RESULTS: Scenario B

Liquid Waste Tank Source - Monroe City Water Intake
Concentration, uCi/ml

Nuclide	In Tank	Entering Lake	At Intake	MPC (water)	C/MPC*
Cobalt 60	2.10E-4	1.04E-4	1.35E-6	5.00E-5	0.03
Cesium 137	2.10E-4	1.86E-4	2.41E-6	2.00E-5	0.12

* C/MPC = ratio of concentration at intake to MPC.

Ingestion Dose Rate, mrem

	Water	Fish	Invertebrate	Total
Adult Whole Body	0.36	29.90	2.38	22.64
Adult, Liver	0.53	30.30	3.62	34.15
Child, Whole Body	0.19	4.24	0.54	0.73
Child, Bone	1.10	29.90	3.68	34.68

3.2.3.2 Airborne Releases

It is assumed that a fire or other catastrophic event results in the release to the environment of the residual sodium including the entire radionuclide inventory which contains a total of 0.98 mCi ^{22}Na and 4.84 mCi ^{137}Cs.

ASSUMPTIONS

- o 100% of inventory becomes airborne.
- o Release occurs over a 2-hour period and individual is exposed for the entire time at the EAB.
- o Dose factors from Regulatory Guide 1.109 and ICRP Publication 30.
- o $X/Q = 1.55xE-5\ sec/m^3$.
- o MPC from 10CFR20, Appendix B, Table II.

RESULTS: Residual Sodium

	Airborne Release		
	Contentration uCi/ml		
Nuclide	At EAB	MPC (air)	C/MPC*
Sodium-22	2.11E-12	6E-9	3.52E-4
Cesium-137	1.04E-11	2E-9	5.21E-3

* C/MPC = Ratio of EAB concentration to MPC.

Adult Dose Rates, mrem	
Whole Body	1.31E-3
Liver*	1.48E-3

* Liver is most critical organ.

3.2.3.3 Discussion

Both Scenario A and B and the releases from the residual sodium result in concentration levels that are well below the MPC values in 10CFR20, Appendix B, Table II for releases to unrestricted areas.

The dose rates associated with Scenario B are below the limits at which precautionary measures would be taken for an accident-type release. The relatively high dose rates associated with the fish and invertebrates are the result of the concentration factors and the models in Regulatory Guide 1.109. In this Scenario, the radioactive liquid is released to the aquifer and groundwater. The results are extremely conservative since no credit was assumed for

- o Dilution from the initial influx of water into the FARB.

- o Removal of suspended particulates by filtering action of the soil and clay.
- o Removal of ionic forms through adsorption by the soil and clay.

The 1875-day travel time to the shoreline of Lake Erie provides ample time to sink wells, follow the progress to the Lake, and take remedial action should it become necessary.

Table 3.1 1980 DISTRIBUTION OF ESTIMATED POPULATION

Direction from Site	DISTANCE FROM SITE (MI)*										
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	0-50
N	29	263	177	79	197	14,912	105,823	530,643	686,014	312,537	1,650,674
NNE	0	102	12	90	81	7,618	100,866	615,106	1,026,606	363,659	2,113,866
NE	0	259	131	12	0	0	11,180	10,183	18,877	549	41,191
ENE	0	0	0	0	0	0	6,960	16,547	14,248	16,899	54,690
E	0	0	0	0	0	0	610	7,056	17,294	3,207	29,067
ESE	0	0	0	0	0	0	0	0	2,849	0	2,849
SE	0	0	0	0	0	0	0	401	6,713	47,673	54,787
SSE	0	0	0	0	0	0	0	1,052	16,653	21,920	39,625
S	41	576	51	0	0	0	0	6,568	15,655	35,130	58,021
SSW	0	710	21	0	0	0	3,004	107,943	22,580	38,523	172,781
SW	0	208	9	0	117	936	11,008	319,037	78,578	23,552	433,445
WSW	0	24	846	2,236	1,779	34,474	6,715	9,531	10,064	9,468	160,923
W	0	58	29	165	600	4,491	5,640	11,222	27,702	29,887	79,794
WNW	0	18	31	52	109	3,806	6,195	17,271	11,078	12,496	51,056
NW	3	76	353	639	318	4,942	7,398	98,185	116,185	37,802	265,901
NNW	0	140	243	64	77	2,621	19,545	120,357	77,607	69,070	289,724
TOTAL	73	2,434	1,903	3,337	3,278	73,800	284,944	1,957,514	2,138,739	1,022,372	5,498,394

Source: ER-OL

*To convert miles to kilometers, multiply by 1.6093.

