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# Effluent Monitoring

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CHAPTER

4

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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 Monitoring Services group of the site's Regulatory Integration & Environmental Services organization can be found in sections 1101–1111 of the Savannah River Site Environmental Monitoring Program, WSRC-3Q1-2, Volume 1, Revision 4, [SRS EM Program, 2002]. 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.*

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## 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 radiation 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”).

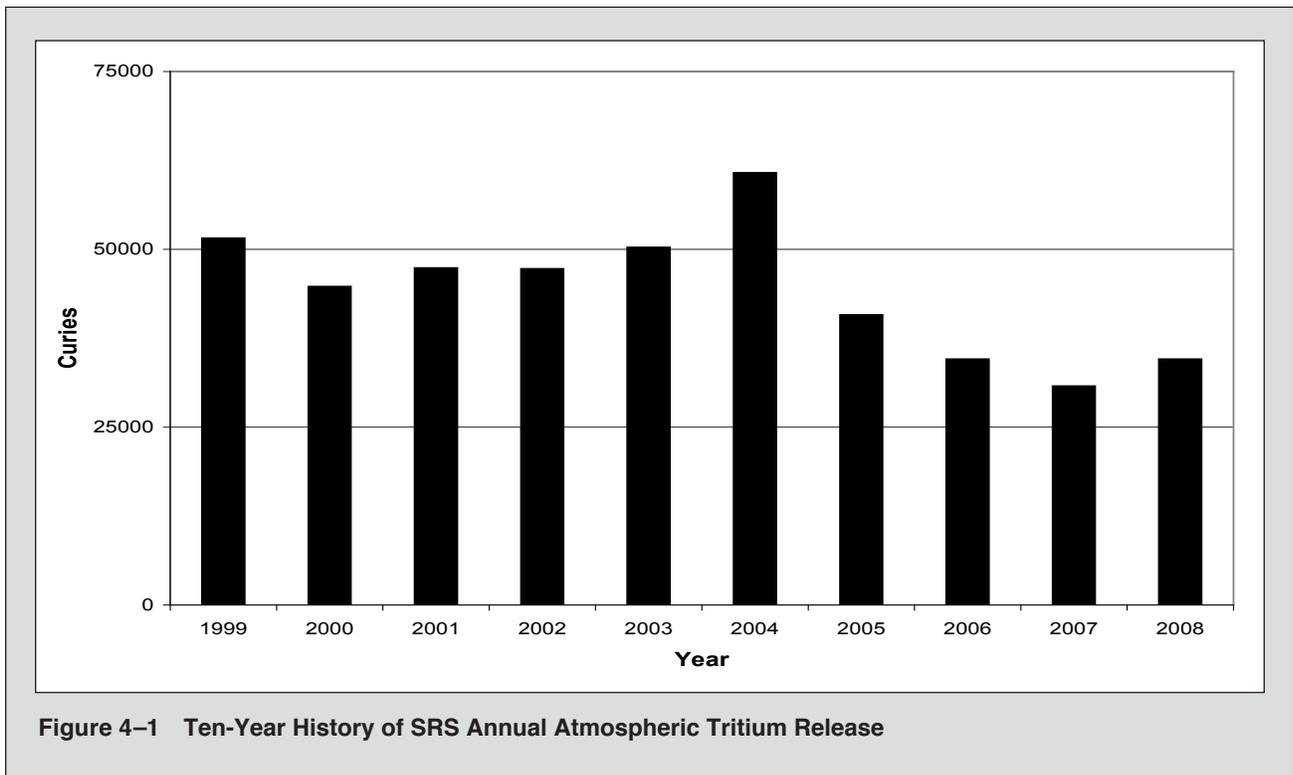
## Airborne Emissions

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, 2002].

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 2008:

- Sampling was changed from weekly to twice a year at the 299-H building stack (also referred to as the 299-H decon facility stack), based on the potential impact category.
- Baseline sampling was conducted at the 241-278H Caustic Extraction Facility and set at a quarterly frequency for the new facility, based on the potential impact category.
- Sampling was discontinued at the 105-C Stack Decon Exhaust because no equipment was decontaminated at the facility during 2008.



### 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 employ conservative assumptions, 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 (chapter 5, "Environmental Surveillance").

