3.0 AIR EMISSIONS DATA

This section discusses and quantifies radionuclide emissions from the Site for calendar year 2002. The stacks, vents, and other points where radioactive materials were released to the atmosphere are described, and the effluent controls employed by the Site to minimize emissions are discussed.

3.1 Emission Determination Process

The emission data presented in this section represent an estimate of Site radionuclide air emissions in calendar year 2002. In many cases, air effluent exiting buildings through stacks or vents was continuously sampled and radionuclide emissions measured. Where such data were available, they are presented here. In other cases, emissions from activities that generated airborne radionuclides were not measured. For these activities, emissions were estimated based on project- or process-specific information, combined with emission factors from various sources. Emission sources that were clearly negligible were not quantified.

Where emissions reported in this section were estimated, rather than directly measured, the emission estimates were based on:

- The radionuclide content of materials handled or processed;
- The form of the radioactive material (gas, liquid, solid, or particulate);
- The mechanisms by which radionuclides were released to the atmosphere;
- The time over which the activities that released radionuclides occurred or the time that the radioactive material was exposed to the atmosphere;
- The control measures employed to reduce radionuclide emissions (a maximum of two stages of HEPA filters were credited, even if additional stages were actually employed); and
- Emission factors appropriate to a given process or activity.

Emission factors were derived from several sources. Radionuclide emission factors listed in Appendix D to 40 CFR 61 were used to calculate emissions due to exposure of radioactive material to the atmosphere during processing or handling. Additional emissions resulting from the release of radionuclide-contaminated particles through handling or processing soil and debris were based on emission factors in EPA's *Compilation of Air Pollutant Emission Factors*, AP-42 (EPA, 1995). Where appropriate, emission data from a DOE publication, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE, 1994), were also used. The appropriate emission factors were combined with project- or process-specific information to yield estimated radionuclide emissions.

In addition to emissions from specific projects or processes, an ongoing source of radionuclide emissions from the Site is the resuspension of contaminated surface soils by wind erosion. Emissions from this source were estimated by combining information regarding Site-wide surface soil concentrations of radionuclide contaminants with a Site-specific soil resuspension factor. The development of the Site-specific soil resuspension factor used in emission calculations was discussed in detail in a previous annual report (DOE, 1996).

Historical surface soil radionuclide concentration data from a Site-specific soil sampling database were used to develop a set of radionuclide concentration isopleths spanning the entire Site. The soil resuspension emissions reflect information based on plutonium and americium concentration isopleths that were updated in 1999 and uranium concentration isopleths that were updated in 1998.

The emissions discussed in this section include the isotopes that have the potential to contribute 10% or more to the Site's total air pathway EDE. These include:

- Uranium isotopes typical of the depleted and enriched uranium that have been used at the Site, as well as uranium isotopes that are naturally present in Site soils;
- Pu-239/240, which contributes more than 97% of the alpha activity in Site plutonium; and
- Am-241, a decay product of Pu-241, which is a minor component of the weapons-grade plutonium that was used at the Site.

Prior to 2001, tritium emissions from the Site were also reported. However, because potential tritium emissions from the Site have decreased to negligible levels in recent years, tritium is no longer reported.

3.2 Point Sources

Radionuclide emissions released through stacks and vents are termed "point" sources. In 2002, radionuclide point source emissions at the Site included both measured releases from stacks and vents in the industrial area and releases that were estimated as described in Section 3.1. Point source emissions for calendar year 2002 and the control technology used at each point source are described in this section.

3.2.1 Measured Point Source Emissions

During calendar year 2002, radionuclide emissions were collected and measured only at significant release points, or at release points that had the potential to become significant due to scheduled decommissioning activities. Significant release points are those that have the potential to discharge radionuclides into the air in quantities that would result in an annual EDE to the public greater than 1% of the 10-mrem standard, based on uncontrolled emissions (without considering HEPA filtration). Insignificant release points are those that have the potential to discharge radionuclides in lesser quantities. Significant release points must be continuously monitored or sampled, while insignificant

release points require periodic confirmatory measurements to verify low emissions (40 CFR 61.93).

Prior to 1999, periodic confirmatory measurements to verify low emissions were made at insignificant release points using the effluent sampling systems described below. Effluent sampling was discontinued at insignificant locations in 1999 and 2000, and the compliance sampling network (an ambient air monitoring network that is described in Section 4.1.1) has been used since then to confirm low emissions.