Table 3.2 DISTRIBUTION OF PROJECTED POPULATION IN YEAR 2000

Direction from Site	DISTANCE FROM SITE (MI)*										
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	0-50
N	37	335	225	100	251	12,367	80,617	404,245	712,580	384,721	1,595,478
NNE	0	130	15	114	103	6,016	77,351	554,465	943,019	448,530	2,029,419
NE	0	329	167	15	0	0	13,198	12,021	22,283	648	48,661
ENE	0	0	0	0	0	0	8,215	19,534	16,820	19,949	64,518
E	0	0	0	0	0	0	720	8,330	20,415	3,785	33,250
ESE	0	0	0	0	0	0	0	0	3,356	0	3,363
SE	0	0	0	0	0	0	0	467	7,804	52,282	60,553
SSE	0	0	0	0	0	0	0	1,225	19,291	23,242	43,758
S	52	733	65	0	0	0	0	7,036	17,432	37,136	62,454
SSW	0	903	27	0	0	0	2,858	112,942	32,285	55,081	204,097
SW	0	265	11	0	149	1,190	14,001	310,191	76,691	28,302	430,800
WSW	0	31	1,076	2,844	2,263	43,849	8,540	12,122	11,825	11,975	94,525
W	0	74	37	210	763	5,712	7,173	13,934	33,400	35,952	97,255
WNW	0	23	39	66	139	4,841	7,879	21,130	13,431	15,071	62,619
NW	4	97	449	813	404	6,286	5,636	116,337	140,874	92,109	363,009
NNW	0	178	309	31	98	3,263	14,889	92,050	72,099	106,183	289,150
Total	93	3,098	2,420	4,243	4,170	83,524	241,077	1,685,705	2,143,612	1,314,966	5,482,908

Source: ER-OL

*To convert miles to kilometers, multiply by 1.6093.

TABLE 3.3 FERMI 1 PERSONNEL EXPOSURE EXPERIENCE, PERSON-REM

MONTH	1973	1974	1975
January	0.73	0.08	0.44
February	0.86	1.07	0.49
March	1.07	0.84	0.49
April	0.21	0.22	0.48
May	0.24	0.43	0.38
June	0.08	0.29	2.28
July	0.42	0.31	0.77
August	0.86	0.10	1.30
September	0.17	0.07	2.39
October	0.03	0.39	0.48
November	0.98	0.76	0.18
December	0.14	0.49	0.02
TOTAL	5.79	5.05	9.70

MONTH	1976	1977	1978	1979	1980	1981
January	0	0	N/A*	0.042	0	N/A
February	0.010	0.030	0	0	0	0
March	0	0	0	0	0	0
April	0.015	0	0.031	0	0	0
May	0	0	0	0.039	0	0.011
June	0	0	0	0	0	0
July	0	0	0	N/A	0	0
August	0	0.011	0.012	0	0	0
September	0	0	0	0	0	0
October	0	0	0	0	N/A	N/A
November	0	0	0	0	0	N/A
December	0	0	N/A	0	0	0
TOTAL	0.025	0.041	0.043	0.081	0	0.011

Table 3.3 **FERMI 1 PERSONNEL EXPOSURE EXPERIENCE, PERSON-REM (Cont.)**

MONTH	1982	1983	1984	1985
January	N/A	0.011	0	0.010
February	0.012	0	0	0.020
March	0.044	0.071	0	0
April	0	0	0	0.010
May	0.010	0.030	0	0.010
June	0	0.024	0	0
July	0.016	0	0	0
August	0.045	0.136	0	0
September	0	0.013	0	0
October	0	0	0	0
November	0.015	0	0.020	0.040
December	0.024	0	0	0.020
TOTAL	0.166	0.285	0.020	0.110

TABLE 3.4 TOTAL NUCLIDE INVENTORY (CURIES)

NUCLIDE	TOTAL ACTIVITY 1986	TOTAL ACTIVITY 2026	TOTAL ACTIVITY 2086
Nb-94	4.06E-02	NC*	NC
Co-60	2.75E+02	1.42E+00	5.21E-04
Ni-59	3.92E+00	NC	NC
Ni-63	8.72E-01	6.42E+01	4.12E+01
C-14	1.34E-09	NC	NC
Fe-55	1.11E+02	2.50E-03	2.92E-10
Na-22	9.80E-04	2.50E-08	3.20E-15
Cs-137	1.08E-02	4.52E-03	1.10E-03
Eu-152	2.75E-03	3.44E-04	1.52E-05
TOTAL	4.77E+02	6.95E+01	4.51E+01

*NC - Essentially no change.

