3006

1999 NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP) ANNUAL REPORT

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MAY 2000

U.S. DEPARTMENT OF ENERGY

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U.S. Department of Energy
Radionuclide Air Emissions Annual Report
(under Subpart H of 40 CFR Part 61)
Calendar Year 1999

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TABLE OF CONTENTS

Preamble			1
Summary			1
Section I	Facility Information		2
	A.	Site Description	2
	B.	Source Descriptions	2
	C.	Radiological Air Particulate Monitoring Program Description	4
		Monitoring Equipment and Locations	4
		Analytical Regime and Sampling Frequency	4
		Air Emission Data Reporting	5
Section II	Air Emissions Data		5
	A.	Air Monitoring Data Completeness Status	5
	B.	Air Monitoring Station Operational Performance	8
Section III	Dose Assessment		8
Section IV	Compliance Assessment		8
Section V	Additional Information		10
	A.	Meteorological Data	10
	B.	Construction/ Modifications at the FEMP	10
	C.	Unplanned Releases of Radionuclides	10
References			17
Section VI	Certification		18

ATTACHMENT D.1

CAP88-PC Computer Model Runs as Supporting Documentation for 40 CFR 61.96

LIST OF TABLES

Table D-1	NESHAP Stack Emissions Monitoring Results
Table D-2	Distance and Direction from Points of Release to Receptors
Table D-3	Net Air Concentrations
Table D-4	Operational Summary for Air Particulate Monitoring Stations in 1999
Table D-5	Annual NESHAP Compliance Ratio Report

LIST OF FIGURES

Figure D-1	Radiological Air Monitoring Station Locations
Figure D-2	1999 Wind Rose Data, 10-Meter Height

LIST OF ACRONYMS

ALARA	As Low As Reasonably Achievable
AMS	air monitoring station
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
D&D	decontamination and dismantlement
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
HEPA	high-efficiency particulate air
IEMP	Integrated Environmental Monitoring Plan
mrem	millirem
mSv	millisieverts
NESHAP	National Emission Standards for Hazardous Air Pollutants
OEPA	Ohio Environmental Protection Agency
WPRAP	Waste Pit Remedial Action Project

PREAMBLE

3006

On May 23, 1997, the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) submitted a written request to the U.S. Environmental Protection Agency (EPA) for approval to use an alternate approach for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H requirements (DOE 1997). The alternate approach utilizes environmental measurements of airborne radionuclide concentrations (as provided for under 40 Code of Federal Regulations [CFR] 61.93[b][5]) rather than air dispersion modeling to demonstrate that radionuclide emissions resulting from FEMP operations remain below the annual NESHAP Subpart H standard. The request for approval of the alternative approach was driven by the recognition that the dominant sources of radiological emissions at the FEMP had changed as the mission of the FEMP changed from uranium metal production (which ended in 1989) to environmental remediation. During production, the primary emission sources from the facility were point sources (stacks and vents); however, under the current mission of full scale environmental remediation, the dominant emission sources are fugitive emissions from diffuse sources (i.e., large scale excavations, wind erosion from stockpiled materials, decontamination and dismantling projects, etc.). Because there is a high degree of uncertainty associated with modeling fugitive emissions, environmental measurements were proposed as an alternative to provide a more accurate assessment of FEMP emissions.

On August 11, 1997, the EPA granted approval to use environmental measurements as an alternative methodology for demonstrating NESHAP compliance (EPA 1997). The FEMP began utilizing environmental measurements for NESHAP compliance purposes in 1998.

SUMMARY

For 1999 the maximum effective dose equivalent from emissions of radionuclides to the ambient air, based on radionuclide measurements at the FEMP fenceline, is estimated to be 0.29 millirem (mrem) (2.9E-03 millisieverts [mSv]), which is in compliance with the Subpart H standard of 10 mrem. This estimation is based on the FEMP's radiological air particulate monitoring program which consists of a network of high volume air monitoring stations (AMS) operated continuously during the year at the FEMP facility fenceline and background locations.

During 1999 there were several cases in which concerns about data recovery and data quality led to the loss or rejection of the data for the purpose of demonstrating compliance with the Subpart H standard. On an individual and cumulative basis, the lost or rejected data were evaluated and found to have minimal influence on the compliance demonstration.

SECTION I: FACILITY INFORMATION

A. Site Description

The FEMP is located on a 1,050 acre (425 hectare) area approximately 18 miles (29 km) northwest of downtown Cincinnati, Ohio. The former production area covers approximately 136 acres (55 hectares) in the center of the FEMP. The facility is sited just north of the small farming community of Fernald, Ohio.

The area immediately surrounding the FEMP is primarily rural in nature, characterized by the predominance of agriculture, with some light industry and private residences. The FEMP is located on a relatively level plain, outside of the 500-year flood plain of the Great Miami River, in an ancestral river valley known as the New Haven Trough.

The climate is characterized as continental, with average temperatures ranging from approximately 29°F (-1.7°C) in January, to 76°F (24.4°C) in July. Average annual precipitation is approximately 41 inches (104 centimeters) per year. Prevailing wind flow is from the south-southwest.

For 37 years, the former Feed Materials Production Center (Fernald site) produced uranium metals for DOE and its predecessors. On July 10, 1989, uranium metals production was suspended. Management responsibilities of the Fernald site were transferred from the Defense Programs organization to the DOE's Office of Environmental Restoration and Waste Management.

Currently, most activities at the FEMP are conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). These activities include sample analysis; waste characterization; the management, treatment, storage and disposal of hazardous, mixed, low-level and solid wastes; and the decontamination and cleanup of radioactively contaminated buildings, equipment, soils, and waters. The site also manages thorium wastes and K-65 Silos waste material which contains radium and produces radon gas.

B. Source Descriptions

The majority of the radioactive airborne contaminants at the FEMP consist of uranium and uranium compounds. Additional radioactive airborne contaminants consist of daughter products from the uranium, actinium, and thorium series decay chains.

For 1999 potential radionuclide emissions sources at the FEMP included:

- Building 11*, emissions from the laundry facilities resulting from the processing of contaminated clothing used at the FEMP and from the respirator washing facility located in the building
- Building 12, fugitive emissions from Tank Farm/Maintenance decontamination and dismantlement (D&D) project
- Building 15, emissions from laboratory operations
- Building 51, emissions from the advanced wastewater treatment facility
- Building 53, emissions from laboratory operations
- Building 56, fugitive emissions from packaging of enriched ingots and derbies
- Building 65, emissions from thorium repackaging operations
- Building 71*, emissions from material sorting and repackaging operations
- Building 78, emissions from repackaging operations
- Building 80, fugitive emissions from metal fuel-core repackaging operations
- Plant 9, fugitive emissions generated from the Thorium/Plant 9 Complex above-grade D&D project
- Waste Pit Remedial Action Project* (WPRAP) dryer stack operations
- Other sources: Fugitive emissions from the D&D of the sewage treatment plant complex, WPRAP excavations of waste pits 3 and 5, on-site disposal facility excavations/ construction, various borrow area excavations, wind erosion of stockpiles (i.e., flyash piles, southern waste units, etc.), earth moving equipment, and material handling operations.

Note: *Indicates 1999 point sources were continuously monitored during process operations. Table D-1 provides a summary of data from point source monitors, and is included as supporting documentation and is not used to demonstrate 40 CFR 61.92 compliance.

All monitored stacks are equipped with a high-efficiency particulate air (HEPA) filter used for effluent controls. HEPA filters are 99.97 percent efficient for particles of 0.3 microns or larger. Additionally, HEPA filtration systems are utilized throughout the FEMP in adhering to the As Low As Reasonably Achievable (ALARA) philosophy. In accordance with 40 CFR 61.94(b)(5), some examples of HEPA filters used at the FEMP include vacuum cleaner exhaust controls, negative pressure ventilation controls, venting glove bags and glove boxes, and general decontamination efforts. Table D-2 is provided to

comply with 40 CFR 61.94 (b)(6) which provides the distance from the points of release to the nearest residence, etc. This table is not used to demonstrate compliance with 40 CFR 61.92.

C. Radiological Air Particulate Monitoring Program Description

The FEMP's radiological air monitoring program is defined in the Integrated Environmental Monitoring Plan (IEMP) (DOE 1999). The program design, as approved by the EPA, is summarized below:

Monitoring Equipment and Locations

- A network of 18 high-volume environmental air samplers comprise the FEMP's radiological air particulate monitoring program for NESHAP compliance (refer to Figure D-1 for monitoring locations). The samplers draw air continuously through an 8-inch by 10-inch filter at a rate of 40-50 cubic feet per minute. The air monitoring stations contain a flow-rate chart recorder and an hour-meter which provides a record of the monitors' operational run-time over the sampling period. Additionally, the samplers are equipped with a flow controller which maintains a constant air flow through the sampler by an electronic probe which automatically adjusts blower/motor speed to correct for variations in line voltage, temperature, pressure, or filter loading.

- The 18 air monitoring stations are divided among on-site and background monitoring locations. Sixteen monitors are located on the FEMP fenceline corresponding to the 16 windrose sectors. Two monitors serve as background monitors, located in the predominant upwind directions of the northwest (3.2 miles from the center of the FEMP) and the southwest (6.2 miles from the center of the FEMP). The EPA siting criteria (40 CFR 58, Appendix E) were considered when selecting these locations.

Analytical Regime and Sampling Frequency

The analytical regime and sampling frequency for this program was designed to account for the major contributors to dose as defined in 40 CFR 61.93(b)(5)(ii) for the purpose of demonstrating NESHAP Subpart H compliance.

- Filters are exchanged on a biweekly basis and analyzed for total uranium and total particulates. These data are used to track site emissions routinely throughout the year to ensure emission controls at the FEMP are operating effectively.

- A portion of each biweekly filter is retained and is used to form a quarterly composite sample. The composite sample is analyzed for the radionuclides expected to be the major contributors to dose from site emissions. The results of the quarterly data are used to track compliance against the NESHAP Subpart H standard during the year and for demonstrating compliance at the end of the year.

Isotopes which comprise the quarterly composite analysis were selected based on the following considerations:

3006

- Radionuclides which are stored in large quantities at the FEMP and which will be handled or processed during the remediation effort (uranium, thorium-230, thorium-232, and radium-226)
- Radionuclides which have been the major contributors to dose based on environmental and stack filter measurements (uranium)
- Radionuclides which, due to their concentrations in waste and contaminated soil, will be the major contributors to dose (uranium, thorium-228, and thorium-230).

Uranium-238, thorium-232, and uranium-235 are initial radionuclides in the uranium, thorium, and actinide decay chains, respectively. The majority of uranium and thorium received and processed during the production era of the FEMP had been separated from its decay chain progeny prior to shipment to the FEMP. As a result, decay chain progeny products were not in equilibrium with the parent concentrations, but may have grown into equilibrium with their parents during the history of operations at the FEMP. In addition to the potential in-growth of decay chain progeny, some of the progeny are difficult to quantify using standard radiochemistry analytical techniques. Analysis is particularly difficult given the limited sample volume and low environmental concentrations of all radionuclides in the quarterly composite samples. In order to account for the progeny's contribution to dose (while avoiding analytical difficulties), a number of progeny radionuclides can conservatively be considered to be present in equilibrium with their parents. These radionuclides (thorium-234, radium-228, actinium-228, radium-224, and thorium-231) are assumed to be in equilibrium with their parent concentrations as measured in the quarterly composites. Refer to Table D-3 for measured net air concentrations.