Effluent Sampling Methods

Point source emissions are measured at the Site with a sampling system that continuously draws a portion of the duct or vent airstream through a filter. Radioactive particles collect on the filters, which were generally exchanged weekly in 2002. Following collection, the filters were screened for long-lived alpha and beta radiation to check for elevated radionuclide emissions.

Following alpha/beta screening, the samples were composited monthly by location and analyzed for plutonium, americium, and uranium isotopes. All radionuclides that could contribute greater than 10% of the potential EDE for a release point were measured during calendar year 2002.

Calendar Year 2002 Effluent Sampling

Due to the complexity of the building ventilation systems at the Site, the number of sampling locations is not a one-to-one match with the number of release or emission points. In most cases, a sampling location corresponds to a single release point. In some cases, however, a single sampling location monitors an effluent stream that is released through multiple stacks or vents.

In calendar year 2002, particulate matter samples were collected at 28 air effluent sampling locations, representing 35 release points. Sixteen of these locations were sampled all year. An additional 12 locations, representing 16 release points, were sampled during a portion of the year. Appendix B lists the sampling locations monitored in calendar year 2002.

Historically, particulate matter samples were collected at many effluent release points that were identified as insignificant. These locations, while not currently sampled, are still considered release points. However, the quantities of radionuclides emitted from these locations in 2002 were negligible, and low emissions from these points were verified using the ambient sampler network. Appendix C to the calendar year 2000 annual report (DOE, 2001) contains additional information regarding previously sampled insignificant release point locations.

During 2002, several changes in point source emission measurements took place. Samplers at three locations were reactivated to support decommissioning activities: 707-R22A/B, -R45A/B, and –R46A/B. During decommissioning, these locations may have

the potential to emit radionuclides into the air in quantities that could result in an annual EDE to the public greater than 1% of the 10-mrem standard, based on uncontrolled emissions (without considering HEPA filtration).

Sampling was discontinued during 2002 at nine locations, representing 10 release points, because the buildings were undergoing active decommissioning. During active decommissioning, the air flow through the ventilation system is disturbed sufficiently that the measurement and quantification of radionuclide releases becomes unreliable and no longer representative, or the sampler locations themselves become compromised by removal of necessary infrastructure. At that point, sampling locations undergoing active decommissioning are removed from service and any radioactive particulate matter release associated with that location will be accounted for through the compliance sampling network.

Sampling continued throughout much of 2002 at Building 440 in anticipation of planned waste repackaging activities. Sampling was discontinued during a portion of the year due to sample pump failure and equipment repairs. No waste repackaging activities occurred while the sampler was out of service, and there is no holdup contamination in the Building 440 duct work that would trigger monitoring when waste repackaging activities are shut down. Waste repackaging was initiated in September 2002 and continued through the rest of the year.

Measured calendar year 2002 emissions of plutonium, americium, and uranium are shown in Table 3-1.

Appendix C shows calendar year 2002 measured point source emissions data that would historically have been contained in DOE's Effluent Information System (EIS)/Off-Site Discharge Information System (ODIS). DOE did not publish an EIS/ODIS report for 2002.

3.2.2 Calculated Point Source Emissions

During 2002, several point sources operated at the Site that did not trigger continuous sampling requirements because they had low emission potential or were of short duration. These sources included a drum crusher in Tent 5 at the 750 Pad, repackaging of waste chemicals in Tent 11 at the 904 Pad, the Building 374 spray dryer, and the installation and operation of decontamination showers in Building 778, which was described in Section 2.2.2**.** Point sources with calculated emissions that continued operation from 2001 are described below. Emissions were calculated for these insignificant release points as described in Section 3.1. Table 3-2 shows calculated point source emission estimates for calendar year 2002.