Table 3.5 RADIATION AND SURFACE CONTAMINATION LEVELS - 1986

LOCATION	RADIATION LEVELS REM/HR.	CONTAMINATION LEVELS, dpm/100 cm^2	
		BETA, GAMMA	ALPHA
FARB			
First Floor	6E-6 TO 10E-5	<1000	<20
Decay pool & cutup area	1 E-5 to 2E-5	-	-
Floor drains, pool area	1.5E-5 to 2.5E-4	-	-
Mezzanine	5E-6 to 8E-6	-	-
Decay pool, inside	1E-5 to 8E-5	-	-
Decay pool, tunnel	1E-4 to 4E-3	1500 to 3500	<20
Cutup pool, inside	8E-5 to 2E-4	1500 - 4000	<20
Cutup pool, tunnel	1E-4	-	-
Repair Pit[1]	6E-6 to 1E-5	<1000	<20
Waste Tanks	1E-4 to 2E-3	-	-
Waste dump tank[2]	8E-2	<1000	<20
Pump room	1E-5 to 1E-4	-	-
Pump room, piping, pumps, etc.	5E-5 to 6E-4	<1000	<20
Sump[3]	1E-4 2E-3	<1000	<20

----

[1] Storage area for Fermi 2 Turbine Bypass Line.

[2] Tank currently full.

[3] Water and sludge samples analyzed: 2.75E-4 uCi/500 ml ^{60}Co. 2.65 E-4 u Ci/500 ml ^{137}Cs.

Table 3.5 RADIATION & SURFACE CONTAMINATION LEVELS - 1986 (Cont.)

REACTOR BUILDING			
Elevation 557 ft.	1E-4 to 1E-3	<1000	<20
Elevation 590	2E-6 to 1E-5	<1000	<20
Containment Cask Car			
Trestle Shed	5E-6 to 1E-5	<1000	<20
Ventilaton Building	8E-6 to 1E-5	<1000	<20
Outside area	5E-6 to 1E-5	<1000	<20
Primary Sodium Tunnel	1E-5 to 9E-5	<1000	<20
Secondary Sodium Tunnel	8E-6 to 1E-5	<1000	<20
Gas Tunnel	1E-5 to 5E-5	<1000	<20
Cold Trap Cell	2E-5 to 5E-5	<1000	<20
Sodium Storage Room	2E-5 to 8E-5	<1000	<20
Covered Storage Area	8E-6 to 1E-5	<1000	-
Sodium Storage Tanks	2E-3	<1000	-
Sodium Transfer Room	8E-6 to 1.2E-5	<1000	-
Sodium Service Building	6E-6 to 1E-5	<1000	-
Waste Gas Building	2E-5 to 5E-5	<1000	<20

Table 3.6 ISOTOPIC ACTIVITY AND DOSE RATE PROJECTION*

SURVEY LOCATION	AREA DS. RATE	Co-60 ACT.	Cs-137 ACT.	40 YEAR DS. RATE	CORRECTED 40 YEAR CURRENT DS. RATE	PERCENT DS. RATE REDUCTION
Decay Pool S. Drain	8.5E+01	8.49#-01	9.86E-02	3.92E+00	1.28E+00	98.50%
Decay Pool SW Pipe	8.0E+01	1.12E+00	2.42E-02	1.08+00	5.76E=-1	99.28%
Cutup Pool S. Drain	1.8E+02	1.89E+00	1.66E-01	6.66E+00	2.31E+00	98.72%
Fuel Pool Ex. Fan	3.0E+01	4.85E-01	4.22E-02	1.10E+00	3.83E-01	98.72%
Pump Room	6.0E+02	2.90E+00	1.58E-01	1.53E+01	6.05E+00	98.99%
MK 15 Tank Room	1.5E+03	3.87E+00	1.02E+00	1.31E+02	3.74E+01	97.51%
RX Bldg. Basement	5.0E+02	7.16E+03	1.14E+00	2.63E+00	2.61E+00	99.48%
Decay Pool Tunnel	1.0E+02	4.99E-01	8.12E-01	2.49E+01	6.38E+00	93.62%
AVERAGE PERCENT DOSE RATE REDUCTION (Co/Cs ACTIVITY)						98.10%

SURVEY LOCATION	AREA DS. RATE	Na-22 ACT.	Cs-137 ACT.	40 YEAR DS. RATE	CORRECTED 40 YEAR CURRENT DS. RATE	PERCENT DS. RATE REDUCTION
NA Storage Tank	2.00E+03	3.77E-02	7.54E+00	7.94E+02	2.18E+02	89.08%
Gas Decay	1.2E+02	7.23E-03	2.13E+00	4.77E+01	1.31E+01	89.06%
AVERAGE PERCENT DOSE RATE REDUCTION (Na/Cs ACTIVITY)						89.07%

* All dose rates are in micro Rem.