### Monitoring Results Summary

The total amount of radioactive material released to the environment is quantified by using (1) [data](#) obtained from continuously monitored airborne effluent release points and (2) estimates of diffuse and

fugitive [sources](#).

**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 2008, about 34,600 Ci of tritium were released from SRS, compared to about 30,800 Ci in 2007. Most of the releases came from the site's tritium facilities.

During the past 10 years, because of changes in the site's missions and the beginning of operations at the Replacement Tritium Facility, the amount of tritium released from SRS has fluctuated but has remained less than 75,000 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 2008 atmo-

spheric 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 main stack, L-Area main stack, and L-Area disassembly basin) and tritium facilities was emitted in 2008 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, 2002].

Depending on the processes involved, liquid effluents also may be monitored with real-time instrumentation to ensure that releases are managed 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 2008](#) 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 Effluent** 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 2008 was 320Ci. Direct releases of tritium to site streams for the years 1999–2008 are shown in figure 4–2.

Operations at D-Area and TNX were discontinued in 2000 and 2001, respectively. A-Area releases 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.

Migration/transport of radionuclides from site seepage basins and SWDF are discussed in chapter 5.

**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” (BAT) waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from BAT 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 2008 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 ETF Outfall U3R–2A at the

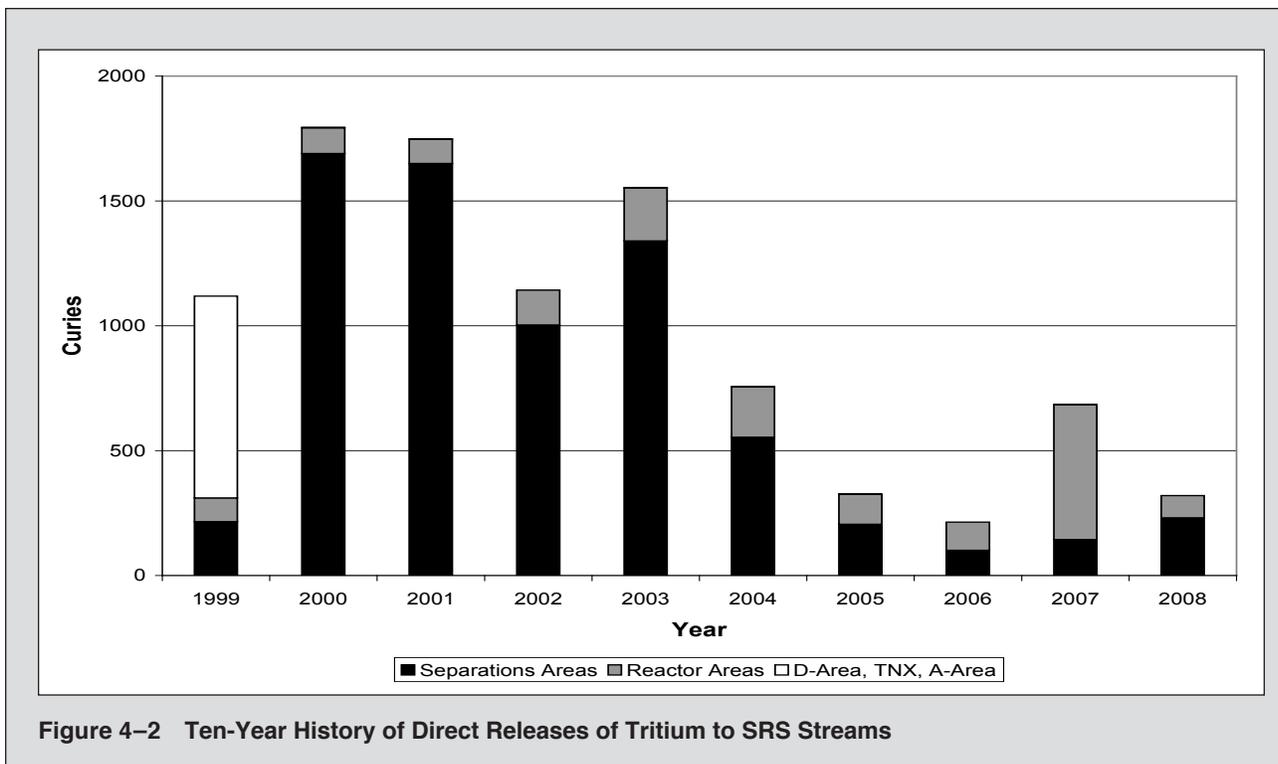


Figure 4-2 Ten-Year History of Direct Releases of Tritium to SRS Streams

Road C discharge point exceeded the DCG guide for 12-month-average tritium concentrations again during 2008. However, as noted previously, DOE Order 5400.5 specifically exempts tritium from BAT waste treatment investigation requirements. This is because there is no practical technology available for removing tritium from dilute liquid waste streams.

In January 2008, H-Canyon released a small amount of alpha-contaminated water to the cooling water system in H-Area. The contaminated water was diverted and captured in the 281-8H retention basin, then transferred to the Effluent Treatment Project for treatment until the alpha level fell below the site's operational discharge limit of 3 dpm/mL. At that point, the 281-8H water was released in batches to Fourmile Branch via the H-017 outfall. However, because DCGs are very conservatively applied at the point of discharge, the 12-month average DCG for plutonium-238 was exceeded at H-017 at the 3-dpm/mL level. A BAT assessment was not deemed necessary for this exceedance because it was a known, episodic event that was handled using BAT (i.e., filtration through the Effluent Treatment Project). Although the DCG for plutonium-238 was exceeded at H-017 as a result of this episodic release, the resulting potential increase in offsite dose was small and well below all applicable dose standards (see chapter 6, "Potential Radiation Doses").

