Chapter 4

Effluent Monitoring

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EFFLUENT monitoring at the Savannah River Site (SRS) is conducted to demonstrate compliance with applicable standards and regulations. Site effluent monitoring activities are divided into radiological and nonradiological programs. A complete description of sampling and analytical procedures used for effluent monitoring by the Environmental Permitting and Monitoring group of the site's Environmental Services Section can be found in sections 1101–1111 (SRS EM Program) of the *Savannah River Site Environmental Monitoring Section Plans and Procedures*, WSRC–3Q1–2, Volume 1. A summary of data results is presented in this chapter; more complete data can be found in tables on the CD included with this report.

Radiological Monitoring

Radiological effluent monitoring results are a major component in determining compliance with applicable dose standards. SRS management philosophy ensures that potential exposures to members of the public and to onsite workers are kept as far below regulatory standards as is reasonably achievable. This philosophy is known as the "as low as reasonably achievable" (ALARA) concept.

SRS airborne and liquid effluents that potentially contain radionuclides are monitored at their points of discharge by a combination of direct measurement and/or sample extraction and analysis. Each operating facility maintains ownership of, and is responsible for, its radiological effluents.

Unspecified alpha and beta releases (the measured gross activity minus the identified individual radionuclides) in airborne and liquid releases are large contributors—on a percentage basis—to offsite doses, especially for the airborne pathway from diffuse and fugitive releases (see definitions below).

The unspecified alpha and beta releases are listed separately in the effluent release tables. They conservatively include naturally occurring radionuclides such as uranium, thorium, and potassium-40, as well as small amounts of unidentified manmade radionuclides. For dose calculations, the unspecified alpha releases were assigned the plutonium-239 dose factor, and the unspecified beta releases were assigned the strontium-90 dose factor (chapter 6, "Potential Radiation Doses").

Airborne Emissions

Process area stacks that release, or have the potential to release, radioactive materials are monitored continuously by applicable online monitoring and/or sampling systems [SRS EM Program, 2001].

Depending on the processes involved, discharge stacks also may be monitored with "real-time" instrumentation to determine instantaneous and cumulative atmospheric releases to the environment. Tritium is one of the radionuclides monitored with continuous real-time instrumentation.

The following effluent sampling and monitoring changes were made during 2005:

- Quarterly sampling was added at TRU Pads 19 and 20.

Diffuse and Fugitive Sources

Estimates of radionuclide releases from unmonitored diffuse and fugitive sources are calculated on an annual basis and are included in the SRS radioactive release totals. A diffuse source is defined as an area source, such as a pond or disposal area. A fugitive source is defined as an undesignated localized source, such as an open tank or naturally ventilated building.

Diffuse and fugitive releases are calculated using the U.S. Environmental Protection Agency's (EPA's) recommended methods [EPA, 2002]. Because these methods are conservative, they generally lead to overestimates of actual emissions. Though these releases are not monitored at their source, onsite and offsite environmental monitoring stations are in place to quantify unexpectedly large diffuse and fugitive releases (see chapter 5, "Environmental Surveillance").