4.0 ALTERNATIVES CONSIDERED

Once a nuclear facility has reached the end of its useful life, it must be placed in a condition such that there is no unreasonable risk from the decommissioned facility to the health and safety of the public. Several alternatives are available: DECON, ENTOMB, and SAFSTOR. The no action alternative is not viable for Fermi 1 since it is already in a decommissioned state. The three alternatives are discussed below.

4.1 DECON

DECON is defined as immediately removing all radioactive materials to levels which are considered acceptable to permit the property to be released for unrestricted use. DECON is the only one of the decommissioning alternatives which leads to termination of the facility license and release of the facility and site for unrestricted use shortly after cessation of facility operations. DECON would involve the removal or decontamination of all equipment, structures, and those portions of the facility containing radioactivity. Although the fuel has been removed from the Fermi 1 site, the reactor vessel, its internals, and most of the sodium piping remain.

- A major effort would be involved in the complete removal of the reactor vessel and its internals, the sodium piping, and the Auxiliary Fuel storage facility. Because of size and induced radioactivity, this would require the removal and cutup into sections of the various piping and equipment and shipment in commercially available licensed shipping casks to an offsite licensed burial site. This is undesirable because

  - Personnel involved would be exposed to additional radioactivity.

  - There are currently no sites available as repositories for such types of radioactive material.

- Razing the site and back fitting for unrestricted use is of little value since Fermi 1 lies within the site boundry of Fermi 2 and could not be used for other purposes.

This alternative is not considered viable since little or no improvement would be realized in personnel exposure, land use, aesthetics, or value.

4.2 ENTOMB

ENTOMB means to encase and maintain property in a strong and structurally long-lived material (e.g., concrete) to assure retention until radioactivity decays to a level acceptable for releasing the facility for unrestricted use. ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within a reasonable time period of continued structural integrity of the entombing structure; approximately 100 years is considered to be consistent with recommended EPA policy on institutional control reliance for radioactivity containment.

Primary considerations for retiring the reactor and primary system were (1) removal of all core and blanket fuel, (2) removal of all sodium, (3) gastight seal of the primary system, and (4) passivation and maintenance of the entire primary sodium system with carbon dioxide. The reactor vessel was sealed within the primary shield tank and the outlying components were sealed directly, using the reactor building as an isolation structure against personnel access to the primary system.

The primary sodium system was filled with nitrogen to which CO_2 was added to reduce the residual sodium deposits to inactive solids. The system was then sealed and maintained at slightly positive inert gas pressure to prevent the entrance of water or moisture and to minimize dispersal of any remaining radioactive material.

To ENTOMB the Fermi 1 facility at the present time would not result in any enhancements over the present decommissioned status.

- o There would be increased personnel exposure due to the removal of radioactive equipment to accomplish the task.
- o The nickel-63 and niobium-94 in the reactor vessel would not decay to levels permitting the release of the facilities for unrestricted use within the guidelines of 100 years.
- o Limited survillance activities would have to be maintained.

4.3 SAFSTOR

SAFSTOR is defined as those activities required to place and maintain a radioactive facility in such condition that the risk to safety is within acceptable bounds and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use. SAFSTOR consists of a short period of preparation for safe storage, a variable safe storage period of continuing care consisting of security, surveillance, and maintenance and a short period of final decontamination. Several subcategories of SAFSTOR are possible. These subcategories are custodial, passive, or hardened, the differences among them being the degree of cleanup and surveillance required.

Fermi 1 was decommissioned according to NRC (AEC) rules and directives in effect at the time and was considered as being left in a decommissioned state. In accordance with present definitions, it is in a passive SAFSTOR condition and at a later date, in approxiamtely 40 years, total removal of the facility could be acomplished if desired.

5.0 CONCLUSIONS

SAFSTOR is the most viable decommissioning alternative for Fermi 1 over the next 40 years. DECON would result in little or no improvement over SAFSTOR, and ENTOMB is not a viable choice because of the presence of long-lived radioisotopes.

