Effluent Monitoring

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. The monitoring is conducted by the Environmental Monitoring Services group of the site's Regulatory Integration & Environmental Services organization—following specific sampling and analytical procedures .that 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, 2002a]. A summary of data results is presented in this chapter; more complete data can be found in tables on the CD housed inside the back cover of this report.

Radiological Monitoring

Radiological effluent monitoring results are a major component in determining compliance with applicable dose standards. SRS environmental management philosophy is that potential exposures to members of the public and to onsite workers be 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, 2002a].

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.

One effluent sampling change occurred in 2009: The sampling frequency at R-Area Reactor was changed from biweekly to monthly in July.

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

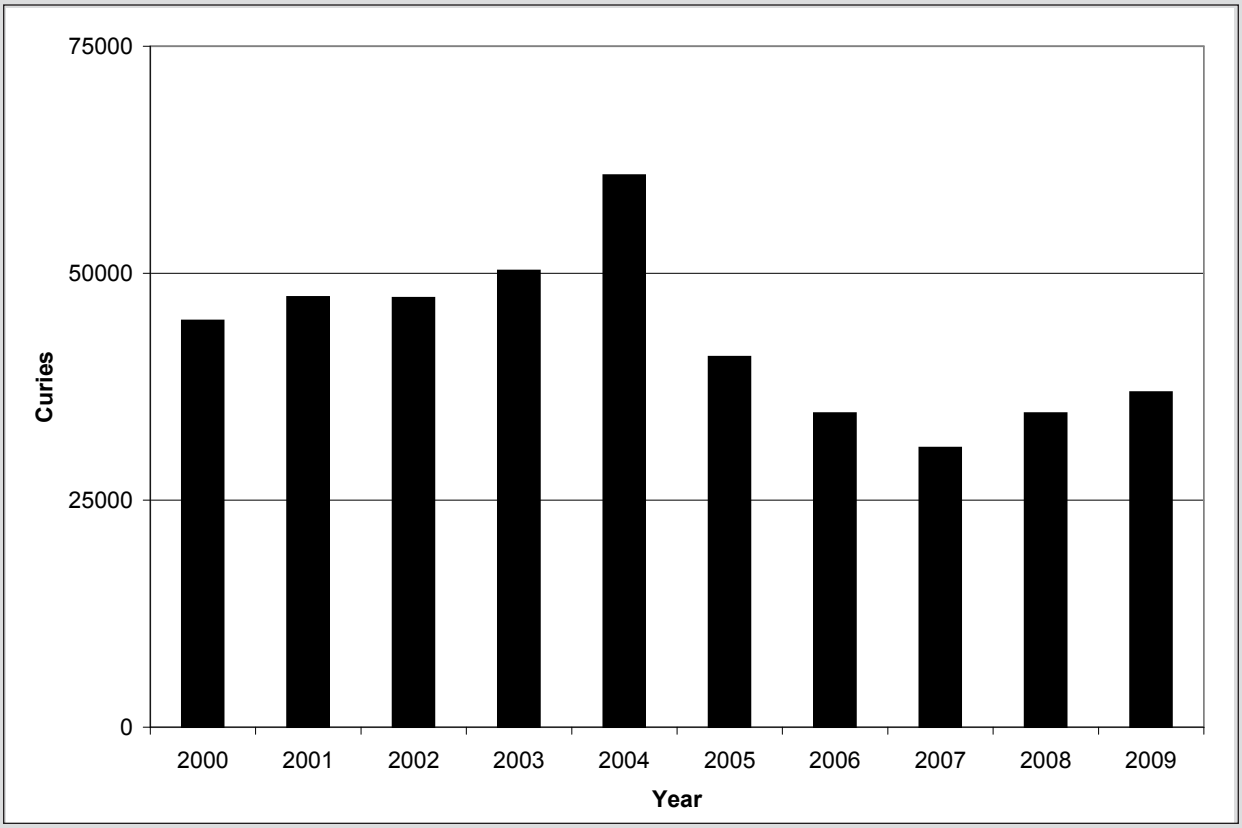

Figure 4–1 Ten-Year History of SRS Annual Atmospheric Tritium Releases

the U.S. Environmental Protection Agency's (EPA's) recommended methods [EPA, 2002a]. 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 in 2009, when about 36,900 Ci of tritium were released from the site—compared to about 34,600 Ci in 2008. 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 and L-Area main stacks) and tritium facilities was emitted in 2009 at concentration levels above the DCGs. Also, plutonium-239 exceeded the DCG at the F-Area Main Stack during this time. 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, 2002a].

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 2009 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 2009 was 238Ci. Direct releases of tritium to site streams for the years 2000–2009 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 2009 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.