Table 3-1. Measured Point Source Radionuclide Emissions

Building/ Location[a]	Isotope Emissions (Ci/yr) [b,c,d]				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
371-N01	1.09E-08	3.89E-09	3.34E-09	0	2.68E-10
371-N02	1.27E-08	2.14E-09	5.03E-09	0	3.65E-09
371-SSS	4.58E-09	3.68E-10	2.00E-09	3.23E-11	1.36E-10
374-MAI	2.12E-09	8.38E-10	9.03E-09	0	4.37E-09
440-101[e]	5.64E-10	2.34E-11	3.78E-09	1.44E-09	0
559-561	2.48E-09	1.49E-09	7.65E-09	6.44E-10	5.25E-09
707-101/103	7.22E-11	2.93E-11	3.37E-10	1.64E-11	1.69E-10
707-102/104	1.26E-10	1.63E-10	5.70E-10	2.75E-10	9.58E-11
707-105	4.52E-10	3.73E-10	1.26E-09	5.28E-10	1.37E-09
707-106	8.52E-11	6.91E-11	7.51E-10	2.09E-11	2.50E-10
707-107	5.31E-10	2.55E-10	7.02E-10	4.32E-11	4.57E-10
707-108	1.38E-09	6.71E-10	8.90E-10	7.86E-11	4.72E-10
707-R21A/B	7.80E-09	1.54E-09	1.88E-09	0	3.55E-09
707-R22A/B[f]	4.34E-09	1.02E-09	4.77E-09	1.02E-09	4.66E-09
707-R23A/B	3.38E-09	7.73E-10	4.47E-09	2.83E-10	6.46E-10
707-R24A/B[g]	1.46E-09	1.69E-09	4.29E-09	0	6.16E-10
707-R25A/B	2.08E-09	1.11E-09	2.28E-09	0	5.02E-10
707-R45A/B[f]	5.31E-09	5.09E-10	2.41E-09	0	2.68E-10
707-R46A/B[f]	5.25E-09	5.44E-10	5.36E-09	0	9.77E-10
771-MAI	4.78E-08	2.46E-08	5.21E-08	4.13E-09	7.24E-08
774-202[h]	5.24E-10	6.04E-11	2.39E-09	1.16E-10	3.84E-11
776-201[i]	9.05E-11	3.04E-11	0	3.49E-12	3.07E-11
776-202[i]	6.01E-09	1.53E-09	4.23E-10	2.17E-10	0
776-204[i]	8.73E-10	2.71E-10	9.10E-10	0	3.95E-10
776-205[i]	1.33E-09	2.00E-10	4.78E-09	0	2.88E-09
776-250[i]	2.75E-08	1.24E-08	2.58E-09	9.93E-11	6.64E-09
776-251[i]	1.29E-09	8.96E-10	0	3.57E-10	8.23E-10
776-252[i]	1.72E-09	2.69E-10	6.26E-10	8.10E-11	3.21E-10

[a] The first number in this column designates the building cluster, the second set of characters designates the specific duct(s) or vent(s). The location of each release point is shown in Figure 3-1 of this report.
[b] Values were corrected for filter blanks.
[c] All measured point sources were controlled by HEPA filters with a tested control efficiency of at least 99.97 percent.
[d] All isotopes that could contribute greater than 10% of the potential EDE for a release point were measured.
[e] Release point 440-101 was inactive during a portion of the year (see discussion in Section 3.2.1).
[f] Samplers reactivated on 1/7/02 to support decommissioning.
[g] Sampler removed from service on 10/7/02 due to active decommissioning.
[h] Sampler removed from service on 9/30/02 due to active decommissioning.
[i] Samplers removed from service on 7/1/02 due to active decommissioning.

Notes:

Am	=	Americium	Ci/yr	=	Curies per year, 1 Ci = 3.7 x 10^{10} Becquerel (Bq)
E#	=	x $10^{\#}$	EDE	=	Effective dose equivalent
HEPA	=	High efficiency particulate air	Pu	=	Plutonium
U	=	Uranium			

Table 3-2. Calculated Point Source Radionuclide Emissions

Activity or Building	Isotope Emissions (Ci/yr) [a]				
	Pu-239/ 240	Am-241	U-233/234	U-235	U-238
750 Pad, Tent 5 Drum Crusher[b]	4.7E-08	4.2E-09	--	--	--
Building 374 Spray Dryer[b]	3.3E-08	3.8E-09	--	--	--
Building 778 Decontamination Showers[b]	8.3E-09	7.4E-10	--	--	--
904 Pad, Tent 11 Waste Chemical Repackaging[b]	2.2E-06	2.3E-07	--	--	--

[a] Emissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. Isotopes for which emissions were not estimated are shown as "--". The locations of the release points listed are shown in Figure 3-1 of this report.
[b] HEPA filtration used with a control efficiency of at least 99.97 percent.