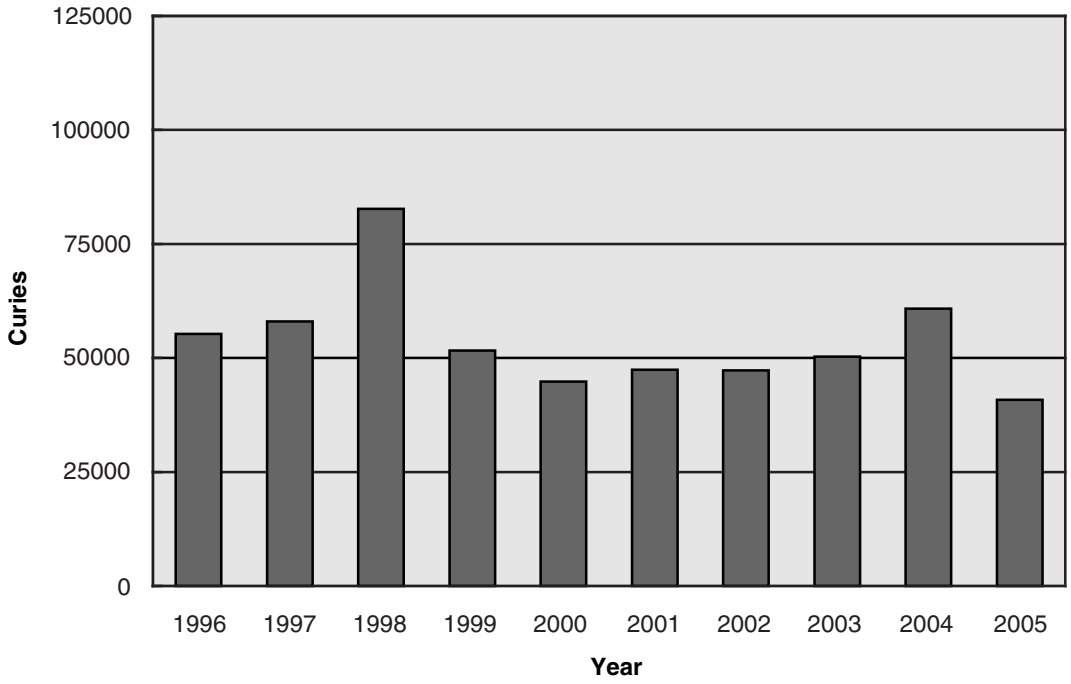

Figure 4–1 Ten-Year History of SRS Annual Atmospheric Tritium Releases

Monitoring Results Summary

The total amount of radioactive material released to the environment is quantified by using data obtained from continuously monitored airborne effluent release points and estimates of diffuse and fugitive sources.

Because of greatly reduced operations in H-Canyon, there were no fission product tritium, carbon-14, or krypton-85 releases from the separations areas in 2005. In the past, estimated releases of these unmonitored radionuclides were calculated based on production levels.

Tritium Tritium in elemental and oxide forms accounted for more than 99 percent of the total radioactivity released to the atmosphere from SRS operations. During 2005, about 40,800 Ci of tritium were released from SRS, compared to about 61,300 Ci in 2004.

During the past 10 years, because of changes in the site's missions and the existence of the Replacement Tritium Facility, the amount of tritium released from SRS has fluctuated but has remained less than 100,000 Ci per year (figure 4–1).

Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Guides Average concentrations of radionuclides in airborne emissions are calculated by dividing the amount of each radionuclide released annually from each stack by the respective yearly stack-flow volumes. These average concentrations then can be compared to the DOE derived concentration guides (DCGs) in DOE Order 5400.5, "Radiation Protection of the Public and the Environment," as a screening method to determine if existing effluent treatment systems are proper and effective. The 2005 atmospheric effluent annual-average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided, by discharge point, on the CD accompanying this report.

DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. DCGs are applicable at the point of discharge (prior to dilution or dispersion) under conditions of continuous exposure.

Most of the SRS radiological stacks/facilities release small quantities of radionuclides at concentrations below the DOE DCGs. However, tritium (in the oxide form) from the reactor (K-Area and L-Area main stacks) and tritium facilities was emitted in 2005 at concentration levels above the DCGs. The offsite dose from all atmospheric releases, however, remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv), as discussed in chapter 6.

Liquid Discharges

Each process area liquid effluent discharge point that releases, or has potential to release, radioactive materials is sampled routinely and analyzed for radioactivity [SRS EM Program, 2001].

Depending on the processes involved, liquid effluents also may be monitored with real-time instrumentation to ensure that instantaneous releases stay within established limits. Because the instruments have limited detection sensitivity, online monitoring systems are not used to quantify SRS liquid radioactive releases at their current low levels. Instead, samples are collected for more sensitive laboratory analysis.