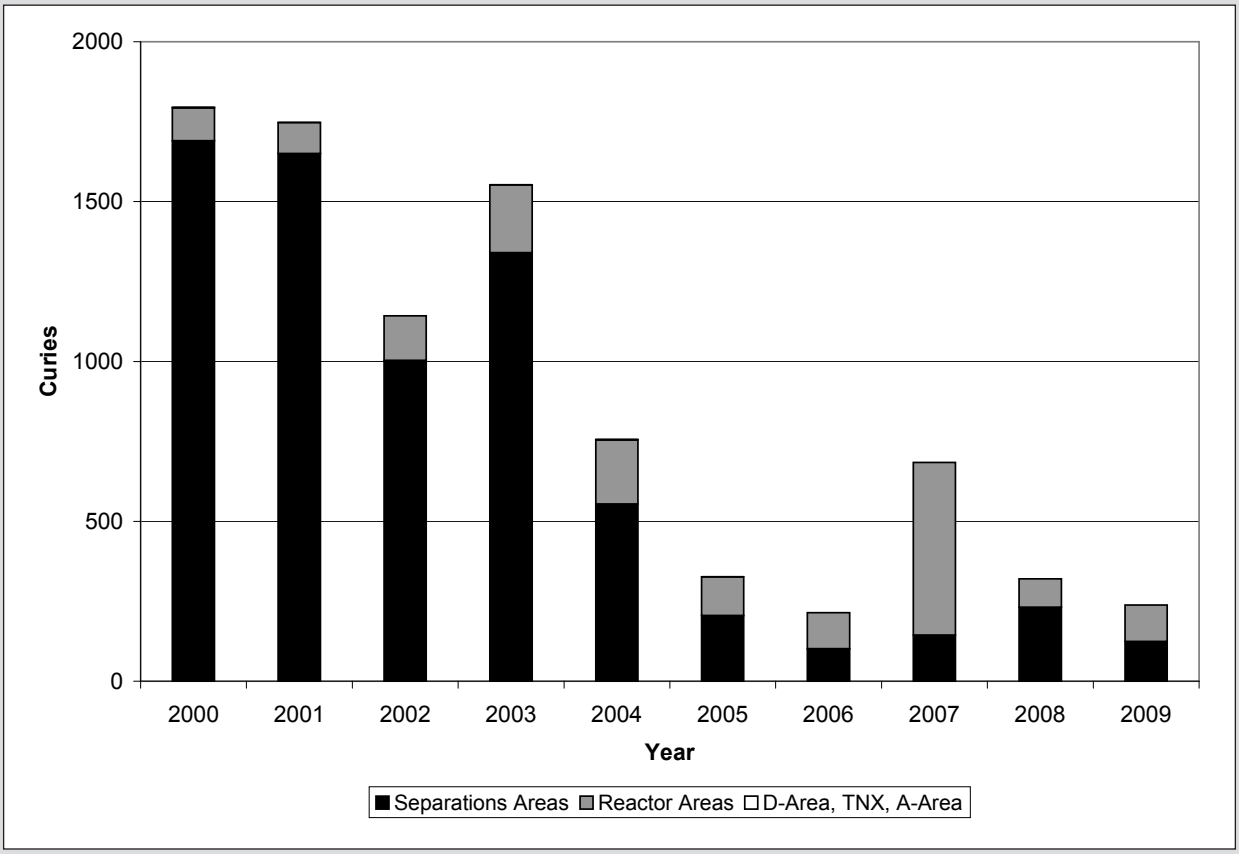

Figure 4–2 Ten-Year History of Direct Releases of Tritium to SRS Streams

The data show that ETF Outfall U3R–2A at the Road C discharge point exceeded the DCG guide for 12-month-average tritium concentrations again during 2009. 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.

No other liquid discharge points exceeded the DOE DCGs during 2009.

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 compliance inspection September 15, 2009 and found no instances of noncompliance.

Monitoring Results Summary

In 2009, operating data were compiled and emissions calculated for 2008 operations for all site air emission sources. Because this process, which begins in January, requires up to six months to complete, this report provides a comprehensive examination of total 2008 emissions, with only limited discussion of available 2009 monitoring results for specific sources. Refer to the "Toxic Air Pollutant Emissions (2006–2008)" table on the CD accompanying this report for a list of the 2008 estimated emissions.

The 2008 total SCDHEC Standard 2 emission estimates for all SRS permitted sources, as determined by the air emissions inventory conducted in 2009, are provided in table 4–1. A review of the calculated emissions for each source for calendar year 2008 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.