Air Emission Data Reporting

In addition to this report, the biweekly and quarterly composite data associated with this program were tracked and reported to the EPA and Ohio Environmental Protection Agency (OEPA) through IEMP quarterly status reports during 1999. In conjunction with the quarterly reports, all monitoring data were provided to the EPA and OEPA via electronic media (data diskettes or CD-ROM) on a quarterly basis.

SECTION II: AIR EMISSIONS DATA

A. Air Monitoring Data Completeness Status

During 1999 there were six cases in which concerns about data recovery and data quality of the quarterly composite results led to the loss or rejection of the data for purposes of demonstrating NESHAP compliance. In some cases, comparable data from 1998 quarterly composite samples were substituted in

place of the rejected data. In each case where data were lost, rejected, and/or substituted, an evaluation was performed in order to determine the impacts with respect to demonstrating NESHAP compliance. On an individual basis, each case of rejected or substituted data had minimal influence on the compliance demonstration. A summary of each case is provided below:

- During the first quarter of 1999, low thorium tracer recovery during laboratory analysis led to the rejection of thorium data (thorium-228, thorium-230, and thorium-232) from the two background monitors AMS-12 and AMS-16. In order to account for background concentrations of thorium, first quarter 1998 thorium data from AMS-12 and AMS-16 were substituted for the rejected 1999 background thorium data. This substitution is supported by the first quarter 1999 isotopic uranium concentrations at the background monitors (AMS-12 and AMS-16) which were slightly lower, yet comparable, to first quarter 1998 isotopic uranium concentrations at the background monitors. The relative agreement between the background uranium concentrations suggests that background isotopic thorium concentrations from the first quarters of 1998 and 1999 would also be similar. Thus, substitution of first quarter 1998 background thorium data in place of the rejected first quarter 1999 background thorium data would not significantly influence the calculation of the net fenceline thorium concentrations or the subsequent calculation of doses from thorium.

- During the first quarter of 1999, low thorium tracer recovery during laboratory analysis also led to the rejection of thorium data (thorium-228, thorium-230, and thorium-232) from monitoring locations AMS-4, AMS-22, and AMS-24. The rejection of isotopic thorium data from AMS-4, AMS-22, and AMS-24 does not significantly affect the compliance demonstration because thorium has not historically contributed the major fraction of dose from FEMP emissions. Furthermore, these monitors are not downwind of the major remediation projects and have not historically been the location of maximum fenceline doses.

- First quarter 1999 radium-226 data from all monitors were rejected because the chemical recoveries were above the laboratory detectors' calibrated range of recoveries. In order to account for radium-226 concentrations at all of the monitors, first quarter 1998 radium-226 data were substituted for the rejected first quarter 1999 data. The substitution would not be expected to significantly change the radium-226 contribution to fenceline doses because there were no significant changes in remediation activities during the first quarters of 1998 or 1999 that involved moving, repackaging, or processing radium-226 bearing wastes. Therefore, radium-226 concentrations during the first quarter of 1999 would be expected to be similar to the radium-226 emissions during the first quarter of 1998.

- Low thorium tracer recoveries during laboratory analysis were also encountered during the second quarter of 1999. During re-analysis, thorium recoveries improved, but an interference with thorium-228 results was observed for the samples from four monitoring stations (AMS-12, AMS-16, AMS-24, and AMS-25). This led to the rejection of thorium-228 data from two fenceline and two background stations. In order to account for thorium-228 concentrations, thorium-228 was assumed to be in equilibrium with thorium-232. This assumption is supported by the thorium-228/thorium-232 equilibrium conditions that occurred at the other fenceline monitors during the second quarter of 1999. This assumption does not significantly affect the compliance demonstration

because thorium-228 has not historically contributed the major fraction of dose from FEMP emissions.

- During the third quarter of 1999, a portion of the composite sample for AMS-23 leaked during transport. While none of the sample escaped the shipping container, the leaked sample volume could not be recovered for analysis. As a result, there was insufficient sample volume available for the complete quarterly analyses. Therefore, the available sample was analyzed for uranium and thorium isotopes and no analysis for radium-226 was performed. The lack of radium-226 data from AMS-23 during the third quarter does not significantly affect the compliance demonstration because radium-226 has not historically contributed the major fraction of dose from FEMP emissions.

- During the fourth quarter of 1999, low radium tracer recovery at the laboratory resulted in the rejection of the radium-226 result from AMS-28. The rejection of radium-226 data from AMS-28 during the fourth quarter does not significantly affect the compliance demonstration because radium-226 has not historically contributed the major fraction of dose from FEMP emissions.

In addition to evaluating each individual case, an assessment of the combined effects of the lost, rejected, and substituted data was made. This assessment, which is described below, considered the maximum fenceline dose with and without corrections for background concentrations of radionuclides. Based on this assessment, the combined effects of the rejected or substituted data had minimal influence on the compliance demonstration.

An assessment of the combined effects of the lost, rejected and substituted data was made by considering the maximum fenceline dose with and without corrections for background concentrations of radionuclides. Accounting for the background concentrations of radionuclides, the maximum effective dose of 0.29 mrem occurred at AMS-3 with AMS-8A and AMS-9C representing the next highest doses at 0.25 mrem and 0.21 mrem, respectively. These doses are well below the Subpart H standard of 10 mrem. If, for the sake of a conservative estimate, fenceline doses are re-calculated without accounting for the background concentrations of isotopic uranium, isotopic thorium, and radium-226, the maximum effective dose is 0.53 mrem, at AMS-3, and remains below the Subpart H standard of 10 mrem. Therefore, based on this assessment, the combined effects of the rejected or substituted data had minimal influence on the compliance demonstration.

Based on the discussion above, substituted data had minimal influence on the compliance demonstration. However, in an effort to improve data recovery and completeness, a different off-site (contract) laboratory is being used for the analysis of the quarterly composite air samples in 2000.

B. Air Monitoring Station Operational Performance

During 1999, operational run-times for the 18 NESHAP air monitoring stations averaged 98.5 percent, with all monitors operating in excess of the 95 percent minimum expectation. In general, interruptions in monitor operations that were encountered during 1999 were the result of power failures and/or equipment failures (refer to Table D-4).

SECTION III: DOSE ASSESSMENT

Based on the sum of the quarterly isotopic results and annual air volumes, the net measured concentrations for each radionuclide were calculated at each fenceline air monitor to determine annual average concentrations. The annual average concentrations at each fenceline air monitor are divided by the corresponding values listed in Subpart H of 40 CFR 61, Appendix E, Table 2 to form a radionuclide-specific compliance ratio. At each fenceline air monitor, the sum of the radionuclide-specific compliance ratios was determined. Refer to Table D-5 for the NESHAP compliance ratios at each air monitor. The maximum value of the sum of the ratios was 0.029 and occurred at AMS-3. AMS-3 operated 99 percent of the time during 1999.

In accordance with 40 CFR 61.107, compliance with the NESHAP standard is demonstrated when the sum of the ratios is less than 1. Based on this approach for demonstrating compliance, the 40 CFR 61, Appendix E, Table 2 values can be assumed to represent the annual average radionuclide concentrations that correspond to a 10 mrem annual effective dose equivalent. It follows that a fraction of the 40 CFR 61, Appendix E, Table 2 values would correspond to an equivalent fraction of a 10 mrem annual effective dose equivalent.

Based on the assumption above, the sum of the radionuclide-specific compliance ratios can be converted to a dose by multiplying the ratio by 10. The maximum value of the sum of the ratios (0.029) converts to a maximum effective dose equivalent of 0.29 mrem (2.9E-03 mSv) at the fenceline (AMS-3). Because the nearest residence is located approximately 1,555 feet (474 meters) downwind (east-southeast) from AMS-3, the actual dose received by this receptor would be substantially lower than 0.29 mrem.

SECTION IV: COMPLIANCE ASSESSMENT

For 1999 the maximum effective dose equivalent from emissions of radionuclides to the ambient air, based on radionuclide measurements at the FEMP fenceline, is estimated to be 0.29 mrem (2.9E-03 mSv), which is in compliance with the Subpart H standard of 10 mrem.

SECTION V: ADDITIONAL INFORMATION

A. Meteorological Data

Refer to Figure D-2 for the 1999 wind rose data.

B. Construction/Modifications at the FEMP

Three projects were completed in 1999 for which the requirements to apply to the EPA for approval to construct or modify were waived due to the provisions of 40 CFR 61.96. These projects were:

- Building 80, uranium metal fuel-core repackaging HEPA system
- Building 56, packaging of enriched ingots and derbies
- Building 12, Tank Farm/ Maintenance D&D Project.

Refer to Attachment D.1 for CAP88-PC computer model runs as supporting documentation for the waivers.

C. Unplanned Releases of Radionuclides

For 1999 no unplanned releases of radionuclides were identified in a review of the 358 notifications received by the site's release evaluators.

TABLE D-1

NESHAP STACK EMISSIONS MONITORING RESULTS

	1999 Annual Results	
Stack Location/ Analysis	Number of Samples (Including Rinsate)[a,b]	Total Pounds[c,d,e]
Building 71 Stack		
Uranium, Total	5	2.6E-05
Thorium-232	5	5.2E-05
Thorium-230	5	1.0E-09
Total Particulate	3	5.8E-01
Laundry Stack		
Uranium, Total	9	2.6E-05
Thorium-232	9	5.8E-04
Thorium-230	9	6.9E-09
Total Particulate	7	6.0E-01
WPRAP Dryer Stack		
Uranium-238	1	ND
Uranium-235/236	1	ND
Uranium-234	1	ND
Thorium-232	1	ND
Thorium-230	1	ND
Thorium-228	1	ND
Radium-226	1	ND
Total Particulate	NS	NS
Total Radon[f]	--	3.9E-03(Ci)

[a]NS = not sampled
[b]WPRAP sample is composite of 23 filters (collected over five days).
[c]Total pounds are only determined from detected results.
[d]ND = non-detectable
[e]Some particulate result(s) could not be determined due to a damaged filter(s).
[f]Sample results are continuously collected and recorded.