No other liquid discharge points exceeded the DOE DCGs during 2008.

### Release of Material Containing Residual Radioactivity (Table)

DOE issued a moratorium in January 2000 prohibiting the release of volume-contaminated metals, and suspended the release of metals from DOE radiological areas in July 2000 for recycling purposes. No volume-contaminated metals or metals for recycling purposes were released from SRS in 2008.

DOE approved an SRS request in 2003 to use supplemental limits for releasing material from the site with no further DOE controls. These supplemental release limits are dose-based, and are such that if any member of the public received any exposure, it would be less than 1 mrem/year. The supplemental limits include both surface and volume concentration criteria. The surface criteria are very similar to those used in previous years. The volume criteria allow the disposal of potentially volume-contaminated material in SRS's Three Rivers Landfill, an onsite sanitary facility. In 2008, no material was released from the site using the SRS Supplemental Release Limits volume concentration criteria.

These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 5400.5.

## 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 industries, 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.gov/environment/baq/docs/regs/>.

### 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 (1) 10 micrometers and (2) 2.5 micrometers, volatile organic compounds (VOCs), and toxic air pollutants. With the issuance of the 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. Actual 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 actual annual emissions for each source then can be compared against their respective permit limitations.

At the SRS A-Area and D-Area Powerhouses, airborne emission specialists under contract to SRS perform stack compliance tests every two years. The tests include sampling of boiler exhaust gases to determine particulate matter, sulfur dioxide, and visible opacity emissions. The permit for the A-Area Powerhouse 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 0.05 percent—and must be certified by the fuel supply vendor and reported to SCDHEC semiannually.

The monitoring of SRS diesel-powered equipment includes 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, electrostatic precipitators, 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. SCDHEC performed an air

**Table 4-1**  
**SRS Estimated SCDHEC Standard 2 Pollutant Air Emissions, 2005-2007**

Pollutant Name	Actual Emissions (Tons/Year)		
	2005	2006	2007
Sulfur dioxide (SO <sub>x</sub> )	6.97E+03	5.10E+03	4.25E+03
Total particulate matter (PM)	9.28E+02	5.04E+02	4.17E+02
Particulate matter <10 micrometers (PM <sub>10</sub> )	5.71E+02	3.82E+02	2.45E+02
Particulate matter <2.5 micrometers (PM <sub>2.5</sub> )	4.77E+02	3.19E+02	2.20E+02
Carbon monoxide (CO)	1.03E+03	7.83E+01	7.62E+01
Ozone (volatile organic compounds)	5.48E+02	1.69E+01	1.61E+01
Gaseous fluorides (as hydrogen fluoride) <sup>a</sup>	1.43E-01	1.42E+01	1.27E+01
Nitrogen dioxide (NO <sub>x</sub> )	7.18E+03	3.15E+03	2.63E+03
Lead (lead components)	1.74E-01	7.60E-02	1.91E-02

<sup>a</sup> The increase in gaseous fluorides from 2005 to 2006 is attributed to updated and corrected D-Area Powerhouse (coal boilers) emission factors. In 2005 and previous years, gaseous fluoride emissions from the D-Area Powerhouse were not calculated.

compliance inspection in August 2008 and found no instances of noncompliance.