Table 4–1
SRS Estimated SCDHEC Standard 2 Pollutant Air Emissions, 2006–2008

Pollutant Name	Actual Emissions (Tons/Year)		
	2006	2007	2008
Sulfur dioxide (SO_x)	5.10E+03	4.25E+03	4.07E+03
Total particulate matter (PM)	5.04E+02	4.17E+02	4.59E+02
Particulate matter <10 micrometers (PM_{10})	3.82E+02	2.45E+02	3.13E+02
Particulate matter <2.5 micrometers ($PM_{2.5}$)	3.19E+02	2.20E+02	2.65E+02
Carbon monoxide (CO)	7.83E+01	7.62E+01	6.73E+02
Ozone (volatile organic compounds)	1.69E+01	1.61E+01	6.53E+01
Gaseous fluorides (as hydrogen fluoride)[a]	1.42E+01	1.27E+01	1.22E+01
Nitrogen dioxide (NO_x)	3.15E+03	2.63E+03	1.89E+03
Lead (lead components)	7.60E-02	1.91E-02	2.67E-02

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 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.

SRNS 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 its Part 70 Air Quality Permit. During 2009, D-Area Powerhouse boilers D#1, D#3, and D#4 were source tested. The results for boilers D#1, D#3, and D#4 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 operates one package steam generating boiler 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 2009. SRS submitted a request to SCDHEC February 26 to remove a second K-Area package steam generating boiler from the site's Part 70 Air Quality Permit. This unit no longer is operational.

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 2009, 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[a] (Btu/hr)
A-Area	2	40.7E+06
D-Area	4	396.0E+06

[a] Capacity indicated is for *each* boiler.

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.

Table 4–3
2009 Boiler Stack Test Results[a]

		Emission Rates	
Boiler	**Pollutant**	**lb/10⁶ Btu**	**lb/hr**
C-Area Boiler #1	Particulates[b]	0.068	26.5
	Sulfur dioxide[b]	0.95	371.9
	Opacity[c]	Avg. 12.5%	
D-Area Boiler #2[d]			
D-Area Boiler #3	Particulates[b]	0.206	64.7
	Sulfur dioxide[b]	0.97	264.7
	Opacity[c]	Avg. 6.5%	
D-Area Boiler #4	Particulates[b]	0.176	81.6
	Sulfur dioxide[b]	0.91	499.3
	Opacity[c]	Avg. 11.0%	

[a] Boiler #1 source test January 14, 2009; Boiler #3 source test June 24, 2009; Boiler #4 source test January 15, 2009.

[b] The compliance level is 0.6 lb/million BTU for particulates, based on source tests using EPA Methods 1–5, and 3.5 lb/million BTU for sulfur dioxide, based on representative samples of sulfur heat value of coal consumed during the source tests.

[c] Opacity limit 40%

[d] Not stack tested during 2009

In 2009, SRS discharged water into site streams 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 2009.

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. These outfalls are expected to be covered under the upcoming new Industrial Stormwater General Permit rather than the individual permits.

Permit ND0072125 is a "no discharge" permit regulating the land application of biosolids (dried sludge) from onsite sanitary wastewater treatment facilities. There were no applications of sludge at SRS in 2009. An application was submitted to SCDHEC in August 2009 for a 10-year renewal of the permit, which expires in 2010. Renewing the permit is expected to be more cost effective than developing a new sludge land application site.

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). Four out of approximately 4,989 sample analyses (includes flow measurements and no-flow designations) performed during 2009 exceeded permit limits. This resulted in a 99.92-percent compliance rate. None of the four permit exceptions resulted in a Notice of Violation by SCDHEC. Details related to the four 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 2009, 16 stormwater outfalls were scheduled for compliance sampling. All samples were obtained as scheduled. In addition to compliance sampling, special grab sampling was conducted at four outfalls to aid in evaluating compliance with the proposed general permit. Complete stormwater data can be found on the CD accompanying this report.

Table 4–4
2009 Exceptions to SCDHEC-Issued NPDES Permit Liquid Discharge Limits at SRS[a]

Company	Outfall	Date(s)	Parameter	Possible Cause(s)	Corrective Actions
SRNS	A–11	February 2	pH (max) Value: 9.8 su[b] Limit: 8.5 su[b]	Rainwater released from a sump associated with a caustic tank	No discharge of sump contents without first verifying that the pH meets outfall limits.
SRR	TH–1 (H–16)	July 2	BOD (invalid result) Value: < 2.0 mg/L Limit: 20 avg., 40 max mg/L	Contaminated contract laboratory dilution water	Isolated event
SRNS	D–01	November 8	Water Temperature Difference (daily max) Value: 12.7° F Limit: 10.8° F	Defective temperature monitoring equipment	Water temperature mediation plan immediately activated; followed by replacement of defective equipment
SRNS	D–01	November 9	Water Temperature Difference (daily max) Value: 11.0° F Limit: 10.8° F	Defective temperature monitoring equipment	Water temperature mediation plan immediately activated; followed by replacement of defective equipment

[a] SRS's compliance rate for 2009 was 99.92 percent.
[b] su = standard units