Monitoring Results Summary

Data from continuously monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility (SWDF) migration release estimates to quantify the total radioactive material released to the Savannah River from SRS operations. SRS liquid radioactive releases for 2005 are shown by source on the CD accompanying this report. These data are a major component in the determination of offsite dose consequences from SRS operations.

Direct Discharges of Liquid Effluents Direct discharges of liquid effluents are quantified at the point of release to the receiving stream, prior to dilution by the stream. The release totals are based on measured concentrations and flow rates.

Tritium accounts for nearly all the radioactivity discharged in SRS liquid effluents. The total amount of tritium released directly from process areas—i.e., reactor, separations, Effluent Treatment Facility (ETF)—to site streams during 2005 was 326 Ci, which was 57 percent less than the 2004 total of 756 Ci. This decrease was due to the fact that ETF continued to process wastewater with less tritium in it than in previous years.

Operations at D-Area and TNX were discontinued in 2000 and 2001, respectively. Releases from A-Area represent only a small percentage of the total direct releases of tritium to site streams. The reactor area releases include the overflows from PAR Pond and L Lake.

Direct releases of tritium to site streams for the years 1996–2005 are shown in figure 4–2. The migration and transport of radionuclides from site seepage basins and the SWDF are discussed in chapter 5.

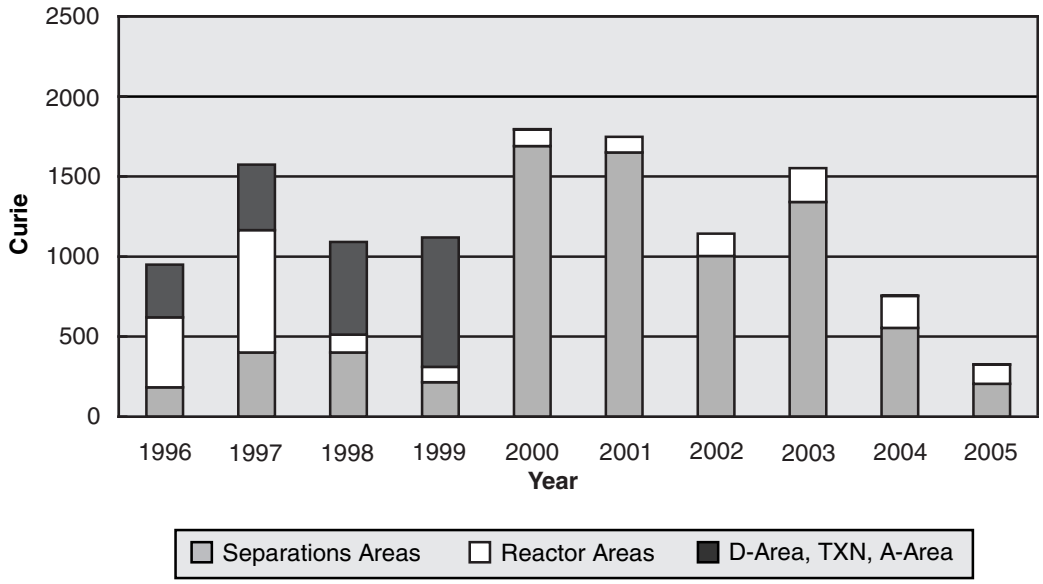

Figure 4–2 Ten-Year History of Direct Releases of Tritium to SRS Streams

Comparison of Average Concentrations in Liquid Releases to DOE Derived Concentration Guides
In addition to dose standards, DOE Order 5400.5 imposes other control considerations on liquid releases. These considerations are applicable to direct discharges but not to seepage basin and SWDF migration discharges. The DOE order lists DCG values for most radionuclides.

DCGs are applicable at the point of discharge from the effluent conduit to the environment (prior to dilution or dispersion). According to DOE Order 5400.5, exceedance of the DCGs at any discharge point may require an investigation of "best available technology" waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from "best available technology" requirements; however, it is not excluded from other ALARA considerations. DOE DCG compliance is demonstrated when the sum of the fractional DCG values for all radionuclides detectable in the effluent is less than 1.00, based on consecutive 12-month-average concentrations. The 2005 liquid effluent annual-average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided, by discharge point, on the CD accompanying this report.