### Monitoring Results Summary

In 2008, operating data were compiled and emissions calculated for 2007 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 2007 emissions, with only limited discussion of available 2008 monitoring results for specific sources.

The 2007 total SCDHEC Standard 2 emission estimates for all SRS permitted sources, as determined by the air emissions inventory conducted in 2008, are provided in table 4-1. A review of the calculated emissions for each source for calendar year 2007 determined that SRS sources had operated in compliance with permitted emission rates. 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](#).

Three power plants with nine overfeed stoker-fed coal-fired boilers are maintained by Savannah River Nuclear Solutions (SRNS) at SRS. The location, number of boilers, and capacity of each boiler for these plants are listed in table 4-2. A-Area Boiler No. 2 was stack-tested in February 2008. At that time, the boiler's sulfur dioxide and visible emissions were found to be in compliance with its permitted limit; however, the boiler's particulate matter emissions were found to be out of compliance with its permitted limit. The boiler was shut down permanently on March 19, 2008, and on September 13, 2008, A-Area Boiler No. 1 also was shut down permanently. Results from the A-Area Boiler No. 2 test are shown in table 4-3.

To replace the aging A-Area coal-fired boilers, SRS began construction of a biomass boiler and an oil-fired backup boiler in October 2007. Known as

**Table 4-2**  
**SRS Power Plant Boiler Capacities**

Location	Number of Boilers	Capacity (Btu/hr)
A-Area	2 <sup>a</sup>	71.7E+06
A-Area	2 <sup>b</sup>	40.7E+06
H-Area	3 <sup>c</sup>	71.1E+06
D-Area	4	396.0E+06

<sup>a</sup> Shut down permanently in March, September 2008  
<sup>b</sup> Operations began in August 2008  
<sup>c</sup> Operations discontinued in 2000 and 2001

the 784-7A Steam Facility, those two boilers are substantially smaller and burn cleaner than the two coal-fired boilers they replaced. The biomass boilers produce significantly less particulate matter, sulfur dioxide, and nitrogen dioxide emissions than the two coal-fired boilers. The biomass boiler and backup

oil-fired boiler began operations in August 2008.

WSRC assumed operational responsibility for the D-Area Powerhouse (484-D) in February 2006 from South Carolina Electric and Gas (SCE&G), which had operated the facility for DOE under a separate contract since 1995. The D-Area Powerhouse has four coal-fired boilers—each on a biennial stack test schedule required by the Part 70 Air Quality Permit. During 2008, only D-Area Powerhouse boilers D#2 and D#4 were scheduled to be tested. Boiler D#4 could not be tested because of extended maintenance repairs; however the results for boiler D#2 are shown in table 4-3. This boiler's particulate matter, sulfur dioxide, and visible emissions were found to be in compliance with its permitted limit.

The three H-Area Powerhouse boilers have not operated since 2000-2001.

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 must be vendor certified semiannually to ensure that the fuel meets permit specifications; the certification was documented twice during 2008. The total diesel fuel consumption for portable air compressors, generators, emergency cooling water

**Table 4-3**  
**2008 Boiler Stack Test Results**

Boiler	Pollutant	Emission Rates	
		lb/10 <sup>6</sup> Btu	lb/hr
A-Area Boiler #2	Particulates <sup>a</sup>	0.690	31.45
	Sulfur dioxide <sup>a</sup>	1.318	53.41
	Opacity <sup>b</sup>	Avg. 12.5%	
D-Area Boiler #2	Particulates <sup>a</sup>	0.088	33.87
	Sulfur dioxide <sup>a</sup>	NC <sup>d</sup>	NC <sup>d</sup>
	Opacity <sup>b</sup>	Avg. 6.9%	
D-Area Boiler #4 <sup>c</sup>	Particulates <sup>a</sup>		
	Sulfur dioxide <sup>a</sup>		
	Opacity <sup>b</sup>		