TABLE D-2[a]

DISTANCE AND DIRECTION FROM POINTS OF RELEASE TO RECEPTORS

Source	Type of Control	Percent Efficiency[b]	Dist. and Direction to Nearest Off Site Receptor
Plant 9	None	NA	959m ESE
Building 11			
Laundry Dryer Exhaust	HEPA	99.97	1016m WSW
Respirator Washing Facility	HEPA	99.97	1017m WSW
Building 12	None	NA	959m NNE
Building 15			
Perchloric Stacks	None	NA	921m WSW
HEPA Exhaust	HEPA	99.97	921m WSW
General Exhaust	None	NA	921m WSW
Building 51	None	NA	671m W
Building 53	None	NA	939m ESE
Building 56	None	NA	750m N
Building 65	HEPA	99.97	844m N
Building 71	HEPA	99.97	944m N
Building 78	HEPA	99.97	833m N
Building 80	None	NA	869m WSW
WPRAP Dryer	HEPA	99.97	904m NNE

[a]Table D-2 is included to comply with 40 CFR 61.94 (b)(6) and not used to demonstrate compliance with 40 CFR 61.92
[b]NA = not applicable

TABLE D-3

NET AIR CONCENTRATIONS[a]

	Uranium (pCi/m^3)			Thorium (pCi/m^3)			Radium (pCi/m^3)[b]
Location	234	235/236	238	228	230	232	226
Fenceline							
AMS-2	2.1E-05	1.1E-06	2.6E-05	2.2E-06	7.6E-06	1.4E-06	1.7E-05
AMS-3	5.6E-05	2.6E-06	6.0E-05	1.5E-06	1.0E-05	8.1E-07	3.1E-05
AMS-4	1.4E-05	5.5E-07	1.8E-05	1.8E-05	8.4E-06	1.7E-06	6.9E-06
AMS-5	5.7E-06	9.0E-08	7.3E-06	0.0E+00	4.5E-06	0.0E+00	0.0E+00
AMS-6	9.4E-06	6.3E-07	2.2E-05	0.0E+00	1.2E-05	0.0E+00	3.5E-06
AMS-7	4.7E-06	1.6E-07	8.2E-06	0.0E+00	1.4E-06	0.0E+00	0.0E+00
AMS-8A	6.1E-05	3.3E-06	6.8E-05	1.1E-07	7.7E-06	2.6E-07	1.7E-05
AMS-9C	4.0E-05	1.9E-06	4.6E-05	8.8E-07	1.1E-05	1.1E-06	1.5E-05
AMS-22	1.0E-05	6.8E-07	1.9E-05	4.2E-07	1.0E-05	1.9E-07	2.7E-06
AMS-23	1.9E-05	6.5E-07	2.4E-05	8.7E-06	3.3E-06	0.0E+00	0.0E+00
AMS-24	6.8E-06	5.7E-07	8.0E-06	1.2E-06[c]	7.4E-06	1.3E-06	1.8E-05
AMS-25	1.7E-06	0.0E+00	7.3E-06	0.0E+00[c]	4.0E-06	0.0E+00	0.0E+00
AMS-26	8.5E-06	6.4E-07	1.3E-05	0.0E+00	1.5E-05	0.0E+00	5.5E-06
AMS-27	6.9E-06	3.8E-07	1.2E-05	1.5E-06	8.4E-06	1.4E-06	2.1E-05
AMS-28	1.8E-06	2.3E-07	1.3E-05	0.0E+00	1.0E-05	0.0E+00	0.0E+00
AMS-29	1.6E-05	1.1E-06	2.2E-05	3.2E-06	8.7E-06	0.0E+00	0.0E+00
Background							
AMS-12	1.0E-05	1.5E-07	9.9E-06	3.6E-	6.4E-06[d]	3.9E-06[d]	5.1E-06
AMS-16	1.3E-05	3.7E-07	1.3E-05	8.6E-	1.4E-05[d]	9.2E-06[d]	2.5E-05

[a]Thorium-234, radium-228, actinium-228, radium-224, and thorium-231 are considered to be in equilibrium with their parent of the primordial decay chain (i.e., uranium-238 pCi/m^3 = thorium-234 pCi/m^3, thorium-232 pCi/m^3 = radium-228, actinium-228, and radium-224 pCi/m^3, uranium-235 pCi/m^3 = thorium-231 pCi/m^3).
[b]First quarter 1999 radium-226 data were rejected and substituted with first quarter 1998 radium-226 data.
[c]Second quarter 1999 thorium-228 data are assumed to be in equilibrium with second quarter 1999 thorium-232 data (primordial decay chain parent).
[d]First quarter 1999 thorium data were rejected and substituted with first quarter 1998 thorium data.

TABLE D-4

OPERATIONAL SUMMARY FOR AIR PARTICULATE MONITORING STATIONS IN 1999

Location	Number of Samples	Sample Start Date	Last Sample Collection Date	Operating Time (hours)[a]	Percent of Operation
Fenceline					
AMS-2	26	12/29/98	12/28/99	8675.0	99.3
AMS-3	26	12/29/98	12/28/99	8648.7	99.0
AMS-4	26	12/29/98	12/28/99	8573.6	98.1
AMS-5	26	12/29/98	12/28/99	8718.6	99.8
AMS-6	26	12/29/98	12/29/99	8587.6	98.0
AMS-7	26	12/29/98	12/28/99	8430.3	96.5
AMS-8A	26	12/29/98	12/28/99	8615.5	98.6
AMS-9C	26	12/29/98	12/28/99	8541.1	97.8
AMS-22	26	12/29/98	12/28/99	8580.8	98.2
AMS-23	26	12/29/98	12/28/99	8631.9	98.8
AMS-24	26	12/29/98	12/29/99	8685.6	99.2
AMS-25	26	12/29/98	12/29/99	8582.8	98.0
AMS-26	26	12/29/98	12/29/99	8643.5	98.7
AMS-27	26	12/29/98	12/29/99	8611.4	98.3
AMS-28	26	12/29/98	12/28/99	8728.6	99.9
AMS-29	26	12/29/98	12/28/99	8628.6	98.8
Background					
AMS-12	26	12/29/98	12/28/99	8726.7	99.9
AMS-16	26	12/29/98	12/28/99	8459.9	96.8

[a]8736 available operating hours from December 29, 1998 through December 28, 1999, and 8760 available operating hours through December 29, 1999.

