Chapter 3

Effluent Monitoring

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EFFLUENT monitoring at 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 and Analysis group (formerly the Environmental Monitoring Section) of the site's Environmental Services Section (formerly the Environmental Protection Department) 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. Savannah River Site (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 emissions (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. Because some (if not most) of these emissions are from naturally occurring radionuclides, these emissions are accounted for separately from actual strontium-90 and plutonium-239 emissions. Therefore, releases of unspecified alpha emissions and nonvolatile beta emissions are listed separately in the source term. Prior to 2000, these emissions were included in plutonium-239 and strontium-89,90 releases. For dose calculations, the unspecified alpha releases were assigned the plutonium-239 dose factor, and the unspecified nonvolatile beta releases were assigned the strontium-90 dose factor (chapter 5, "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 2002:

- Air effluent sampling at the K-Area disassembly basin stacks was discontinued at the end of October, following dewatering of the facility.
- Air effluent sampling at 232–H (lines 1 and 2 stack and line 3 stack) was discontinued in October, with regulatory approval, because releases at this location have been extremely low during the past several years.

Diffuse and Fugitive Sources

Estimates of radionuclide releases from unmonitored diffuse and fugitive sources also are included in the SRS radioactive release totals. A diffuse source is defined as an area source. A fugitive source is defined as an undesigned localized source.

Diffuse and fugitive releases are calculated using the U.S. Environmental Protection Agency's (EPA's)

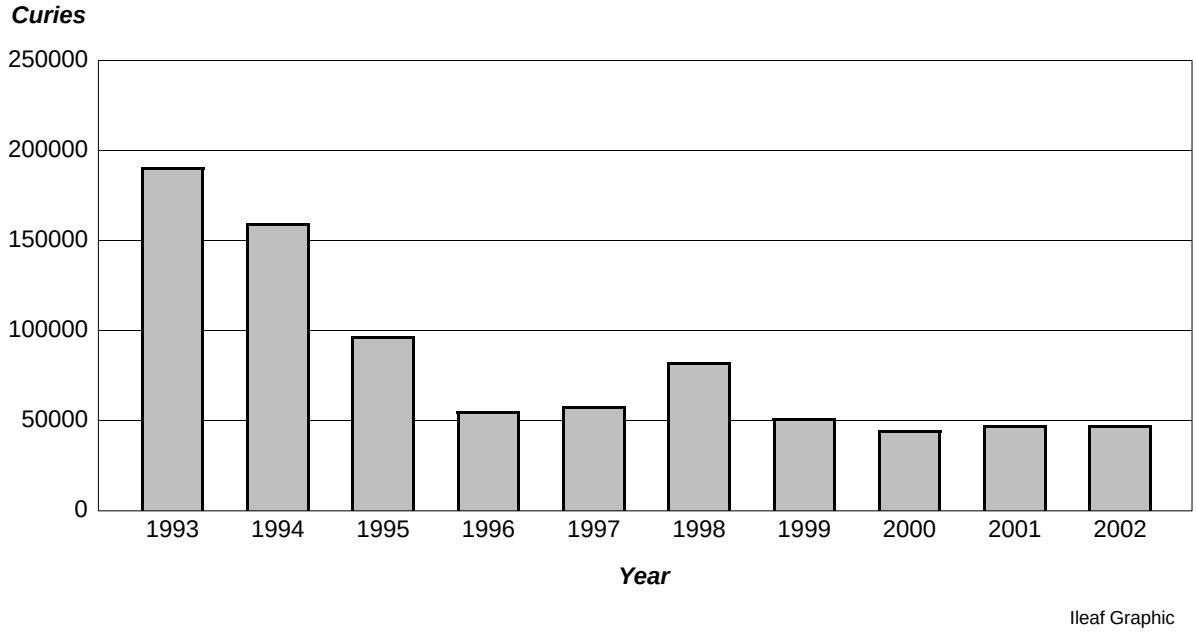

Figure 3–1 Ten-Year History of SRS Annual Atmospheric Tritium Releases

recommended methods. Because these methods are conservative, they generally lead to overestimates of actual emissions.

Monitoring Results

The total amount of radioactive material released to the environment is quantified by using data obtained from continuously monitored airborne effluent releases points and estimates of diffuse and fugitive sources in conjunction with calculated release estimates of unmonitored radionuclides from the separations areas.

The unmonitored radionuclides in the separations areas are fission product tritium, carbon-14, and krypton-85. These radionuclides cannot be measured readily in the effluent streams; therefore, the values are calculated on an annual basis and are based on production levels.

Because of decreased operations in H-Canyon, the amount of krypton-85 estimated to have been released by the site decreased 51 percent—from 64,700 Ci in 2001 to 31,500 in 2002. This accounted for 40 percent of the total radioactivity released to the atmosphere from SRS operations.