Retaining Fermi 1 in a SAFSTOR status for a 40-year period will reuslt in the following:

- Reduction in dose rate of more than 90%.
- Reduction in personnel exposure at the time of final action.
- Reduction in volume of radioactive wastes at time of final action.
- Increased availability of repository sites for radioactive materials.
- Continued compatibility with the long-term use of the Fermi 2 site since Fermi 1 buildings are being used for Fermi 2 activities.
- Nominal expense and impact on the community because use of Fermi 2 personnel for Fermi 1 surveillance activities provides readily available manpower resources.
- Integration of Fermi 1 into the Fermi 2 decommissioning program.
- Continued minimization of the risk to the health and safety of the public.
- Continued minimization of the environmental impact since any impact due to decommissioning activities has already occurred.

6.0 REFERENCES

1. Letter Detroit Edison to NRC, "Amendment Request for Extension of the 'Possession Only' License for Fermi 1", NE-85-0714, May 17, 1985.

2. Letter NRC to Detroit Edison, "Request for Additional Information", February 27, 1986.

3. Letter Detroit Edison to NRC, "Supplemental Information on Fermi 1", VP-86-0092, July 23, 1986.

4. Letter NRC to Detroit Edison, "Request for Additional Information", May 22, 1986.

5. Letter Detroit Edison to NRC, "Request for Additional Information As Outlined in 10CFR51.45(b) for Fermi 1", VP-86-0118, September 15, 1986.

6. Letter NRC to Detroit Edison, "Request for Additional Information - Enrico Fermi Atomic Power Plant, Unit No. 1", December 2, 1986.

7. Letter Detroit Edison to NRC, "Submittal of Environmental Information for Fermi 1", NRC-87-0051, May 5, 1987.

8. "Retirement of the Enrico Fermi Atomic Power Plant", NP-20047 and NP-20047, Supplement 1, PRDC, March 1974 and October 1975; these reports are on file at the Department of Energy, Office of Public Affairs, Technical Information Center, Oak Ridge, Tennessee.

9. Letter John F. Stolz (USNRC) to Dr. Roland A. Finston, Stanford University, March 17, 1981 (with Enclosure 1).

APPENDIX 1

FERMI 1 STATUS

TABLE OF CONTENTS

1.0 INTRODUCTION

The retirement plan for the Enrico Fermi 1 Power Plant was previously presented to the Atomic Energy Commission via a September 24, 1973 letter from the Power Reactor Development Company. The following discussion is an update of that information which reflects the current status of Fermi 1.

As reflected in the September 24, 1973 submittal, the core fuel sections of all 214 Core A fuel subassemblies composed of 25.6 $^w/_o$ enriched uranium molybdenum alloy were shipped to the Savannah River Plant facility for reprocessing.

The complete inventory of approximately 70,000 gallons of primary sodium was stored frozen in 1344, 55-gallon drums stored in the reactor containment dome and, just prior to shipment, in the cask car trestleway. This sodium was shipped to Argonne National Laboratory-West between October 29 and November 12, 1984. Though virtually all sodium has been removed from the systems within Fermi 1, a residual heel of sodium [approximately 450 gallons (estimated)] is retained in vessels and piping formerly used for sodium.

The main source of activity in the facility, concentrated in the lower elevation of the reactor building, was estimated in June 1973 to be 1550 curies, of which slightly more than 1500 curies was due to Cobalt 60 present in the reactor support plates, holddown mechanism, and shield bars. At the present time, the Cobalt 60 is calculated to have decayed to approximately 320 curies, and in 2025, the time that "safe store" condition is intended to be terminated, it will have decayed to approximately 1.6 curies. Other contributors present in 1973 (Co-58, Fe-59, and Cr-51) are now essentially absent. Typical radiation levels in the high radioactivity regions within the Protected Area presently average between 1.0 and 15 mrem/hr. Areas outside the protected area are less than 5 microrem/hr above natural background.

The safe storage condition of the facility is maintained on the basis of the Technical Specifications and the Administrative and Surveillance Procedures which prescribe the administration, access control, monitoring, periodic environmental and radiological surveys, long term maintenance provisions, and record keeping requirements.

2.0 FACILITY DESCRIPTION

The Fermi 1 facility is located within the owner controlled area and outside the protected area of the nearby Fermi 2 Unit. Figure 1 presents the current facility plan. As shown in the figure, the following buildings are identified:

2.1 Reactor Building

The Reactor (or containment) Building contains, below floor, the empty radioactive reactor vessel (which itself is contained in the Primary Shield Tank), heat exchangers, primary sodium pumps, and the primary sodium overflow tank (which has been passified and is open to the atmosphere). A moisture detector is located in the area sump that alarms in the manned control station. Operators enter this area twice a year to check the moisture detector operation in accordance with the Technical Specifications. No moisture has been detected in this area since the retirement of the facility.