The data show that the U3R–2A ETF outfall at the Road C discharge point exceeded the DCG guide for 12-month-average tritium concentrations during 2005. However, as noted previously, DOE Order 5400.5 specifically exempts tritium from "best available technology" waste treatment investigation requirements. This is because there is no practical technology available for removing tritium from dilute liquid waste streams. No other discharge points exceeded the DOE DCGs during 2005.

Nonradiological Monitoring

Airborne Emissions

The South Carolina Department of Health and Environmental Control (SCDHEC) regulates both radioactive and nonradioactive criteria and toxic air pollutant emissions from SRS sources. Each source of air emissions is permitted or exempted by SCDHEC on the SRS Part 70 Air Quality Permit (issued in 2003), with specific limitations and monitoring requirements identified. This section will cover only nonradioactive emissions.

The bases for the limitations and monitoring requirements specified in the Part 70 Air Quality Permit are outlined in various South Carolina and federal air pollution control regulations and standards. Many of the applicable standards are source dependent, i.e., applicable to certain types of industry, processes, or equipment. However, some standards govern all sources for criteria pollutants, toxic air pollutants, and ambient air quality. Air pollution control regulations and standards applicable to SRS sources are discussed briefly in appendix A, "Applicable Guidelines, Standards, and Regulations," of this report. The SCDHEC air standards for toxic air pollutants can be found at http://www.scdhec.net/baq on the Internet.

At the beginning of 2005, the SRS Part 70 Air Quality Permit identified 45 nonexempt radiological and nonradiological air emission units. During the year, SCDHEC issued two revisions to the permit.

Description of Monitoring Program

Major nonradiological emissions of concern from stacks at SRS facilities include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter smaller than 10 microns, volatile organic compounds (VOCs), and toxic air pollutants. With the issuance of the new Part 70 Air Quality Permit, SRS has several continuous and periodic monitoring requirements; only the most significant are discussed below.

The primary method of source monitoring at SRS is the annual air emissions inventory. Emissions from SRS sources are determined during this inventory from standard calculations using source operating parameters, such as hours of operation, process throughput, and emission factors provided in the EPA "Compilation of Air Pollution Emission Factors," AP–42. Many of the processes at SRS, however, are unique sources requiring nonstandard, complex calculations. The hourly and total annual emissions for each source then can be compared against their respective permit limitations.

At the SRS powerhouses, airborne emission specialists under contract to SRS perform stack compliance tests every two years for each boiler. The tests include sampling of the boiler exhaust gases to determine particulate matter, sulfur dioxide, and visible opacity emissions. The permit also requires a weekly sample and laboratory analysis of coal for sulfur content and, a daily visible-emissions inspection to verify compliance with opacity standards.

For the package steam generating boilers in K-Area, fuel oil-fired water heaters in B-Area, and diesel-powered equipment, compliance with sulfur dioxide standards is determined by analysis of the fuel oil purchased from the offsite vendor. Sulfur content of the fuel oil must be below 0.5 percent and must be reported to SCDHEC annually as part of the SRS annual compliance certification report due in May of each year.

Monitoring of SRS diesel-powered equipment consists of tracking fuel oil consumption monthly and calculating a 12-month rolling total for determining permit compliance with a site consumption limit.

SRS has several soil vapor extraction units and two air strippers that are sources of toxic air pollutants and VOCs. These units must be sampled monthly for VOC concentrations, and the total VOC emissions must be calculated for comparison against a 12-month rolling limit. The VOC emissions then are reported to SCDHEC on a quarterly basis.

Several SRS sources have pollutant control devices—such as multiclone dust collectors, baghouse dust collectors, or condensers—whose parameters must be monitored continuously or whenever the system is operated. The operating parameters must be recorded and compared against specific operating ranges.