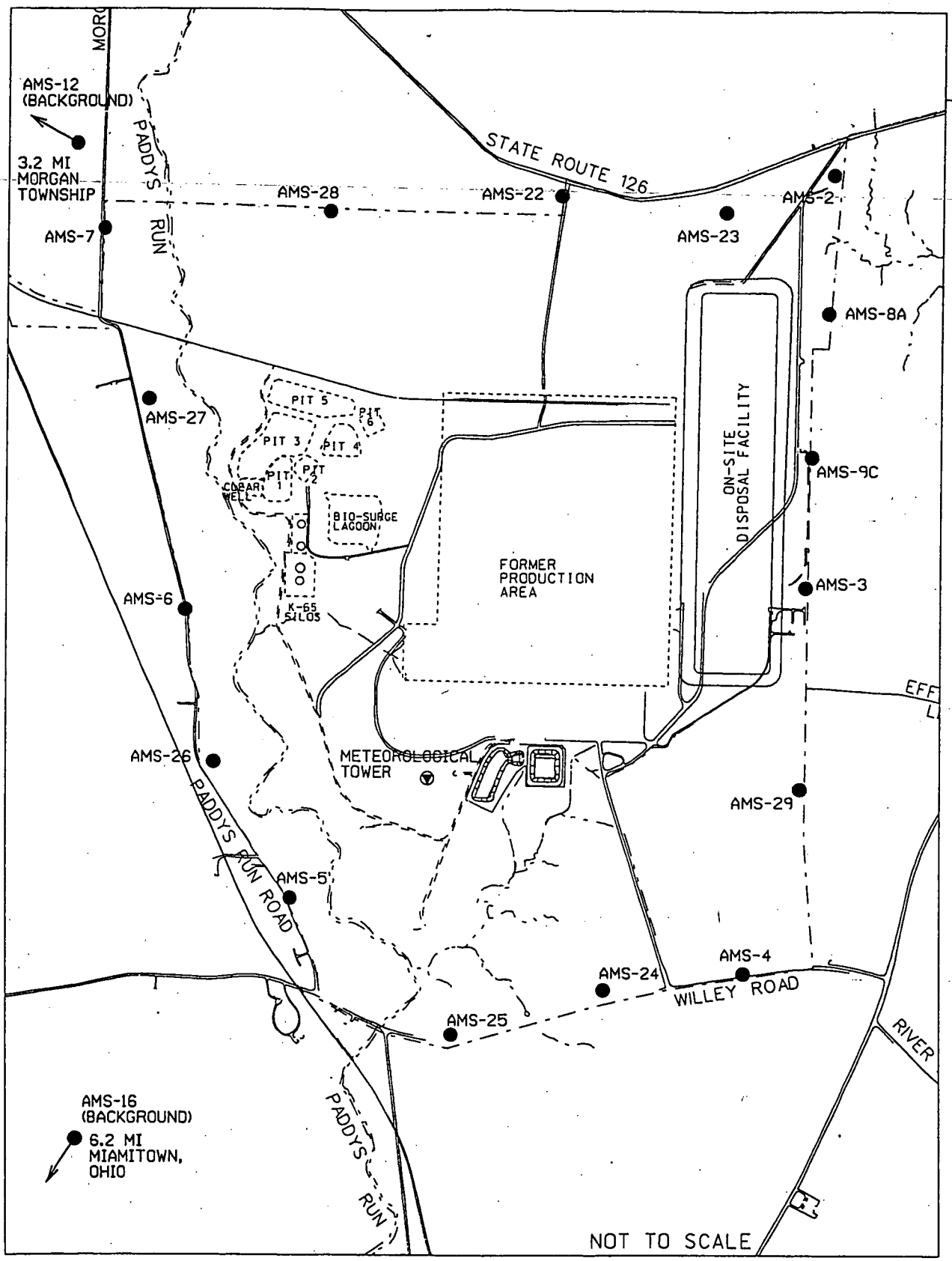
TABLE D-5

ANNUAL NESHAP COMPLIANCE RATIO REPORT

	40 CFR 61 (NESHAP) Subpart H Appendix E, Table 2; Net Ratios[a]													
Location	Actinium-228[b]	Radium-224[b]	Radium-226[c]	Radium-228[b]	Thorium-228	Thorium-230	Thorium-231[b]	Thorium-232	Thorium-234[b]	Uranium-234	Uranium-235 Uranium-236	Uranium-238	Ratio Totals	Dose[d] (mrem)
Fenceline														
AMS-2	3.9E-07	9.5E-06	5.2E-03	2.4E-04	6.9E-04	2.2E-03	3.7E-09	2.3E-03	1.2E-05	2.8E-03	1.5E-04	3.2E-03	1.7E-02	0.17
AMS-3	2.2E-07	5.4E-06	9.5E-03	1.4E-04	4.8E-04	3.0E-03	8.8E-09	1.3E-03	2.7E-05	7.2E-03	3.5E-04	7.2E-03	2.9E-02	0.29
AMS-4	4.5E-07	1.1E-05	2.1E-03	2.8E-04	5.7E-03	2.5E-03	1.9E-09	2.7E-03	8.3E-06	1.8E-03	7.4E-05	2.2E-03	1.7E-02	0.17
AMS-5	-	-	-	-	-	1.3E-03	3.1E-10	-	3.3E-06	7.4E-04	1.2E-05	8.8E-04	3.0E-03	0.030
AMS-6	-	-	1.1E-03	-	-	3.6E-03	2.2E-09	-	1.0E-05	1.2E-03	8.6E-05	2.7E-03	8.7E-03	0.087
AMS-7	-	-	-	-	-	4.1E-04	5.4E-10	-	3.7E-06	6.2E-04	2.1E-05	9.9E-04	2.0E-03	0.020
AMS-8A	7.0E-08	1.7E-06	5.2E-03	4.4E-05	3.5E-05	2.3E-03	1.2E-08	4.2E-04	3.1E-05	8.0E-03	4.5E-04	8.1E-03	2.5E-02	0.25
AMS-9C	3.0E-07	7.4E-06	4.7E-03	1.9E-04	2.9E-04	3.2E-03	6.6E-09	1.8E-03	2.1E-05	5.2E-03	2.6E-04	5.6E-03	2.1E-02	0.21
AMS-22	5.2E-08	1.3E-06	8.1E-04	3.3E-05	1.4E-04	2.9E-03	2.4E-09	3.1E-04	8.6E-06	1.3E-03	9.2E-05	2.3E-03	7.9E-03	0.079
AMS-23	-	-	-	-	2.8E-03	9.6E-04	2.3E-09	-	1.1E-05	2.5E-03	8.8E-05	2.9E-03	9.2E-03	0.092
AMS-24	3.5E-07	8.6E-06	5.4E-03	2.2E-04	3.8E-04[e]	2.2E-03	2.0E-09	2.1E-03	3.6E-06	8.9E-04	7.7E-05	9.6E-04	1.2E-02	0.12
AMS-25	-	-	-	-	-[e]	1.2E-03	-	-	3.3E-06	2.2E-04	-	8.8E-04	2.3E-03	0.023
AMS-26	-	-	1.7E-03	-	-	4.4E-03	2.2E-09	-	5.8E-06	1.1E-03	8.7E-05	1.5E-03	8.8E-03	0.088
AMS-27	3.9E-07	9.6E-06	6.3E-03	2.4E-04	4.9E-04	2.5E-03	1.3E-09	2.3E-03	5.3E-06	9.0E-04	5.2E-05	1.4E-03	1.4E-02	0.14
AMS-28	-	-	-	-	-	3.0E-03	7.8E-10	-	6.0E-06	2.3E-04	3.1E-05	1.6E-03	4.9E-03	0.049
AMS-29	-	-	-	-	1.0E-03	2.5E-03	3.8E-09	-	9.8E-06	2.0E-03	1.5E-04	2.6E-03	8.4E-03	0.084
Background														
AMS-12	1.1E-06	2.6E-05	1.5E-03	6.7E-04	1.2E-03[e,f]	1.9E-03[f]	5.3E-10	6.3E-03[f]	4.5E-06	1.3E-03	2.1E-05	1.2E-03	NA[g]	
AMS-16	2.5E-06	6.2E-05	7.6E-03	1.6E-03	2.8E-03[e,f]	4.0E-03[f]	1.3E-09	1.5E-02[f]	6.1E-06	1.7E-03	5.0E-05	1.6E-03	NA[g]	

Maximum Year-to-Date Ratio: 0.0293
Maximum Year-to-Date Dose (mrem): 0.293

[a]A "-" indicates the filter results were less than or equal to the blank results, and/or the indicator concentrations were less than or equal to the average net background concentrations.
[b]Isotopes are assumed to be in equilibrium with their primordial decay chain parent.
[c]First quarter 1999 radium-226 data were rejected and substituted with first quarter 1998 radium-226 data.
[d]Dose conversions are based on the NESHAP standard of 10 mrem per year.
[e]Second quarter 1999 thorium-228 data assumed to be in equilibrium with second quarter 1999 thorium-232 data (primordial decay chain parent).
[f]First quarter 1999 thorium data were rejected and substituted with first quarter 1998 thorium data.
[g]NA = not applicable



LEGEND:

FEMP BOUNDARY

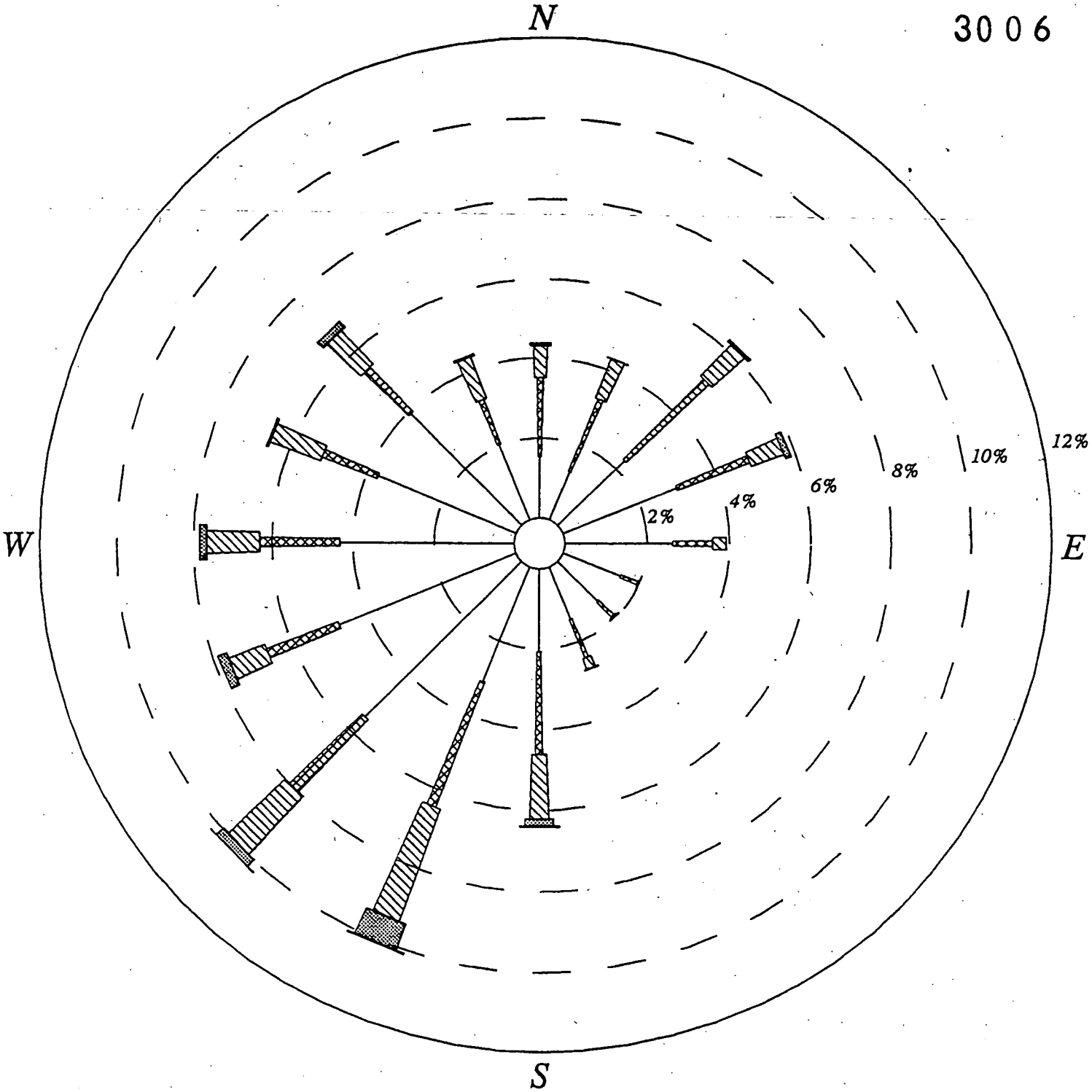
AMS LOCATION

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO AMS LOCATION OFF MAP

000021

FIGURE D-1. RADIOLOGICAL AIR MONITORING STATION LOCATIONS

STATE PLANAR COORDINATE SYSTEM 1927
05-APR-2000



CALM WINDS 8.27%

WIND SPEED (KNOTS)

NOTE: Frequencies indicate direction from which the wind is blowing.

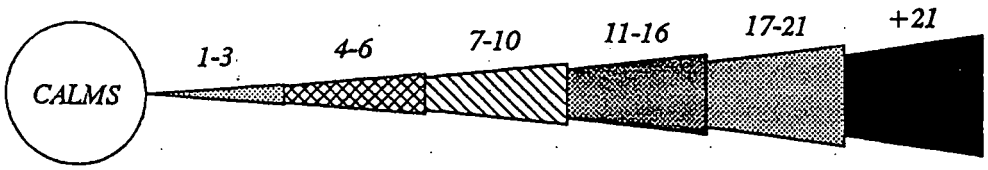


FIGURE D-2. 1999 WIND ROSE DATA, 10-METER HEIGHT

REFERENCES

U.S. Dept. of Energy, 1999, "Integrated Environmental Monitoring Plan, Revision 1," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997, DOE-0980-97, Johnny Reising to James Saric and Michael Murphy, "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H," dated May 23, 1997.

U.S. Environmental Protection Agency, 1997, Jack Barnett to Johnny Reising, "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H," dated August 11, 1997.

SECTION VI: CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment (see 18 U.S.C. 1001).

Name: JACK CRAIG

Signature: [signature]

Date: 5/25/00

ATTACHMENT D.1

CAP88-PC COMPUTER MODEL RUNS AS SUPPORTING DOCUMENTATION FOR 40 CFR 61.96

BUILDING 80, URANIUM METAL FUEL-CORE REPACKAGING HEPA SYSTEM

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Aug 11, 1999 9:41 am

Facility: Fernald Environmental Management Project
Address: P.O. Box 538704
7400 Willey Road
City: Cincinnati
State: OH Zip: 45253-8704

Effective Dose Equivalent (mrem/year)
1.19E-03

At This Location: 869 Meters North Northeast

Source Category: point
Source Type: Stack
Emission Year: 1999

Comments: Appendix D EDE determination.

Dataset Name: 99CORESEDE
Dataset Date: Aug 11, 1999 9:40 am
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 869 Meters North Northeast
Lifetime Fatal Cancer Risk: 1.56E-08

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	1.85E-06
BREAST	2.14E-06
R MAR	5.58E-05
LUNGS	9.51E-03
THYROID	1.81E-06
ENDOST	7.20E-04
RMNDR	6.45E-05
EFFEC	1.19E-03

RADIONUCLIDE EMISSIONS DURING THE YEAR 1999

uclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
-238	Y	0.30	2.0E-05	2.0E-05
-235	Y	1.00	1.9E-09	1.9E-09

SITE INFORMATION

Temperature:	20 degrees C
Precipitation:	146 cm/y
Mixing Height:	965 m

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 6.10
Diameter (m): 0.31

Plume Rise
Momentum (m/s): 7.98E+00
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

1246	1907	1513	1204	2178	869	982	1058	1275	1221
1421	1270	1270	1829	1779	1331				

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Aug 11, 1999 9:41 am

Facility: Fernald Environmental Management Project
Address: P.O. Box 538704
7400 Willey Road
City: Cincinnati
State: OH Zip: 45253-8704

Source Category: point
Source Type: Stack
Emission Year: 1999

Comments: Appendix D EDE determination.