Above floor level, the Reactor Building contains the machinery dome, containment crane, and other machinery. The primary system has been capped with carbon dioxide at approximately two inches water pressure. Though virtually all sodium has been removed from the system an estimated 450 gallons of residual heel of sodium remains in the vessels or pipes formerly used for sodium. This residual sodium contains an estimated 1.7 mCi of Cs-137 and 0.34 mCi of Sr-90.

The Reactor Building outer air lock door is kept locked, except when occupied, to provide additional security. The interlock on the emergency exit has been removed and the outer door can be operated from the inside in case of an emergency.

2.2 Fuel and Repair Building (FARB)

This building houses the fuel storage pool and fuel cut up pool which were drained out, cleaned and painted with strippable paint. In addition, above floor, there is the sealed containment steam cleaning chamber and below floor, the sealed transfer tank room, mechanical equipment room, liquid radioactive waste tank rooms, and the "hot" drains sump. The transfer tank room houses a drained and sealed transfer tank containing a heel of passivated residual sodium. The radioactive liquid waste tanks were originally drained. The "hot" sump has been left active. A moisture detector in the sump alarms at the manual control station when water gets to the applicable level. The sump pumps presently pump into the liquid waste tanks: MK 7, 8, 9, or 15. In the last 10 years, during which Fermi 1 has been in a safe storage condition, approximately ~~15,000~~ gallons of water have been discharged to the tanks. The quantity of liquid in the tanks is monitored from level indicators located in the upper floor of the Fuel and Repair Building. The total capacity of the tanks is ~~37,500~~ gallons. Much of this water came from water in-leakage from pipe penetrations to the Health Physics Building. The situation causing the in-leakage has been corrected.

Radiation indications within the general area of the ground level floor of the Fuel and Repair Building are below detectable levels. Slight contamination has been found in the fuel and cut-up pools and the "hot" sump.

As of May 1985, the activity at the bottom of the sump pump was 100,000 dpm/100cm^2 and at the shaft of the pump was 20,000 dpm/100cm^2. One corner of the bottom of the sump measured 15 mrem/hr.

2.3 Sodium Storage Building

The primary Sodium Storage Building contains three 15,000 gallon tanks. The sodium in these tanks was removed and placed in 55 gallon drums. These drums were shipped to Argonne National Laboratory-West in Idaho. The three primary sodium storage tanks have been passivated with a carbon dioxide cover gas which is maintained on the tanks.

Entrance to the sodium tank room is through a steel door in the north wall of the building which has been locked.

The Sodium Storage Tank room was surveyed for radiation levels on April 15, 1985. The radiation levels between tanks range between 0.5-1.0 mrem/hr.

2.4 Waste Gas Building

This building contains two deactivated waste gas tanks and is nonradioactive.

2.5 Waste Gas Tunnel

The tunnel runs east to west from the Reactor Building along-side the south wall of the Waste Gas Building. The tunnel steps down as it approaches the Waste Gas Building and becomes too congested and small for access along its whole length. Access is via a steel cover southeast of the Waste Gas Building.

2.6 Inert Gas Building

The south end of this building contains a 500 cubic foot vacuum tank, a 200 cubic foot vapor trap, and a 500 cubic foot hold-up tank. The north room contains three inert gas compressors. Both rooms are nonradioactive.

2.7 NaK Room

The room houses the NaK equipment (used in conjunction with the sodium cold trap) which has been disconnected. The sodium drumming facility is also located in this room. Radiation surveys indicate only trace amounts of radioactive material present in equipment and structures in this room.

2.8 Cold Trap Room

This room contains sodium piping needed formerly for sodium drumming, and the piping and valves to and from the primary sodium tunnel. Some of the latter has been cut and capped. Others have had the valves closed and the handwheels disconnected. Some miscellaneous radioactive materials are being stored in the room.

Not shown in Figure 1 is a second story above the Cold Trap Room, NaK Room, and part of the Inert Gas Building. This second story contains the handwheels to the sodium valves at the north end of the room (some disconnected) and the electrical feeds for sodium heating.

2.9 Vent Building

This building has been emptied of all equipment and the fence has been modified to be continuous past the east doors of the building.

2.10 Primary Sodium Tunnel

This tunnel is steel lined and runs from the northwest corner of the Reactor Building to the Cold Trap Room. The piping in this tunnel has been drained and capped at the Reactor Building, and either capped or isolated with closed disconnect valves in the Cold Trap Room. Access to this tunnel is via a manhole near the transfer corridor.

2.11 Fission Product Detector Building

This is a small building, partly below ground level, to the east of the Reactor Building. It contains some slightly radioactive piping.