Tritium Tritium in elemental and oxide forms accounted for 60 percent of the total radioactivity released to the atmosphere from SRS operations. During 2002, about 47,300 Ci of tritium were released from SRS, compared to about 47,400 Ci in 2001.

Because of improvements in facilities, processes, and operations, and because of changes in the site's missions, the amount of tritium (and other atmospheric radionuclides) released has been reduced throughout the history of SRS. In recent years, because of changes in the site's missions and the existence of the Replacement Tritium Facility, the total amount of tritium released has fluctuated but has remained less than 100,000 Ci per year (figure 3–1).

Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Guides Average concentrations of radionuclides in airborne emissions are calculated by dividing the yearly release total of each radionuclide from each stack by the yearly stack flow quantities. 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 2002 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, certain radionuclides—tritium (in the oxide form) from the reactor facilities and the tritium facilities, plutonium-239 from the 291–F stack, and plutonium-238 and plutonium-239 from the 221–S stack—were emitted at concentration levels above the DCGs. Because of the extreme difficulty involved in removing tritium and because of current facility designs, site missions, and operational considerations, this situation is unavoidable. The offsite dose consequences from all atmospheric releases during 2002, however, remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv) (chapter 5).

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.

Monitoring Results

Data from continuously monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility migration release estimates to quantify the total radioactive material released to the Savannah River from SRS operations. SRS liquid radioactive releases for 2002 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) to site streams during 2002 was 1,140 Ci**,** which was 35 percent less than the 2001 total of 1,748 Ci.

Direct releases of tritium to site streams for the years 1993–2002 are shown in figure 3–2. The migration and transport of radionuclides from site seepage basins and the Solid Waste Disposal Facility is discussed in chapter 4 (“Radiological Environmental Surveillance”).

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 Solid Waste Disposal Facility 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 2002 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 2002. 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 2002.

Nonradiological Monitoring

Airborne Emissions

The South Carolina Department of Health and Environmental Control (SCDHEC) regulates nonradioactive air emissions—both criteria pollutants and toxic air pollutants—from SRS sources. Each source of air emissions is permitted or exempted by SCDHEC, with specific limitations and monitoring requirements identified. The bases for the limitations and monitoring requirements are outlined in various