Notes:

Am	=	Americium
Ci/yr	=	Curies per year, 1 Ci = 3.7 x 10^{10} Becquerel (Bq)
E#	=	x $10^{\#}$
EDE	=	Effective dose equivalent
HEPA	=	High efficiency particulate air
Pu	=	Plutonium
U	=	Uranium
--	=	Not estimated/negligible

904 Pad, Tent 11 Repackaging of Waste Chemicals: In 1999, 2000, 2001, and 2002, drums of waste chemicals were repackaged in the Tent 11 containment structure on the 904 Pad. The drums were evaluated, characterized, and repackaged for off-Site disposal, or returned to on-Site storage.

The containment structure air exhausted through two stages of HEPA filters. Emission estimates for this project were based on the conservative assumption that all drums were at the maximum allowable concentration for low-level waste (100 nanocuries plutonium per gram waste), and on the assumption that there would be 20 drums within the structure open to the atmosphere at all times.

750 Pad, Tent 5 Drum Crusher: In 2000, a drum crusher was installed within the Tent 5 containment structure at the 750 Pad and has operated since that time. Operation of the drum crusher was initially limited to empty drums with contamination levels less than or equal to 20 disintegrations per minute (dpm) per 100 square centimeters (cm^2). The maximum process rate of the drum crusher was approximately 30 drums per hour. In 2001, the maximum contamination level of the drums was raised to 100,000 dpm/ 100 cm^2.

The containment structure air exhausted through a single-stage HEPA filter. For 2002, dose calculations were based on the conservative assumptions that the crusher would

operate at the maximum process rate 24 hours per day, 5 days per week, 52 weeks per year and that each drum was contaminated at 100,000 dpm/100 cm^2 over the entire surface area. In fact, the drum crusher operated only intermittently during 2002, so the actual emissions would have been substantially less than estimated here.

Building 374 Spray Dryer Operation: The spray dryer in Building 374 was revitalized in 2001 to treat the backlog of liquid radioactive concentrate stored at the Site. Concentrated liquid was fed into the spray dryer chamber where it was dried into salt, which was filtered and loaded into drums for shipment. Dose calculations were based on the conservative assumptions that the spray dryer operated at the maximum design rate 24 hours per day, 5 days per week, 52 weeks per year, although the spray dryer actually operated only in January and February 2002, then was shut down in March.

The process air exhausted through two stages of HEPA filters. The off-Site EDE was calculated based on the maximum radionuclide content of the influent; the maximum design process rate operating 24 hours per day, 5 days per week, 52 weeks per year; and an emission factor from Appendix D to 40 CFR 61.

Unmonitored Building Stacks and Vents: Small amounts of radionuclides continued to be released from various building stacks and vents that have been classified as insignificant release points. Individually, none of these release points had the potential to release radionuclides in amounts that could result in an off-Site EDE in excess of 1% of the 10 mrem standard, even if the emissions were uncontrolled. Many of these release points were controlled by two or more stages of HEPA filters; consequently, actual emissions would have been a fraction of a percent of the standard limitation. As a result, no attempt has been made to estimate emissions from these sources; instead, the compliance sampling network data have been used to demonstrate that none of these points released significant quantities of radionuclides during calendar year 2002 (see Section 4.1 of this report).

3.2.3 Control Technology for Point Sources

HEPA filters are used to control radioactive particulate matter emissions from air effluent systems. All of the point source locations listed in Table 3-1 used HEPA filtration in 2002. Effluent air from areas where plutonium or plutonium-contaminated wastes were processed was typically cleaned by a minimum of four stages of HEPA filters. Effluent air from uranium processing areas was generally cleaned by a minimum of two stages of HEPA filters. HEPA filters were bench tested prior to installation in the buildings to ensure that they would meet a minimum filter efficiency of 99.97% (Novick, et al., 1985). Filter assemblies were tested again for leaks following installation.

Waste repackaging activities at the 904 Pad, Tent 11, and the Building 374 spray dryer were controlled by two stages of HEPA filters. The drum crushing activities at the 750 Pad, Tent 5, and the Building 778 decontamination showers were controlled by a single-stage HEPA filter.

3.3 Nonpoint Sources

Radionuclide emissions that are not released through specific stacks or vents are termed "nonpoint" (or diffuse) sources. Table 3-3 summarizes emissions from nonpoint sources for calendar year 2002.