Dataset Name: 99CORESEDE
Dataset Date: Aug 11, 1999 9:40 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	1.85E-06
BREAST	2.14E-06
R MAR	5.58E-05
LUNGS	9.51E-03
THYROID	1.81E-06
ENDOST	7.20E-04
RMNDR	6.45E-05
EFFEC	1.19E-03

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	4.63E-05
INHALATION	1.14E-03
AIR IMMERSION	4.03E-13
GROUND SURFACE	7.49E-08
INTERNAL	1.19E-03
EXTERNAL	7.49E-08
TOTAL	1.19E-03

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-238	1.19E-03
U-235	7.17E-08
TOTAL	1.19E-03

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	6.99E-11
BONE	3.88E-11
THYROID	3.23E-13
BREAST	3.99E-12
LUNG	1.54E-08
STOMACH	2.59E-12
BOWEL	5.35E-12
LIVER	2.09E-12
PANCREAS	1.69E-12
URINARY	1.40E-10
OTHER	2.07E-12
TOTAL	1.56E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	2.56E-10
INHALATION	1.54E-08
AIR IMMERSION	8.68E-18
GROUND SURFACE	1.58E-12
INTERNAL	1.56E-08
EXTERNAL	1.58E-12
TOTAL	1.56E-08

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-238	1.56E-08
U-235	9.38E-13
TOTAL	1.56E-08

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

Direction	Distance (m) 1246	1907	1513	1204	2178	869	982
N	3.4E-04	1.8E-04	2.5E-04	3.6E-04	1.4E-04	6.2E-04	5.0E-04
NNW	1.5E-04	7.7E-05	1.1E-04	1.6E-04	6.3E-05	2.7E-04	2.2E-04
NW	1.2E-04	6.6E-05	9.2E-05	1.3E-04	5.4E-05	2.1E-04	1.8E-04
WNW	1.1E-04	5.7E-05	8.0E-05	1.1E-04	4.7E-05	1.9E-04	1.5E-04
W	1.5E-04	8.2E-05	1.2E-04	1.6E-04	6.7E-05	2.7E-04	2.2E-04
WSW	4.3E-04	2.2E-04	3.1E-04	4.5E-04	1.7E-04	7.7E-04	6.2E-04
SW	2.7E-04	1.4E-04	2.0E-04	2.9E-04	1.2E-04	4.8E-04	4.0E-04
SSW	3.8E-04	1.9E-04	2.7E-04	4.0E-04	1.5E-04	6.9E-04	5.6E-04
S	3.5E-04	1.8E-04	2.5E-04	3.7E-04	1.4E-04	6.3E-04	5.1E-04
SSE	3.3E-04	1.7E-04	2.4E-04	3.5E-04	1.3E-04	6.1E-04	4.9E-04
SE	2.9E-04	1.6E-04	2.2E-04	3.1E-04	1.3E-04	5.0E-04	4.2E-04
ESE	4.3E-04	2.2E-04	3.2E-04	4.5E-04	1.8E-04	7.7E-04	6.3E-04
E	3.0E-04	1.5E-04	2.2E-04	3.1E-04	1.3E-04	5.3E-04	4.3E-04
ENE	3.3E-04	1.7E-04	2.4E-04	3.5E-04	1.4E-04	6.0E-04	4.9E-04
NE	3.7E-04	1.9E-04	2.7E-04	3.9E-04	1.5E-04	6.7E-04	5.4E-04
NNE	6.7E-04	3.5E-04	5.0E-04	7.1E-04	2.8E-04	1.2E-03	9.7E-04

Direction	Distance (m) 1058	1275	1221	1421	1270	1270	1829
N	4.5E-04	3.3E-04	3.6E-04	2.8E-04	3.3E-04	3.3E-04	1.9E-04
NNW	1.9E-04	1.4E-04	1.5E-04	1.2E-04	1.4E-04	1.4E-04	8.2E-05
NW	1.6E-04	1.2E-04	1.3E-04	1.0E-04	1.2E-04	1.2E-04	7.0E-05
WNW	1.4E-04	1.0E-04	1.1E-04	8.8E-05	1.0E-04	1.0E-04	6.1E-05
W	2.0E-04	1.5E-04	1.6E-04	1.3E-04	1.5E-04	1.5E-04	8.7E-05
WSW	5.5E-04	4.1E-04	4.4E-04	3.4E-04	4.1E-04	4.1E-04	2.3E-04
SW	3.5E-04	2.6E-04	2.8E-04	2.2E-04	2.7E-04	2.7E-04	1.5E-04
SSW	4.9E-04	3.6E-04	3.9E-04	3.0E-04	3.6E-04	3.6E-04	2.0E-04
S	4.5E-04	3.3E-04	3.6E-04	2.8E-04	3.4E-04	3.4E-04	1.9E-04
SSE	4.4E-04	3.2E-04	3.5E-04	2.7E-04	3.2E-04	3.2E-04	1.8E-04
SE	3.7E-04	2.8E-04	3.0E-04	2.4E-04	2.8E-04	2.8E-04	1.7E-04
ESE	5.6E-04	4.1E-04	4.4E-04	3.5E-04	4.2E-04	4.2E-04	2.3E-04
E	3.8E-04	2.9E-04	3.1E-04	2.4E-04	2.9E-04	2.9E-04	1.6E-04
ENE	4.3E-04	3.2E-04	3.4E-04	2.7E-04	3.2E-04	3.2E-04	1.8E-04
NE	4.8E-04	3.6E-04	3.8E-04	3.0E-04	3.6E-04	3.6E-04	2.0E-04
NNE	8.7E-04	6.5E-04	6.9E-04	5.5E-04	6.5E-04	6.5E-04	3.7E-04

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1779	1331
N	2.0E-04	3.1E-04
NNW	8.5E-05	1.3E-04
NW	7.3E-05	1.1E-04
WNW	6.3E-05	9.7E-05
W	9.1E-05	1.4E-04
WSW	2.4E-04	3.8E-04
SW	1.6E-04	2.5E-04
SSW	2.1E-04	3.4E-04
S	2.0E-04	3.1E-04
SSE	1.9E-04	3.0E-04
SE	1.7E-04	2.7E-04
ESE	2.4E-04	3.9E-04
E	1.7E-04	2.7E-04
ENE	1.9E-04	3.0E-04
NE	2.1E-04	3.3E-04
NNE	3.9E-04	6.1E-04

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m) 1246	1907	1513	1204	2178	869	982
N	4.5E-09	2.3E-09	3.3E-09	4.7E-09	1.8E-09	8.1E-09	6.6E-09
NNW	1.9E-09	9.6E-10	1.4E-09	2.0E-09	7.8E-10	3.5E-09	2.8E-09
NW	1.6E-09	8.2E-10	1.2E-09	1.7E-09	6.7E-10	2.8E-09	2.3E-09
WNW	1.4E-09	7.1E-10	1.0E-09	1.4E-09	5.8E-10	2.4E-09	2.0E-09
W	2.0E-09	1.0E-09	1.5E-09	2.1E-09	8.4E-10	3.5E-09	2.8E-09
WSW	5.5E-09	2.8E-09	4.1E-09	5.9E-09	2.2E-09	1.0E-08	8.1E-09
SW	3.6E-09	1.8E-09	2.6E-09	3.7E-09	1.5E-09	6.3E-09	5.2E-09
SSW	4.9E-09	2.4E-09	3.5E-09	5.2E-09	1.9E-09	9.0E-09	7.3E-09
S	4.5E-09	2.3E-09	3.3E-09	4.8E-09	1.8E-09	8.2E-09	6.6E-09
SSE	4.3E-09	2.1E-09	3.1E-09	4.6E-09	1.7E-09	8.0E-09	6.4E-09
SE	3.8E-09	2.0E-09	2.8E-09	4.0E-09	1.6E-09	6.6E-09	5.4E-09
ESE	5.6E-09	2.8E-09	4.1E-09	5.9E-09	2.3E-09	1.0E-08	8.2E-09
E	3.9E-09	2.0E-09	2.8E-09	4.1E-09	1.6E-09	6.9E-09	5.6E-09
ENE	4.3E-09	2.2E-09	3.2E-09	4.6E-09	1.8E-09	7.9E-09	6.4E-09
NE	4.8E-09	2.4E-09	3.5E-09	5.1E-09	1.9E-09	8.7E-09	7.1E-09
NNE	8.8E-09	4.5E-09	6.5E-09	9.3E-09	3.7E-09	1.6E-08	1.3E-08

Direction	Distance (m) 1056	1275	1221	1421	1270	1270	1829
N	5.8E-09	4.3E-09	4.6E-09	3.6E-09	4.3E-09	4.3E-09	2.4E-09
NNW	2.5E-09	1.8E-09	2.0E-09	1.5E-09	1.9E-09	1.9E-09	1.0E-09
NW	2.0E-09	1.5E-09	1.6E-09	1.3E-09	1.5E-09	1.5E-09	8.8E-10
WNW	1.8E-09	1.3E-09	1.4E-09	1.1E-09	1.3E-09	1.3E-09	7.5E-10
W	2.5E-09	1.9E-09	2.0E-09	1.6E-09	1.9E-09	1.9E-09	1.1E-09
WSW	7.2E-09	5.3E-09	5.7E-09	4.5E-09	5.4E-09	5.4E-09	3.0E-09
SW	4.6E-09	3.4E-09	3.7E-09	2.9E-09	3.4E-09	3.4E-09	1.9E-09
SSW	6.4E-09	4.7E-09	5.1E-09	3.9E-09	4.7E-09	4.7E-09	2.6E-09
S	5.9E-09	4.4E-09	4.7E-09	3.7E-09	4.4E-09	4.4E-09	2.4E-09
SSE	5.7E-09	4.2E-09	4.5E-09	3.5E-09	4.2E-09	4.2E-09	2.3E-09
SE	4.9E-09	3.7E-09	3.9E-09	3.1E-09	3.7E-09	3.7E-09	2.1E-09
ESE	7.3E-09	5.4E-09	5.8E-09	4.5E-09	5.4E-09	5.4E-09	3.0E-09
E	5.0E-09	3.7E-09	4.0E-09	3.1E-09	3.8E-09	3.8E-09	2.1E-09
ENE	5.6E-09	4.2E-09	4.5E-09	3.5E-09	4.2E-09	4.2E-09	2.3E-09
NE	6.3E-09	4.6E-09	5.0E-09	3.9E-09	4.7E-09	4.7E-09	2.6E-09
NNE	1.1E-08	8.5E-09	9.1E-09	7.2E-09	8.6E-09	8.6E-09	4.8E-09

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1779	1331
N	2.5E-09	4.0E-09
NNW	1.1E-09	1.7E-09
NW	9.1E-10	1.4E-09
WNW	7.9E-10	1.2E-09
W	1.1E-09	1.8E-09
WSW	3.1E-09	5.0E-09
SW	2.0E-09	3.2E-09
SSW	2.7E-09	4.4E-09
S	2.5E-09	4.1E-09
SSE	2.4E-09	3.9E-09
SE	2.2E-09	3.5E-09
ESE	3.2E-09	5.0E-09
E	2.2E-09	3.5E-09
ENE	2.4E-09	3.9E-09
NE	2.7E-09	4.3E-09
NNE	5.0E-09	7.9E-09