2.12 Sodium Piping Galleries

There are two below ground piping galleries that were used to house secondary sodium piping.

The west gallery consists of two chambers (i.e., north and south chambers) which hold the secondary sodium lines that supplied the No. 3 steam generator. The sodium lines have been capped where they exit and enter the Reactor Building.

The ground level entry to the north chamber was sealed off as part of the decommissioning program. Entry is now made via a short 30" diameter tunnel which runs between the biological shield wall space and the north chamber.

Access to the south chamber is via a steel door just above ground level at the north wall of the Steam Generator building.

The east gallery consists of three separate chambers and contains the secondary sodium pipe lines that supplied the Nos. 1 and 2 steam generators. These lines have been capped as in the west gallery.

Access to the three chambers is by means of steel doors just above ground level outside the southeast quadrant of the Reactor Building.

2.13 Biological Shield Wall Area

This is approximately a three foot wide annulus that surrounds the building below floor level to about three feet below the concrete pedestal on which the steel Reactor Building stands. Various service piping systems are located in the annulus. It is entered via a bolted-in-place cover at the west azimuth outside of the containment shell. An access ladder has been left in place. In addition, at about 30° north of the entrance, at just below floor level, there is an access port to the northwest secondary sodium pipe gallery chamber.

The annulus has four floor drains that drain into a collection tank and sump pump system located in the basement of the Steam Generator Building. In addition, there is a moisture detector that alarms at the manned control station. The water drained into the tank is nonradioactive.

2.14 Fuel Transfer Corridor

This is a covered way covering the tracks of the former fuel handling cask car. The end adjacent to the Reactor Building was modified after 1966 to provide a covered access to the Reactor Building air lock. The area is free of contamination.

2.15 Health Physics Building

This building has been removed. Only the foundation slab remains. There are potentially radioactive drains and lines to the hot sump in the FARB which have been permanently plugged and marked. Due to some problems with rain water in-leakage via these drains and where they penetrate the FARB, the entire area between the foundation slab and the FARB has been covered by a concrete slab. Since this has been done, there has been no consequential in-leakage. Radiation levels above the slab are in the same range as those of natural concrete.

2.16 Primary System Cover Gas

The primary system is defined as the reactor vessel and all connecting volumes. These include the three primary loops, the machinery dome, and the primary sodium service, and secondary sodium systems out to the welded fittings. The primary system is connected to reserve and backup supplies of carbon dioxide to passivate the residual sodium and is kept at approximately two inches water pressure with a relief valve set for approximately 5 psig. The relief valve is checked annually for proper operation.

The cover gas is instrumented to alarm in the manned control station at low (1/2-in water gauge) and high (2 psig increasing pressure) pressure. Primary cover gas alarm tests are performed every six months.

2.17 Liquid Waste Discharge System

All potentially contaminated drains and sumps collect in the hot sump in the Fuel and Repair Building. The liquid waste collected in the hot sump is discharged to the liquid waste tanks (MK 7, 8, 9, 15). Liquid quantities in these tanks are monitored and recorded. If there is a need to discharge the liquid from the tanks, the water will be processed via a portable liquid radwaste processing system, such as is typically used at many power reactor facilities, until it is acceptable for discharge in accordance with the Technical Specifications.

Liquid waste collected in non-contaminated sump systems are not part of the Liquid Waste Discharge System. Non-contaminated sumps collect underground water or rain water intruding in non-contaminated areas. These sumps discharge to the plant drain system which drains to Lake Erie.

2.18 Other

The remaining Fermi 1 buildings (e.g., the steam generator, control, and office buildings) were not exposed to the radioactivity resulting from the operation of Fermi 1. Due to this, they have been used for various activities affiliated with the operation of the oil peaker unit (now decommissioned) and Fermi 2.

3.0 ADMINISTRATION

The Detroit Edison Company has the responsibility for maintaining a continuing administrative and surveillance program in compliance with current Nuclear Regulatory Commission requirements to ensure that the health and safety of the public and employees are not threatened or injured.

The Vice President, Nuclear Operations, who reports to the Group Vice President has overall responsibility for the Enrico Fermi Unit 1 reactor facility. Responsibility for the decommissioned Enrico Fermi Unit 1 reactor facility is delegated through the line organization of the Vice President, Nuclear Operations, to a qualified Custodian selected from the staff of the adjacent Fermi 2 Atomic Power Plant. The Custodian is assisted in his duties by Custodial Delegates and Custodial Agents.

In addition, the facility administrative and surveillance program is audited by means of a Review committee which will also review and approve all matters of safety associated with any maintenance activities in the facility.