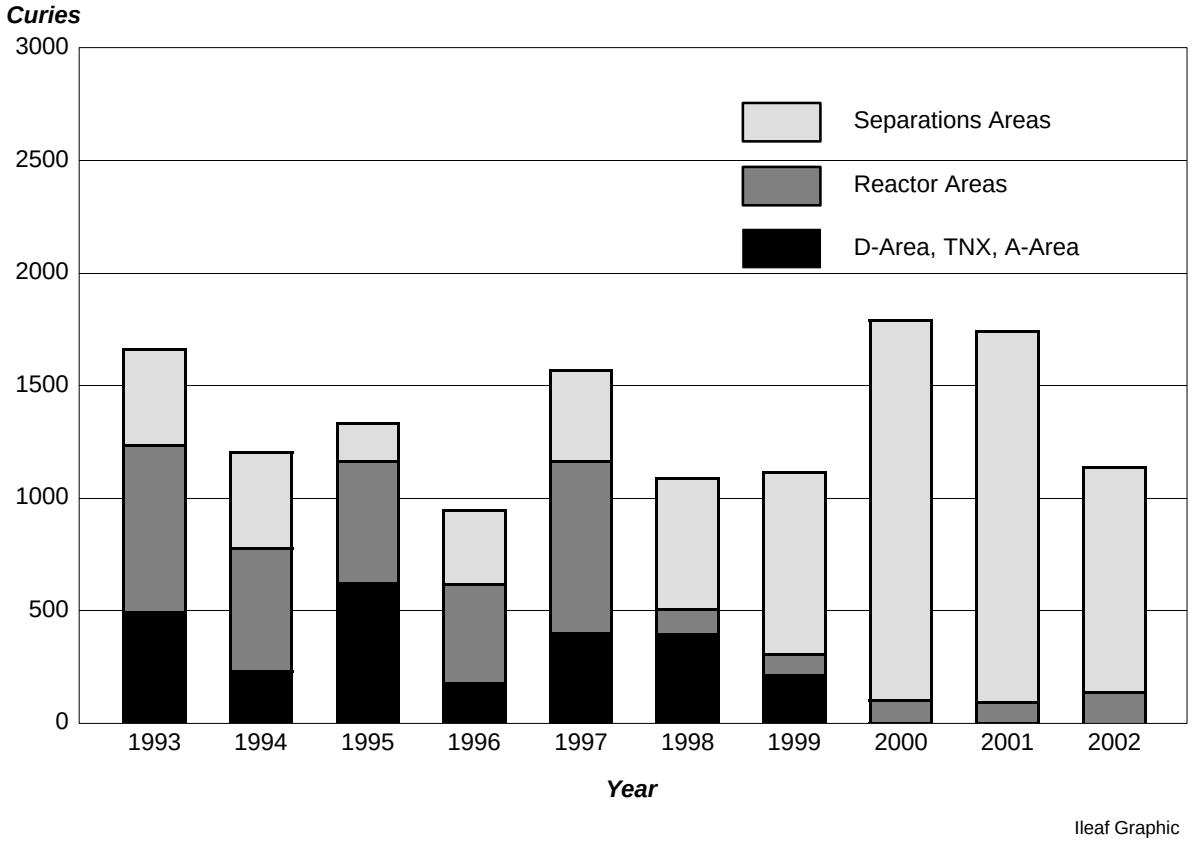

Figure 3–2 Ten-Year History of Direct Releases of Tritium to SRS Streams

Operations at D-Area and TNX were discontinued in 2000 and 2001, respectively. Releases from A-Area and the reactor areas 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.

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 and 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." The SCDHEC air standards for toxic air pollutants can be found at http://www.scdhec.net/baq on the Internet.

At SRS, there are 150 permitted/exempted nonradiological air emission sources, 128 of which were in operation in some capacity during 2002. The remaining 22 sources either were being maintained in a "cold standby" status or were under construction.

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. Only the most significant monitoring requirements are discussed below.

The most significant method of source monitoring at SRS is the annual air emissions inventory. Emissions from SRS sources are determined during an annual emissions inventory from standard calculations using source operating parameters. 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, stack compliance tests are performed every 2 years for each boiler by airborne emission specialists under contract to SRS.

Sulfur content and BTU output are used to calculate sulfur dioxide emissions. SCDHEC also conducts visible-emissions observations during the tests to verify compliance with opacity standards. The day-to-day control of particulate matter smaller than

10 microns is demonstrated by opacity meters in all SRS powerhouse stacks.

For the package steam generating boilers in K-Area, compliance with sulfur dioxide standards is determined by analysis of the fuel oil purchased from the offsite vendor. The percent of sulfur in the fuel oil must be below 0.5 and is reported to SCDHEC each quarter.

Monitoring of SRS diesel-powered equipment consists of tracking fuel oil consumption as the basis for determining permit compliance.

SRS has several sources of toxic air pollutants; however, there are no specific monitoring requirements in their respective permits. Because some toxic air pollutants also are regulated as VOCs, some SRS sources (soil vapor extraction units and air strippers) are required to be monitored by calculating and reporting VOC emissions on a quarterly basis.

Compliance by all SRS permitted sources is determined during annual compliance inspections by the local SCDHEC district air manager.

Compliance by all toxic air pollutant and criteria pollutant sources also is determined by using U.S. Environmental Protection Agency (EPA)-approved air dispersion models. The Industrial Source Complex Version No. 3 model was used to predict maximum ground-level concentrations occurring at or beyond the site boundary for new sources permitted in 2002.

Monitoring Results

In 2002, operating data were compiled and emissions calculated for 2001 operations for all site air emission sources. Because this process, which begins in January, requires up to 6 months to complete, this report will provide a comprehensive examination of total 2001 emissions, with only limited discussion of available 2002 monitoring results for specific sources.

The 2001 total criteria and toxic air pollutant emissions results for all SRS sources, as determined by the 2002 air emissions inventory, are provided in table 3–1 and on the CD accompanying this report. A review of the calculated emissions for each source for calendar year 2001 determined that SRS sources had operated in compliance with permitted emission rates. Actual 2002 emissions will be compiled and reported in depth in the *SRS Environmental Report for 2003*. Some toxic air pollutants (e.g., benzene) regulated by SCDHEC also are, by nature, VOCs. As such, the total for VOCs in table 3–1 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. These pollutants are included because they are compounds of some Standard No. 8 pollutants.

Table 3–1
2001 Criteria Pollutant Air Emissions

Pollutant Name	Actual Emissions[a] (Tons/Year)
Sulfur dioxide	5.37E+02
Total suspended particulates	5.64E+02
PM_{10} (particulate matter 10 microns)	1.96E+02
Carbon monoxide	4.58E+03
Ozone (volatile organic compounds)	1.54E+02
Gaseous fluorides (as hydrogen fluoride)	1.67E–01
Nitrogen dioxide	3.87E+02
Lead	7.95E–02

a From all SRS sources (permitted and nonpermitted)

Two power plants with five overfeed stoker-fed coal-fired boilers are operated by Westinghouse Savannah River Company (WSRC) at SRS. The location, number of boilers, and capacity of each boiler for these plants are listed in table 3–2. Because of an alternating test schedule, only A-Area boiler No. 1 was stack tested in 2002. Test results, shown in table 3–3, indicated the boiler was being operated in compliance with permitted emission rates.