40 CFR PART 61.96(b) - APPLICATION FOR APPROVAL

1. Assumptions

- 1,329,000 pounds of depleted uranium metal cores
- Depleted uranium metal cores are by weight 0.2% U^{235} & rest U^{238}
- Activity of U^{235} is 15.8 µCi / kg-U^{235}
- Activity of U^{238} is 333.6 µCi / kg-U^{238}
- Emission estimate from Appendix D, 40 CFR 61, for solid metal is 10^{-6}
- Emissions are particulates
- Particulate control factor for HEPA filter control is 0.99 per Appendix D
- EF means emission factor

2. Calculation of U^{235} & U^{238} Emissions

U^{235} Emissions

1,329,000 lbs-U	0.002 lbs-U^{235}	10^{-6} lbs-solids	1 kg	1 - .99 (EF)	15.8 µCi	= 1.905E-3 µCi
	1 lbs-U	1 lb-solids	2.205 lbs		kg-U^{235}	

U^{238} Emissions

1,329,000 lbs-U	0.998 lbs-U^{235}	10^{-6} lbs-solids	1 kg	1 - .99 (EF)	333.6 µCi	= 20.07 µCi
	1 lbs-U	1 lb-solids	2.205 lbs		kg-U^{238}	

Used these values of nearest receptors for Uranium Metal Fuel Core Repackaging at Building 80

— R. Palmer 8/10/99

FEMP RECEPTOR LOCATOR PROGRAM

Distances to Offsite receptors

3006

SOURCE:	Bldg. 80 OEP Tank Breathing HEPA System	
	N-S	E-W
	480080	1380150

MONITOR	N-S (ft)	E-W (ft)	DISTANCE (meters)	DIRECTION	
1	484280	1380920	1301	N	
2	484160	1380410	1246	N	1
3	485470	1376970	1907	NNW	2
4	483380	1376440	1513	NW	3
5	482190	1376812	1204	WNW	4
6	479190	1377440	869	WSW	6
7	477630	1378060	982	SW	7
8	477060	1378440	1058	SSW	8
9	476910	1378470	1094	SSW	
10	476220	1378810	1245	SSW	
11	476160	1379000	1245	SSW	
12	475900	1380000	1275	S	9
13	476190	1381100	1221	SSE	10
14	476250	1381380	1226	SSE	
15	474780	1383190	1862	SSE	
16	476840	1383500	1421	SE	11
17	479060	1384190	1270	ESE	12
18	479340	1384250	1270	E	13
19	483380	1385160	1829	ENE	14
20	484720	1383690	1779	NE	15
21	484120	1381810	1331	NNE	16
22	485190	1379730	1563	N	
23	481839	1374096	1922	WNW	
24	480015	1386674	1989	E	
25	482361	1388613	2672	ENE	
26	479562	1373023	2178	W	5
27	475060	1385970	2343	SE	
28	485440	1379375	1651	N	
29	476940	1384000	1514	SE	
30	481557	1387895	2403	E	
31	481767	1388075	2470	ENE	
32	485630	1379200	1716	N	
A	479562	1372826	2238	W	
B	483560	1376440	1550	NW	
C	485310	1376810	1891	NNW	
D	485500	1376560	1982	NNW	
E	485310	1376560	1934	NW	
F	477000	1375340	1741	WSW	
G	477000	1375220	1772	WSW	
H	485220	1383620	1890	NE	

FILE: do-dist.wk4

BUILDING 56, PACKAGING OF ENRICHED INGOTS AND DERBIES

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Oct 12, 1999 1:36 pm

Facility: Fernald Environmental Management Project
Address: 7400 Willey Road
City: Fernald
State: OH Zip: 45013

Effective Dose Equivalent
(mrem/year)

3.04E-03

At This Location: 750 Meters North Northeast
Source Category: DOE Facility - Remediation
Source Type: Area
Emission Year: 1999

Comments: PACKAGING Enriched Ingots and Derbies in Bldg. 56

Dataset Name: BLDG56pkgappl
Dataset Date: Oct 12, 1999 1:35 pm
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 750 Meters North Northeast
Lifetime Fatal Cancer Risk: 4.00E-08

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	4.37E-06
BREAST	5.08E-06
R MAR	1.26E-04
LUNGS	2.44E-02
THYROID	4.28E-06
ENDOST	1.63E-03
RMNDR	1.46E-04
EFFEC	3.04E-03

RADIONUCLIDE EMISSIONS DURING THE YEAR 1999

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-235	Y	1.00	1.4E-07	1.4E-07
U-238	Y	0.30	3.8E-05	3.8E-05

SITE INFORMATION

Temperature:	12 degrees C
Precipitation:	102 cm/y
Mixing Height:	950 m

SOURCE INFORMATION

Source Number: 1

Source Height (m): 5.00
Area (sq m): 6.28E+02

Plume Rise
Momentum (m/s): 1.00E+00
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

750	1089	1574	1339	1134	2370	1206	1446	1683	1741
1383	1351	2254	1510	1339	839				

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Oct 12, 1999 1:36 pm

Facility: Fernald Environmental Management Project
Address: 7400 Willey Road
City: Fernald
State: OH Zip: 45013

Source Category: DOE Facility - Remediation
Source Type: Area
Emission Year: 1999

Comments: PACKAGING Enriched Ingots and Derbies in Bldg. 56

Dataset Name: BLDG56pkgappl
Dataset Date: Oct 12, 1999 1:35 pm
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	4.37E-06
BREAST	5.08E-06
R MAR	1.26E-04
LUNGS	2.44E-02
THYROID	4.28E-06
ENDOST	1.63E-03
RMNDR	1.46E-04
EFFEC	3.04E-03

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	1.04E-04
INHALATION	2.93E-03
AIR IMMERSION	5.95E-12
GROUND SURFACE	3.33E-07
INTERNAL	3.04E-03
EXTERNAL	3.33E-07
TOTAL	3.04E-03

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-235	7.17E-06
U-238	3.03E-03
TOTAL	3.04E-03

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.59E-10
BONE	8.78E-11
THYROID	8.16E-13
BREAST	9.93E-12
LUNG	3.94E-08
STOMACH	6.31E-12
BOWEL	1.28E-11
LIVER	5.19E-12
PANCREAS	4.10E-12
URINARY	3.18E-10
OTHER	5.01E-12
TOTAL	4.00E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	5.76E-10
INHALATION	3.94E-08
AIR IMMERSION	1.37E-16
GROUND SURFACE	7.40E-12
INTERNAL	4.00E-08
EXTERNAL	7.40E-12
TOTAL	4.00E-08

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-235	9.42E-11
U-238	3.99E-08
TOTAL	4.00E-08

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	750	1089	1574	1339	1134	2370	1206
N	1.6E-03	8.3E-04	4.5E-04	5.9E-04	7.7E-04	2.4E-04	7.0E-04
NNW	6.7E-04	3.5E-04	2.0E-04	2.5E-04	3.3E-04	1.0E-04	3.0E-04
NW	5.5E-04	3.0E-04	1.7E-04	2.2E-04	2.8E-04	9.1E-05	2.5E-04
WNW	4.8E-04	2.6E-04	1.5E-04	1.9E-04	2.4E-04	7.9E-05	2.2E-04
W	6.9E-04	3.8E-04	2.1E-04	2.8E-04	3.6E-04	1.1E-04	3.2E-04
WSW	1.9E-03	1.0E-03	5.6E-04	7.3E-04	9.6E-04	2.9E-04	8.7E-04
SW	1.2E-03	6.7E-04	3.7E-04	4.8E-04	6.3E-04	1.9E-04	5.7E-04
SSW	1.7E-03	8.9E-04	4.8E-04	6.3E-04	8.3E-04	2.5E-04	7.5E-04
S	1.6E-03	8.4E-04	4.6E-04	6.0E-04	7.8E-04	2.4E-04	7.1E-04
SSE	1.5E-03	8.0E-04	4.4E-04	5.7E-04	7.5E-04	2.2E-04	6.8E-04
SE	1.3E-03	7.3E-04	4.1E-04	5.3E-04	6.9E-04	2.2E-04	6.2E-04
ESE	2.0E-03	1.0E-03	5.8E-04	7.5E-04	9.8E-04	3.0E-04	8.9E-04
E	1.4E-03	7.3E-04	4.0E-04	5.2E-04	6.8E-04	2.1E-04	6.2E-04
ENE	1.5E-03	8.0E-04	4.4E-04	5.7E-04	7.5E-04	2.3E-04	6.8E-04
NE	1.7E-03	8.8E-04	4.8E-04	6.3E-04	8.3E-04	2.5E-04	7.5E-04
NNE	3.0E-03	1.6E-03	9.1E-04	1.2E-03	1.5E-03	4.7E-04	1.4E-03

	Distance (m)						
Direction	1446	1683	1741	1383	1351	2254	1510
N	5.2E-04	4.1E-04	3.9E-04	5.6E-04	5.8E-04	2.6E-04	4.9E-04
NNW	2.2E-04	1.8E-04	1.7E-04	2.4E-04	2.5E-04	1.1E-04	2.1E-04
NW	1.9E-04	1.5E-04	1.5E-04	2.1E-04	2.1E-04	9.8E-05	1.8E-04
WNW	1.7E-04	1.3E-04	1.3E-04	1.8E-04	1.8E-04	8.5E-05	1.6E-04
W	2.4E-04	1.9E-04	1.8E-04	2.6E-04	2.7E-04	1.2E-04	2.3E-04
WSW	6.4E-04	5.0E-04	4.8E-04	6.9E-04	7.2E-04	3.1E-04	6.0E-04
SW	4.2E-04	3.3E-04	3.2E-04	4.6E-04	4.7E-04	2.1E-04	4.0E-04
SSW	5.6E-04	4.3E-04	4.1E-04	6.0E-04	6.2E-04	2.7E-04	5.2E-04
S	5.3E-04	4.1E-04	3.9E-04	5.7E-04	5.9E-04	2.6E-04	4.9E-04
SSE	5.0E-04	3.9E-04	3.7E-04	5.4E-04	5.6E-04	2.4E-04	4.7E-04
SE	4.7E-04	3.7E-04	3.5E-04	5.1E-04	5.2E-04	2.4E-04	4.4E-04
ESE	6.6E-04	5.2E-04	4.9E-04	7.1E-04	7.4E-04	3.2E-04	6.2E-04
E	4.6E-04	3.6E-04	3.4E-04	5.0E-04	5.2E-04	2.3E-04	4.3E-04
ENE	5.0E-04	3.9E-04	3.7E-04	5.4E-04	5.6E-04	2.5E-04	4.7E-04
NE	5.6E-04	4.3E-04	4.1E-04	6.0E-04	6.2E-04	2.7E-04	5.2E-04
NNE	1.0E-03	8.2E-04	7.7E-04	1.1E-03	1.2E-03	5.1E-04	9.7E-04

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1339	839
N	5.9E-04	1.3E-03
NNW	2.5E-04	5.5E-04
NW	2.2E-04	4.5E-04
WNW	1.9E-04	4.0E-04
W	2.8E-04	5.8E-04
WSW	7.3E-04	1.6E-03
SW	4.8E-04	1.0E-03
SSW	6.3E-04	1.4E-03
S	6.0E-04	1.3E-03
SSE	5.7E-04	1.3E-03
SE	5.3E-04	1.1E-03
ESE	7.5E-04	1.6E-03
E	5.2E-04	1.1E-03
ENE	5.7E-04	1.3E-03
NE	6.3E-04	1.4E-03
NNE	1.2E-03	2.5E-03