3.3.1 Nonpoint Source Descriptions

In calendar year 2002, nonpoint sources of radionuclide emissions at the Site included resuspension of contaminated soils by wind erosion and by mechanical disturbance due to excavation, handling, and vehicle traffic. Mechanical disturbance of contaminated soils was associated with:

- Solar Ponds Closure,
- 903 Pad remediation,
- Building 886 slab removal,
- Building 123 slab removal,
- Building 442 slab removal,
- Building 889 slab removal,
- Building 662/663 slab removal,
- Building 707 loading dock modifications, and
- Building 707 cargo storage pad construction.

Calendar year 2002 nonpoint sources also included the Building 886 demolition project. Radionuclide emissions were measured by an ambient network activated for the Building 886 demolition and were found to be negligible.

Several other structures were demolished during 2002, including:

- Buildings 125, S125, 280, 381, 442L, 442W, 452, 662, 663, 709A, 828, 850, 864, 875, 880, 932, 331A, 335, 367, S452, 666, 884, 910;
- Trailers T452A-G, T760B, T886A-C, T891D-E, T891G, T891P-Q, T891V, T891T, T893A-B, T334B-D, T760A; and
- Tents 07, 08, 09, and 14.

These structures were not radiologically contaminated above free release criteria. Therefore, no radionuclide emissions were calculated for these demolition projects.

Calendar year 2002 nonpoint sources also included emissions from sludge dewatering activities at the 231 Tank System, the removal of Solar Pond sludge from the 750 Pad, and, as described in Section 3, the resuspension of contaminated soil.

Table 3-3. Nonpoint Source Radionuclide Emissions

Source or Project[b]	Isotope Emissions (Ci/yr)[a]				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
Resuspension by Wind Erosion	4.8E-05	1.5E-05	2.2E-07	3.2E-08	1.5E-07
Solar Ponds Closure	2.1E-05	4.9E-05	2.4E-05	8.7E-07	1.0E-05
903 Pad Remediation	4.9E-06	1.1E-06	6.5E-09	9.4E-10	2.7E-08
Building 886 Slab Remediation	3.1E-07	8.3E-10	7.9E-09	3.0E-10	2.8E-09
Building 123 Slab Remediation	1.1E-07	2.9E-07	4.8E-07		3.9E-07
Building 442 Slab Remediation	4.8E-07	7.2E-08	5.9E-7	4.6E-08	2.0E-07
Building 889 Slab Remediation	1.8E-06	1.4E-07	1.1E-06	8.6E-08	3.7E-07
Building 662/663 Slab Remediation	1.1E-04	9.4E-06	--	--	--
231 Tank System Sludge Removal	8.2E-06	6.7E-06	--	--	--
750 Pad Solar Pond Sludge Removal	2.6E-04	6.3E-04	1.8E-05	1.2E-.06	2.7E-05
Building 707 Loading Dock Modifications	1.6E-07	2.3E-08	1.9E-07	1.5E-08	6.3E-08
Building 707 Cargo Storage Pad Construction	4.8E-07	7.2E-08	5.8E-07	4.5E-08	1.9E-07

[a] Emissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. The locations of the nonpoint release emission sources are shown in Figures 3-1 through 3-6 of this report.
[b] Emissions assumed to be uncontrolled.

Notes:

Am	=	Americium
Ci/yr	=	Curies per year, 1 Ci = 3.7 x 10^{10} Becquerel (Bq)
E#	=	x$10^{\#}$
EDE	=	Effective dose equivalent
Pu	=	Plutonium
U	=	Uranium

3.3.2 Control Technology for Nonpoint Sources

Particulate emissions from significant earth-moving activities at the Site and from decommissioning activities were controlled by water spray or other dust suppression measures, with an estimated control efficiency of 50 percent. Fugitive dust control plans that specify the control measures to be used to minimize emissions of contaminated dust are developed for each project with the potential to generate significant radionuclide emissions from soil or debris handling, or from demolition activities. For calculation

purposes, all projects listed in Table 3-3 were assumed to be uncontrolled, even though fugitive dust control measures were employed for most of the projects.

3.4 Release Locations

Figure 3-1 shows the location of various emission sources listed in Tables 3-1 through 3-3. Source areas for wind erosion of radionuclides are shown in Appendix D.

See separate file for Fig 3-1

Figure 3-1. Industrial Area Source Locations