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 year was certified by the vendor to meet the requirements of the permit.

At SRS, 97 permitted and exempted sources, both portable and stationary, are powered by internal combustion diesel engines. These sources include portable air compressors, diesel generators, emergency cooling water pumps, and fire water pumps. During the 2002 compliance inspections, total fuel oil consumption and opacity for all inspected diesel engines were found to be in compliance.

Table 3–2
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 3–3
Boiler Stack Test Results (A-Area)

Boiler	Pollutant	Emission Rates	
		lb/10^6 BTU	lb/hr
A #2	Particulates[a]	0.56	51.91
	Sulfur dioxide[a]	NC[b]	NC[b]

a The compliance level is 0.6 lb/million BTU for particulates and 3.5 lb/million BTU for sulfur dioxide.
b Not calculated

Another significant source of criteria pollutant emissions at SRS is the controlled burning of vegetation and undergrowth by the U.S. Department of Agriculture Forest Service–Savannah River (USFS–SR) as a means of preventing uncontrolled forest fires. USFS–SR personnel burned only 4,505 acres across the site during 2002 because of drought conditions. This number contrasts with the 17,711 acres burned in 2001.

Thirty-three of the SRS permitted sources are permitted for toxic air pollutants; 19 of these were operated during 2002. Several of the toxic air pollutant sources—specifically, the soil vapor extraction and air stripper units—have permit conditions requiring the calculation of the running total annual VOC emissions, which are to be calculated and reported to SCDHEC quarterly. As reported to SCDHEC during 2002, the calculated annual VOC emissions were determined to be 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 was conducted during 2002 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.

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 2002, SRS discharged water into site streams and the Savannah River under two NPDES permits: one for industrial wastewater (SC0000175) and one for stormwater runoff—SCR00000 (industrial discharge). Permit SC0000175 regulated 31 industrial wastewater outfalls in 2002. 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 2002. 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

SRS reports analytical results to SCDHEC through a monthly discharge monitoring report (EPA Form 3320–1).

Twenty-eight of the 31 outfalls permitted by SC0000175 in 2002 discharged. Results from only 10 of the 5,401 sample analyses performed during the year exceeded permit limits. A list of the 2002 NPDES exceedances appears in table 3–4. SRS achieved a 99.8-percent compliance rate—higher than the DOE-mandated 98-percent rate.

The 2002 exceedance total of 10 represents a decrease from the 24 exceedances of 2001.

SRS received approval from EPA and SCDHEC in 2001 to use *Daphnia ambigua* as the species for chronic-toxicity testing. It was anticipated that this approval would allow the site to use both *Ceriodaphnia dubia* and *Daphnia ambigua* as test species; however, only *Daphnia ambigua* was

approved. As a result, SRS filed an appeal with SCDHEC in October 2001. The appeal was dismissed in May 2002, and the site began using *Daphnia ambigua* in June 2002.

One hundred percent of the required stormwater discharge samples were collected and analyzed during 2002. This included an adverse climatic condition waiver for outfall E–01. SCDHEC has not mandated permit limits for stormwater outfalls.

During the first and third quarters of 2002, dewatered sludge was sampled and analyzed for pollutants of concern, and approximately 70 cubic yards of sludge was applied to the land. No sludge was applied during the second and fourth quarters. The analytical results indicated that pollutant concentrations were within regulatory limits.

Table 3–4
2002 Exceedances of SCDHEC-Issued NPDES Permit Liquid Discharge Limits at SRS

Department/ Division	Outfall	Date	Analysis	Possible Cause	Corrective Action
FSS/LSD/LOS	A–01	Jan. 14	C–TOX	Test organism inappropriate for discharge water	Use of alternate species approved but under appeal
FSS/LSD/LOS	A–01	March 8	C–TOX	Test organism inappropriate for discharge water	Use of alternate species approved but under appeal
FSS/LSD/LOS	A–01	April 8	C–TOX	Test organism inappropriate for discharge water	Use of alternate species approved but under appeal
ERD	A–11	Feb. 4	C–TOX	Test organism inappropriate for discharge water	Use of alternate species approved but under appeal
ERD	A–11	March 8	C–TOX	Test organism inappropriate for discharge water	Use of alternate species approved but under appeal
SUD	H–08	Jan. 31	pH	Unknown	Resampled; in compliance
SWD	H–16	April 22	pH	Unknown	Resampled; in compliance
ERD	A–11	June 3	C–TOX	Incomplete third brood during lab analysis	None required
DPD	H–02	August 22	TSS	Ruptured domestic water line	Line repaired
HLW	H–07	Sept. 23	pH	Leakage from process well	Well valve repaired

Key: C-TOX – Chronic toxicity
TSS – Total suspended solids