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m) 750	1089	1574	1339	1134	2370	1206
N	2.1E-08	1.1E-08	5.9E-09	7.7E-09	1.0E-08	3.0E-09	9.1E-09
NNW	8.8E-09	4.6E-09	2.5E-09	3.3E-09	4.3E-09	1.3E-09	3.9E-09
NW	7.2E-09	3.9E-09	2.2E-09	2.8E-09	3.6E-09	1.1E-09	3.3E-09
WNW	6.3E-09	3.3E-09	1.9E-09	2.4E-09	3.1E-09	9.7E-10	2.8E-09
W	9.1E-09	4.9E-09	2.7E-09	3.6E-09	4.6E-09	1.4E-09	4.2E-09
WSW	2.6E-08	1.3E-08	7.3E-09	9.5E-09	1.3E-08	3.7E-09	1.1E-08
SW	1.6E-08	8.7E-09	4.8E-09	6.2E-09	8.2E-09	2.5E-09	7.4E-09
SSW	2.3E-08	1.2E-08	6.3E-09	8.3E-09	1.1E-08	3.2E-09	9.8E-09
S	2.1E-08	1.1E-08	6.0E-09	7.8E-09	1.0E-08	3.0E-09	9.2E-09
SSE	2.0E-08	1.0E-08	5.7E-09	7.4E-09	9.8E-09	2.8E-09	8.8E-09
SE	1.7E-08	9.5E-09	5.4E-09	6.9E-09	9.0E-09	2.8E-09	8.2E-09
ESE	2.6E-08	1.4E-08	7.5E-09	9.8E-09	1.3E-08	3.8E-09	1.2E-08
E	1.8E-08	9.5E-09	5.2E-09	6.8E-09	8.9E-09	2.7E-09	8.1E-09
ENE	2.0E-08	1.0E-08	5.7E-09	7.5E-09	9.8E-09	2.9E-09	8.9E-09
NE	2.2E-08	1.2E-08	6.3E-09	8.2E-09	1.1E-08	3.2E-09	9.8E-09
NNE	4.0E-08	2.1E-08	1.2E-08	1.5E-08	2.0E-08	6.1E-09	1.8E-08

Direction	Distance (m) 1446	1683	1741	1383	1351	2254	1510
N	6.8E-09	5.3E-09	5.0E-09	7.3E-09	7.6E-09	3.3E-09	6.3E-09
NNW	2.9E-09	2.2E-09	2.1E-09	3.1E-09	3.2E-09	1.4E-09	2.7E-09
NW	2.5E-09	1.9E-09	1.8E-09	2.6E-09	2.7E-09	1.2E-09	2.3E-09
WNW	2.1E-09	1.7E-09	1.6E-09	2.3E-09	2.4E-09	1.0E-09	2.0E-09
W	3.1E-09	2.5E-09	2.3E-09	3.4E-09	3.5E-09	1.5E-09	2.9E-09
WSW	8.4E-09	6.6E-09	6.2E-09	9.0E-09	9.4E-09	4.1E-09	7.8E-09
SW	5.5E-09	4.3E-09	4.1E-09	5.9E-09	6.2E-09	2.7E-09	5.1E-09
SSW	7.3E-09	5.6E-09	5.3E-09	7.8E-09	8.1E-09	3.5E-09	6.8E-09
S	6.9E-09	5.3E-09	5.1E-09	7.4E-09	7.7E-09	3.3E-09	6.4E-09
SSE	6.5E-09	5.1E-09	4.8E-09	7.0E-09	7.3E-09	3.1E-09	6.1E-09
SE	6.1E-09	4.8E-09	4.6E-09	6.6E-09	6.8E-09	3.0E-09	5.7E-09
ESE	8.6E-09	6.7E-09	6.4E-09	9.3E-09	9.6E-09	4.2E-09	8.0E-09
E	6.0E-09	4.7E-09	4.4E-09	6.5E-09	6.7E-09	2.9E-09	5.6E-09
ENE	6.6E-09	5.1E-09	4.8E-09	7.1E-09	7.3E-09	3.2E-09	6.1E-09
NE	7.3E-09	5.6E-09	5.3E-09	7.8E-09	8.1E-09	3.5E-09	6.7E-09
NNE	1.4E-08	1.1E-08	1.0E-08	1.5E-08	1.5E-08	6.7E-09	1.3E-08

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1339	839
N	7.7E-09	1.7E-08
NNW	3.3E-09	7.2E-09
NW	2.8E-09	5.9E-09
WNW	2.4E-09	5.2E-09
W	3.6E-09	7.5E-09
WSW	9.5E-09	2.1E-08
SW	6.2E-09	1.4E-08
SSW	8.3E-09	1.8E-08
S	7.8E-09	1.7E-08
SSE	7.4E-09	1.7E-08
SE	6.9E-09	1.4E-08
ESE	9.8E-09	2.1E-08
E	6.8E-09	1.5E-08
ENE	7.5E-09	1.6E-08
NE	8.2E-09	1.8E-08
NNE	1.5E-08	3.3E-08

40 CFR PART 61.96(b) - APPLICATION FOR APPROVAL FOR BUILDING 56

1. Assumptions

- 46,270 pounds of enriched uranium metal ingots
- 207,006 pounds of enriched uranium metal derbies
- Enriched uranium metal cores are by weight 1.25% U^{235} & rest U^{238}
- Activity of U^{235} is Correction Factor (1.25/.2) * 98.8 µCi / kg-U^{235}
- Activity of U^{238} is 333.6 µCi / kg-U^{238}
- Emission estimate from Appendix D, 40 CFR 61, for solid metal is 10^{-6}
- Emissions are particulates
- EF means emission factor

2. Calculation of U^{235} & U^{238} Emissions

Activity of U^{235} Emissions

253,276 lbs-U	0.0125 lbs-U^{235}	10^{-6} lbs-solids	1 kg	98.8 µCi	= 0.142 µCi
	1 lbs-U	1 lb-solids	2.205 lbs	kg-U^{235}	

Activity of U^{238} Emissions

253,276 lbs-U	0.9875 lbs-U^{235}	10^{-6} lbs-solids	1 kg	333.6 µCi	= 37.84 µCi
	1 lbs-U	1 lb-solids	2.205 lbs	kg-U^{235}	

FEMP RECEPTOR LOCATOR PROGRAM

Distances to Offsite receptors

SOURCE:	Building 56	
	N-S	E-W
	481700	1380500

RECEPTOR	N-S (ft)	E-W (ft)	DISTANCE (meters)	DIRECTION	
1	484280	1380920	797	N	
2	484160	1380410	750	N	1
3	485470	1376970	1574	NW	3
4	483380	1376440	1339	WNW	4
5	482190	1376812	1134	W	5
6	479190	1377440	1206	SW	7
7	477630	1378060	1446	SSW	8
8	477060	1378440	1547	SSW	
9	476910	1378470	1586	SSW	
10	476220	1378810	1748	SSW	
11	476160	1379000	1749	SSW	
12	475900	1380000	1774	S	
13	476190	1381100	1689	S	
14	476250	1381380	1683	S	9
15	474780	1383190	2263	SSE	
16	476840	1383500	1741	SSE	10
17	479060	1384190	1383	SE	11
18	479340	1384250	1351	ESE	12
19	483380	1385160	1510	ENE	14
20	484720	1383690	1339	NE	15
21	484120	1381810	839	NNE	16
22	485190	1379730	1089	NNW	2
23	481839	1374096	1952	W	
24	480015	1386674	1951	ESE	
25	482361	1388613	2481	E	
26	479562	1373023	2370	WSW	6
27	475060	1385970	2622	SE	
28	485440	1379375	1190	NNW	
29	476940	1384000	1801	SE	
30	481557	1387895	2254	E	13
31	481767	1388075	2309	E	
32	485630	1379200	1262	NNW	
A	479562	1372826	2428	WSW	
B	483560	1376440	1361	WNW	
C	485310	1376810	1573	NW	
D	485500	1376560	1668	NW	
E	485310	1376560	1629	NW	
F	477000	1375340	2127	SW	
G	477000	1375220	2155	SW	
H	485220	1383620	1434	NE	

FILE: do-dist.wk4

BUILDING 12, TANK FARM/ MAINTENANCE D&D PROJECT

Building 12

Tank Farm/Maintenance D&D Project

Distances to Receptors

Direction	Distance
N	986
NNW	973
NW	1848
WNW	1360
W	2156
WSW	1258
SW	1400
SSW	1499
S	1465
SSE	1473
SE	1529
ESE	1086
E	1721
ENE	1420
NE	1365
NNE	959

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Aug 26, 1997 2:49 pm

Facility: Fernald Environmental Management Project
Address: P.O. Box 398704
7400 Willey Road
City: Cincinnati
State: OH Zip: 25253-8704

Effective Dose Equivalent
(mrem/year)

2.49E-03

At This Location: 959 Meters North Northeast

Source Category: Remediation Site
Source Type: Area
Emission Year: 1997

Comments: Monitor Determination for Tank Farm,
Maint. Blgd D&D Project

Dataset Name: tankfarm/maintbl
Dataset Date: Aug 26, 1997 2:49 pm
Wind File: WNDFILES\FEMPSTD.WND

3006

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 959 Meters North Northeast
Lifetime Fatal Cancer Risk: 3.22E-08

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	6.10E-06
BREAST	7.05E-06
R MAR	1.80E-04
LUNGS	1.94E-02
THYROID	5.95E-06
ENDOST	2.33E-03
RMNDR	2.08E-04
EFFEC	2.49E-03

RADIONUCLIDE EMISSIONS DURING THE YEAR 1997

3006

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-238	Y	1.00	7.5E-05	7.5E-05
U-235	Y	1.00	1.5E-07	1.5E-07
U-234	Y	1.00	1.5E-08	1.5E-08

SITE INFORMATION

Temperature:	12 degrees C
Precipitation:	102 cm/y
Mixing Height:	950 m

SOURCE INFORMATION

Source Number: 1

Source Height (m): 3.00
Area (sq m): 2.71E+04

Plume Rise
Momentum (m/s): 2.00E+00
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

986	973	1848	1360	2156	1258	1400	1499	1465	1473
1529	1086	1721	1420	1365	959				

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Aug 26, 1997 2:49 pm

Facility: Fernald Environmental Management Project
Address: P.O. Box 398704
7400 Willey Road
City: Cincinnati
State: OH Zip: 25253-8704

Source Category: Remediation Site
Source Type: Area
Emission Year: 1997

Comments: Monitor Determination for Tank Farm, Maint. Blgd D&D Project

Dataset Name: tankfarm/maintbl
Dataset Date: Aug 26, 1997 2:49 pm
Wind File: WNDFILES\FEMPSTD.WND