Written procedures delineate the qualification, selection and responsibilities of the Custodian, Custodial Delegates and Agents, and members of the Review Committee.

4.0 ACCESS CONTROL

The area encompassed by physical barriers and to which access is controlled is the Protected Area. The Protected Area, is enclosed by either a chain link fence or building walls which provide equivalent degree of resistance to penetration. The fence is topped by three or more strands of barbed wire or brackets angled outward with an overall height of no less than seven feet. Normal entry to the Protected Area is through a normally locked gate in the fence adjacent to the Sodium Building. Other doors in walls which act a part of the Protected Area boundary are locked or permanently sealed.

Access to the Protected Area is controlled, limited and recorded. The access key is in the manned control station. A second key is held in safe keeping by the Custodian for use only in extenuating circumstances.

Written procedures delineate the requirements associated with entry into the Protected Area and specific areas within the Protected Area to prevent unauthorized entries and to protect the safety and health of authorized personnel.

5.0 MONITORING AND ALARMS

Monitoring detectors for water intrusion are located in three areas: (1) the Fuel and Repair Building basement hot sump, (2) the lower reactor building overflow tank pit, and (3) the Biological Shield Wall Area. Accumulation of water in these areas activates an alarm in the manned control station.

The primary system cover gas pressure is also monitored with high and low alarms. The monitors and the alarm circuitry are periodically checked and calibrated in accordance with the Technical Specifications and written procedures.

6.0 SURVEYS, INSPECTIONS, AND TESTING

Two types of surveys are identified, environmental and radiological, in addition to periodic facility inspections and instrumentation testing.

For the environmental surveys, a number of stations have been established where it is estimated that maximum concentrations of radioactive material discharged from the facility may occur. Two different regimes of sampling and analysis are utilized. A summary of these regimes is given in Table 1.

1. Regime I is followed if activity is released.

2. Regime II is followed if no activity has been released during the previous 90 days.

Periodic radiation surveys are performed to check for the presence of gamma radiation and transferable contamination at the frequency specified in the Technical Specifications. Gamma radiation measurements using portable survey instruments and contamination checks using smears are made of the following areas:

Reactor Building - Operating floor, doors and seals around machinery dome, breather pipe, sump pump serving Reactor Building annulus.

Fuel and Repair Building - Pool area, operating floor access points to contamination areas, Steam Cleaning Room access plug.

Environmental and radiological surveys are performed by or under supervision of qualified personnel having parallel duties and responsibilities at Fermi 2.

A monthly visual inspection of the Protected Area is performed by Custodial Agents. The inspection consists of a visual inspection of the fence, gates and all exterior doors at the Protected Area, a check and recording of the level of liquid in the liquid water tanks, a check on the condition of the strippable paint on the decay and cut-up pools in the Fuel and Repair Building, and verifications of the operation of the sump pumps which serve the Protected Area. All abnormal conditions observed are reported to the Fermi 2 Nuclear Shift Supervisor so that corrective measures may be taken. The Custodian is also notified of all abnormal conditions immediately, and of the corrective action taken.

Testing and calibration of the water intrusion monitors, and testing the primary cover gas pressure alarms, is performed every six months. Testing of the carbon dioxide pressure relief valve is performed annually. All testing is performed in accordance with written and approved procedures.

7.0 PROCEDURES

Procedures ensure that the requirements of the Technical Specifications are carried out in a proper and timely manner. They also serve as training and reference units for future Custodians, Custodial Delegates and Custodial Agents. Administrative procedures include Custodial qualifications, responsibilities and authority, Procedure Manual control, Custodial Delegate and Custodial Agent selection and function, reporting procedures, Review Committee functions and financial accounting procedures. In addition, there are appropriate procedures for details of inspections, surveillances and operation.

TABLE 1

ENVIRONMENTAL SURVEY REGIMES

Sample Media	Number of Stations Indicator	Background	Regime I	II
Water				
South Lagoon	1	0	G26b	G26b
River Water	1	1	G1b	G26b
Lake Water	1	0	G1b	G26b
Raw City Water*	0	3	G4b	G26b
Sediment				
South Lagoon Sediment	1	0	G26g	G26g
River Sediment	1	1	G26g	G26g

Symbols:

G - Grab Sample

Frequency of Sampling:

1 - one week interval
4 - four week interval
26 - twenty-six week interval

Type of Analysis:

b - beta
g - gamma

Example: G1b - Sample is collected at one week intervals and analyzed for beta radioactivity

*List of Cities

Detroit
Monroe
Fermi Plant