<sup>a</sup> The compliance level is 0.6 lb/million Btu for particulates and 3.5 lb/million Btu for sulfur dioxide.  
<sup>b</sup> Opacity limit 40%  
<sup>c</sup> Not stack tested during 2008  
<sup>d</sup> Not calculated

pumps, and fire water pumps was found to be well below the SRS limit for the entire reporting period. As reported to SCDHEC during 2008, the calculated annual VOC emissions were well below the permit limit for each unit.

### 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 is conducted as required as part of the Title V and construction permitting process. 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 803-898-3882.

In 2008, SRS discharged water into site streams and the Savannah River under three NPDES permits: two for industrial wastewater, SC0047431 (covers D-Area) and SC0000175 (covers remainder of site), and one for stormwater runoff—SCR000000 (industrial discharge). A fourth 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 2008.

SRS submitted a permit application in 2006 for each of nine individual stormwater outfalls for which the average of any four consecutive analyses exceeded the proposed EPA Multisector General Permit

benchmarks. At the end of 2008, the site still had no response from SCDHEC regarding the individual permit applications.

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 five of the 4,529 sample analyses (includes flow measurements and no-flow designations) performed during 2008 exceeded permit limits. This resulted in a 99.89-percent compliance rate for discharge monitoring results. Of the five exceptions, two warranted SCDHEC Notices of Violation, but no fines were assessed. Details related to the five exceptions appear in table 4-4. A complete presentation of the NPDES data, with the exceptions noted, can be found on the CD accompanying this report.

In 2008, 17 stormwater outfalls were scheduled for compliance sampling. All samples were obtained as scheduled, with the additional sampling of one outfall to determine the effectiveness of an installed best management practice (BMP). In addition to compliance sampling, special grab sampling was conducted at six outfalls to aid in evaluating compliance with the proposed general permit. It was reported in 2006 that 10 outfalls had exceeded EPA benchmarks and would require corrective actions. By the end of 2007, seven of these outfalls were in compliance. Installation of BMPs for the remaining three outfalls was completed in June 2008; evaluation of the effectiveness of these BMPs is ongoing. Complete [stormwater data](#) can be found on the CD accompanying this report.

**Table 4-4**  
**2008 Exceptions to SCDHEC-Issued NPDES Permit Liquid Discharge Limits at SRS<sup>a</sup>**

Business Unit	Outfall	Date(s)	Parameter	Possible Cause(s)	Corrective Actions
Site Infrastructure	K-12	March 11	Total Suspended Solids (TSS) (weekly avg) Value: 66 mg/L Limit: 45 mg/L	Infiltration of solids from nearby construction; cement-like material poured in a collection system; inadequate aeration	Eliminated infiltration, verified contaminants not present, replaced air diffuser heads
Liquid Waste Operations	H-16	May 12	TSS (holding time) Value: 7.9 days Limit: 7 days	Laboratory exceeded holding time because sample not logged in upon receipt at laboratory	Isolated incident, but laboratory took steps to prevent repeat
Site Infrastructure	G-10	July 16	Fecal Coliform (daily max) Value: 746 col/100 mL Limit: 400 col/100 mL	Cause not identified after thorough investigation; appears to be anomaly	Pursue onsite certification for fecal coliform analyses to reduce potential for contamination or growth during sample transport to offsite laboratory
Materials Disposition	H-12	August 7	Copper (daily max) Value: 39.9 mg/L Limit: 35 mg/L	Solids in the sample	Unable to determine specific cause; comprehensive sampling plan implemented
Defense Programs	H-02	November 11	Copper (monthly avg) Value: 0.0073 mg/L Limit: 0.007 mg/L	Until November 1, copper limit was monitor and report (no limit); on November 1, limit of 0.007 mg/l imposed by SCDHEC	Permit modification issued by SCDHEC; effective November 30, monthly average limit raised to 0.032 mg/l

<sup>a</sup> SRS's compliance rate for 2008 was 99.89 percent.