Compliance by all SRS permitted sources is evaluated during annual compliance inspections by the local SCDHEC district air manager. The inspections include a review of each permit condition, i.e., daily monitoring readings, equipment calibrations, control device inspections, etc.

Monitoring Results Summary

In 2005, operating data were compiled and emissions calculated for 2004 operations for all site air emission sources. Because this process, which begins in January, requires up to 6 months to complete, this report provides a comprehensive examination of total 2004 emissions, with only limited discussion of available 2005 monitoring results for specific sources.

The 2004 total criteria and toxic air pollutant emissions results for all SRS sources, as determined by the air emissions inventory conducted in 2005, are provided in table 4–1 and on the CD accompanying this report. A review of the calculated emissions for each source for calendar year 2004 determined that SRS sources had operated in compliance with permitted emission rates. Actual 2005 emissions will be compiled and reported in depth in the *SRS Environmental Report for 2006*. Some toxic air pollutants (e.g., benzene) regulated by SCDHEC also are, by nature, VOCs. As such, the total for VOCs in table 4–1 includes toxic air pollutant emissions. This table also includes the emissions for some hazardous air pollutants that are regulated under the Clean Air Act but not by SCDHEC Standard No. 8 (“Toxic Air Pollutants”). These pollutants are included because they are compounds of some Standard No. 8 pollutants.

Table 4–1
2004 SRS Criteria Pollutant Air Emissions

Pollutant Name	Actual Emissions (Tons/Year)
Sulfur dioxide (SO_x)	2.15E+03
Total particulate matter (PM)	4.82E+02
Particulate matter $\leq$10 microns (PM_{10})	1.89E+02
Carbon monoxide (CO)	9.82E+02
Ozone (volatile organic compounds)	5.44E+02
Gaseous fluorides (as hydrogen fluoride)	1.39E–01
Nitrogen dioxide (NO_x)	4.24E+03
Lead (lead components)	1.58E-01

Two power plants with five overfeed stoker-fed coal-fired boilers are operated by Washington Savannah River Company (WSRC) at SRS. The location, number of boilers, and capacity of each boiler for these plants are listed in table 4–2. Because of an alternating test schedule, only A-Area boiler No. 1 was stack-tested in 2005 (February). At that time, the boiler’s particulate matter, sulfur dioxide, and visible emissions were found to be in compliance with its permitted limit. Results from the test are shown in table 4–3.

SRS also has two package steam generating boilers in K-Area fired by No. 2 fuel oil. The percent of sulfur in the fuel oil burned during the first quarter of 2005 was certified by the vendor to meet the requirements of the permit.

The total diesel fuel consumption for portable air compressors, generators, emergency cooling water pumps, and fire water pumps was found to be well below the SRS limit for the entire reporting period.

As reported to SCDHEC during 2005, the calculated annual VOC emissions were well below the permit limit for each unit.

Table 4–2
SRS Power Plant Boiler Capacities

Location	Number of Boilers	Capacity (Btu/hr)
A-Area	2	71.7E+06
H-Area	3	71.1E+06

Table 4–3
Boiler Stack Test Results (A-Area)

Boiler	Pollutant	Emission Rates	
		lb/10^6 Btu	lb/hr
A #1	Particulates[a]	0.269	19.50
	Sulfur dioxide[a]	1.49	NC[b]
	Opacity[c]	Avg. 10.3%	

[a] The compliance level is 0.6 lb/million Btu for particulates and 3.5 lb/million Btu for sulfur dioxide.
[b] Not calculated
[c] Opacity limit 40%

In 2005. the annual air compliance inspection was conducted by the SCDHEC district air manager. During the inspection, all SRS permitted sources were found to be in compliance with their respective permit conditions and limits, and all required reports were determined to have been submitted to SCDHEC within specified time limits.