3006

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	6.10E-06
BREAST	7.05E-06
R MAR	1.80E-04
LUNGS	1.94E-02
THYROID	5.95E-06
ENDOST	2.33E-03
RMNDR	2.08E-04
EFFEC	2.49E-03

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	1.52E-04
INHALATION	2.34E-03
AIR IMMERSION	4.97E-12
GROUND SURFACE	3.61E-07
INTERNAL	2.49E-03
EXTERNAL	3.61E-07
TOTAL	2.49E-03

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-238	2.48E-03
U-235	5.31E-06
U-234	5.44E-07
TOTAL	2.49E-03

3006

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	2.26E-10
BONE	1.25E-10
THYROID	1.10E-12
BREAST	1.35E-11
LUNG	3.14E-08
STOMACH	8.47E-12
BOWEL	1.58E-11
LIVER	6.97E-12
PANCREAS	5.62E-12
URINARY	4.55E-10
OTHER	6.87E-12
TOTAL	3.22E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	8.39E-10
INHALATION	3.14E-08
AIR IMMERSION	1.13E-16
GROUND SURFACE	7.90E-12
INTERNAL	3.22E-08
EXTERNAL	7.90E-12
TOTAL	3.22E-08

3006

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-238	3.22E-08
U-235	6.96E-11
U-234	6.99E-12
TOTAL	3.22E-08

3006

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	986	973	1848	1360	2156	1258	1400
N	1.2E-03	1.2E-03	4.3E-04	7.0E-04	3.3E-04	7.9E-04	6.7E-04
NNW	5.0E-04	5.1E-04	1.9E-04	3.0E-04	1.5E-04	3.4E-04	2.9E-04
NW	4.4E-04	4.5E-04	1.7E-04	2.6E-04	1.3E-04	3.0E-04	2.5E-04
WNW	3.8E-04	3.8E-04	1.4E-04	2.3E-04	1.1E-04	2.6E-04	2.2E-04
W	5.6E-04	5.8E-04	2.1E-04	3.4E-04	1.7E-04	3.8E-04	3.2E-04
WSW	1.5E-03	1.5E-03	5.2E-04	8.6E-04	4.1E-04	9.8E-04	8.2E-04
SW	9.7E-04	9.9E-04	3.5E-04	5.8E-04	2.8E-04	6.5E-04	5.5E-04
SSW	1.3E-03	1.3E-03	4.5E-04	7.4E-04	3.5E-04	8.4E-04	7.0E-04
S	1.2E-03	1.2E-03	4.3E-04	7.1E-04	3.4E-04	8.0E-04	6.8E-04
SSE	1.1E-03	1.2E-03	4.1E-04	6.7E-04	3.2E-04	7.6E-04	6.4E-04
SE	1.1E-03	1.1E-03	4.0E-04	6.5E-04	3.1E-04	7.4E-04	6.2E-04
ESE	1.5E-03	1.6E-03	5.4E-04	8.9E-04	4.2E-04	1.0E-03	8.5E-04
E	1.1E-03	1.1E-03	3.8E-04	6.3E-04	3.0E-04	7.1E-04	6.0E-04
ENE	1.1E-03	1.2E-03	4.1E-04	6.8E-04	3.2E-04	7.7E-04	6.5E-04
NE	1.3E-03	1.3E-03	4.5E-04	7.5E-04	3.5E-04	8.5E-04	7.1E-04
NNE	2.4E-03	2.4E-03	8.5E-04	1.4E-03	6.7E-04	1.6E-03	1.3E-03

	Distance (m)						
Direction	1499	1465	1473	1529	1086	1721	1420
N	6.0E-04	6.2E-04	6.1E-04	5.8E-04	1.0E-03	4.8E-04	6.5E-04
NNW	2.6E-04	2.7E-04	2.6E-04	2.5E-04	4.3E-04	2.1E-04	2.8E-04
NW	2.3E-04	2.4E-04	2.3E-04	2.2E-04	3.7E-04	1.8E-04	2.5E-04
WNW	2.0E-04	2.0E-04	2.0E-04	1.9E-04	3.2E-04	1.6E-04	2.1E-04
W	2.9E-04	3.0E-04	3.0E-04	2.8E-04	4.8E-04	2.3E-04	3.2E-04
WSW	7.3E-04	7.6E-04	7.6E-04	7.1E-04	1.2E-03	5.9E-04	8.0E-04
SW	4.9E-04	5.1E-04	5.1E-04	4.8E-04	8.3E-04	3.9E-04	5.4E-04
SSW	6.3E-04	6.5E-04	6.5E-04	6.1E-04	1.1E-03	5.0E-04	6.9E-04
S	6.0E-04	6.3E-04	6.2E-04	5.9E-04	1.0E-03	4.8E-04	6.6E-04
SSE	5.7E-04	5.9E-04	5.9E-04	5.5E-04	9.8E-04	4.6E-04	6.3E-04
SE	5.6E-04	5.8E-04	5.7E-04	5.4E-04	9.3E-04	4.5E-04	6.1E-04
ESE	7.6E-04	7.9E-04	7.8E-04	7.4E-04	1.3E-03	6.1E-04	8.3E-04
E	5.4E-04	5.6E-04	5.5E-04	5.2E-04	9.1E-04	4.3E-04	5.9E-04
ENE	5.8E-04	6.0E-04	5.9E-04	5.6E-04	9.8E-04	4.6E-04	6.3E-04
NE	6.4E-04	6.6E-04	6.5E-04	6.2E-04	1.1E-03	5.1E-04	6.9E-04
NNE	1.2E-03	1.2E-03	1.2E-03	1.2E-03	2.0E-03	9.6E-04	1.3E-03

3006

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1365	959
N	7.0E-04	1.2E-03
NNW	3.0E-04	5.3E-04
NW	2.6E-04	4.6E-04
WNW	2.3E-04	3.9E-04
W	3.4E-04	5.9E-04
WSW	8.6E-04	1.5E-03
SW	5.7E-04	1.0E-03
SSW	7.3E-04	1.3E-03
S	7.0E-04	1.3E-03
SSE	6.7E-04	1.2E-03
SE	6.5E-04	1.1E-03
ESE	8.9E-04	1.6E-03
E	6.3E-04	1.1E-03
ENE	6.7E-04	1.2E-03
NE	7.4E-04	1.3E-03
NNE	1.4E-03	2.5E-03

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m) 986	973	1848	1360	2156	1258	1400
N	1.5E-08	1.6E-08	5.4E-09	8.9E-09	4.2E-09	1.0E-08	8.5E-09
NNW	6.4E-09	6.5E-09	2.3E-09	3.8E-09	1.8E-09	4.3E-09	3.6E-09
NW	5.5E-09	5.7E-09	2.0E-09	3.3E-09	1.6E-09	3.7E-09	3.1E-09
WNW	4.7E-09	4.9E-09	1.7E-09	2.8E-09	1.4E-09	3.2E-09	2.7E-09
W	7.2E-09	7.3E-09	2.6E-09	4.2E-09	2.0E-09	4.8E-09	4.0E-09
WSW	1.9E-08	1.9E-08	6.6E-09	1.1E-08	5.1E-09	1.3E-08	1.1E-08
SW	1.2E-08	1.3E-08	4.4E-09	7.3E-09	3.4E-09	8.3E-09	7.0E-09
SSW	1.6E-08	1.7E-08	5.7E-09	9.4E-09	4.4E-09	1.1E-08	9.0E-09
S	1.5E-08	1.6E-08	5.4E-09	9.0E-09	4.2E-09	1.0E-08	8.6E-09
SSE	1.5E-08	1.5E-08	5.1E-09	8.6E-09	3.9E-09	9.8E-09	8.2E-09
SE	1.4E-08	1.4E-08	5.0E-09	8.3E-09	3.9E-09	9.4E-09	7.9E-09
ESE	2.0E-08	2.0E-08	6.9E-09	1.1E-08	5.3E-09	1.3E-08	1.1E-08
E	1.4E-08	1.4E-08	4.8E-09	8.0E-09	3.7E-09	9.1E-09	7.6E-09
ENE	1.5E-08	1.5E-08	5.2E-09	8.6E-09	4.0E-09	9.8E-09	8.2E-09
NE	1.6E-08	1.7E-08	5.7E-09	9.5E-09	4.4E-09	1.1E-08	9.1E-09
NNE	3.1E-08	3.1E-08	1.1E-08	1.8E-08	8.5E-09	2.1E-08	1.7E-08

Direction	Distance (m) 1499	1465	1473	1529	1086	1721	1420
N	7.6E-09	7.9E-09	7.8E-09	7.4E-09	1.3E-08	6.1E-09	8.3E-09
NNW	3.2E-09	3.3E-09	3.3E-09	3.1E-09	5.4E-09	2.6E-09	3.5E-09
NW	2.8E-09	2.9E-09	2.9E-09	2.7E-09	4.7E-09	2.3E-09	3.1E-09
WNW	2.4E-09	2.5E-09	2.5E-09	2.3E-09	4.0E-09	1.9E-09	2.6E-09
W	3.6E-09	3.8E-09	3.7E-09	3.5E-09	6.1E-09	2.9E-09	3.9E-09
WSW	9.4E-09	9.8E-09	9.7E-09	9.1E-09	1.6E-08	7.5E-09	1.0E-08
SW	6.2E-09	6.5E-09	6.4E-09	6.0E-09	1.1E-08	5.0E-09	6.8E-09
SSW	8.0E-09	8.3E-09	8.3E-09	7.8E-09	1.4E-08	6.4E-09	8.8E-09
S	7.7E-09	8.0E-09	7.9E-09	7.4E-09	1.3E-08	6.1E-09	8.4E-09
SSE	7.3E-09	7.5E-09	7.5E-09	7.0E-09	1.3E-08	5.8E-09	8.0E-09
SE	7.1E-09	7.3E-09	7.3E-09	6.8E-09	1.2E-08	5.6E-09	7.7E-09
ESE	9.7E-09	1.0E-08	1.0E-08	9.4E-09	1.7E-08	7.7E-09	1.1E-08
E	6.8E-09	7.1E-09	7.0E-09	6.6E-09	1.2E-08	5.4E-09	7.5E-09
ENE	7.3E-09	7.6E-09	7.6E-09	7.1E-09	1.3E-08	5.8E-09	8.0E-09
NE	8.1E-09	8.4E-09	8.3E-09	7.8E-09	1.4E-08	6.4E-09	8.9E-09
NNE	1.5E-08	1.6E-08	1.6E-08	1.5E-08	2.6E-08	1.2E-08	1.7E-08

3006

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1365	959
N	8.9E-09	1.6E-08
NNW	3.7E-09	6.7E-09
NW	3.3E-09	5.8E-09
WNW	2.8E-09	5.0E-09
W	4.2E-09	7.5E-09
WSW	1.1E-08	2.0E-08
SW	7.3E-09	1.3E-08
SSW	9.4E-09	1.7E-08
S	9.0E-09	1.6E-08
SSE	8.5E-09	1.6E-08
SE	8.2E-09	1.5E-08
ESE	1.1E-08	2.1E-08
E	8.0E-09	1.4E-08
ENE	8.6E-09	1.6E-08
NE	9.5E-09	1.7E-08
NNE	1.8E-08	3.2E-08