Ambient Air Quality

Under existing regulations, SRS is not required to conduct onsite monitoring for ambient air quality; however, the site is required to show compliance with various air quality standards. To accomplish this, air dispersion modeling was conducted during 2005 for new emission sources or modified sources as part of the sources' construction permitting process. The modeling analysis showed that SRS air emission sources were in compliance with applicable regulations. Additional information about ambient-air-quality regulations at the site can be found in appendix A of this report.

Liquid Discharges

Description of Monitoring Program

SRS monitors nonradioactive liquid discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES), as mandated by the Clean Water Act. As required by EPA and SCDHEC, SRS has NPDES permits in place for discharges to the waters of the United States and South Carolina. These permits establish the specific sites to be monitored, parameters to be tested, and monitoring frequency—as well as analytical, reporting, and collection methods. Detailed requirements for each permitted discharge point can be found in the individual permits, which are available to the public through SCDHEC's Freedom of Information office at 803–734–5376.

In 2005, SRS discharged water into site streams and the Savannah River under two NPDES permits: one for industrial wastewater (SC0000175) and one for stormwater runoff—SCR000000 (industrial discharge). A third permit, SCR100000, does not require sampling unless requested by SCDHEC to address specific discharge issues at a given construction site; SCDHEC did not request such sampling in 2005. The public comment period for draft Permit SCR100000 expired in February 2004, and the submitted comments still are under resolution. The final draft of the permit is expected to be released in February 2006. SRS will continue to operate under the existing permit (SCR100000), but already has implemented the new requirements into the site program in anticipation of the disclosure of an effective date for the new permit.

Permit ND0072125 is a "no discharge" water pollution control land application permit that regulates sludge application and related sampling at onsite sanitary wastewater treatment facilities.

NPDES samples are collected in the field according to 40 CFR 136, the federal document that lists specific sample collection, preservation, and analytical methods acceptable for the type of pollutant to be analyzed. Chain-of-custody procedures are followed after collection and during transport to the analytical laboratory. The samples then are accepted by the laboratory and analyzed according to procedures listed in 40 CFR 136 for the parameters required by the permit.

Monitoring Results Summary

SRS reports industrial wastewater analytical results to SCDHEC through a monthly discharge monitoring report (EPA Form 3320–1). Results from only one of the 3,493 sample analyses performed during 2005 exceeded permit limits—a 99.97-percent compliance rate, which is higher than the DOE-mandated 98-percent rate. The single exceedance (of daily maximum limit for total suspended solids) occurred March 5 at outfall A–11 (table 4–4)—the result of stream bank erosion upstream of the sampling location.

All 11 routine stormwater outfalls were sampled in 2005. A new NPDES general permit for stormwater discharges became effective in July. A decision is expected from SCDHEC by April 2006 on a requirement for individual permits for some of the stormwater outfalls. To provide SCDHEC with information that could reduce the number of outfalls that must meet the individual-permit requirement, WSRC performed additional sampling in 2005. Results of both this sampling—Phase II (23 outfalls) and Phase III (20

outfalls)—and the routine sampling can be found in the NPDES stormwater monitoring data table on the CD accompanying this report. All the routine and Phase III results were obtained by the required stormwater sampling protocol. Phase II results, however, should be reviewed for information only because many of the samples could not be collected by certified protocol due to the reduced timeframe required to support activities related to the new stormwater permit.

No sludge-application activities were conducted in 2005.

Table 4–4
2005 Exceedances of SCDHEC-Issued NPDES Permit Liquid Discharge Limits at SRS[a]

Facility/Division/Unit	Outfall	Date	Analysis	Possible Cause(s)	Corrective Action(s)
SRNL	A–11	March 5	TSS	Sample taken shortly after significant rain event that caused collapse of section of channel bank	Personnel instructed not to start composite samplers if the SRS weather prediction is for a 60% or greater chance of rain

Key: TSS – Total Suspended Solids

[a]The DOE-mandated NPDES compliance rate is 98 percent; SRS's compliance rate for 2005 was 99.97 percent.