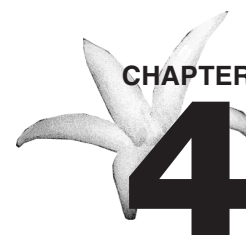

Effluent Monitoring

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Effluent monitoring at the Savannah River Site (SRS) is conducted to demonstrate compliance with applicable standards and regulations. Site airborne and liquid effluent monitoring activities are divided into radiological and nonradiological programs. This monitoring is conducted in accordance with specific Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Department of Energy (DOE) sampling and analytical procedures. A summary of data results is presented in this chapter; more detailed data can be found in tables on the CD housed inside the back cover of this report.

Radiological Monitoring

The U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) establish the requirements and limits that regulate radionuclide emissions from facilities owned or operated by the DOE. The methods for estimating and reporting radioactive emissions are detailed in 40 CFR 61 Subpart H. The SCDHEC regulates both radioactive and nonradioactive air pollutant emissions from SRS sources. Each source of air emissions is permitted or exempted by SCDHEC on the SRS Part 70 Air Quality Permits, with specific limitations and monitoring requirements. This section of the chapter will cover the radioactive emissions.

Radiological effluent monitoring results are a major component in demonstrating compliance with standards for radiological doses to the public established by EPA, SCDHEC and DOE. SRS works to ensure that radiation exposures to employees and releases of radioactivity to the environment are maintained below regulatory limits, and deliberate efforts are taken to further reduce exposures and releases.

SRS airborne and liquid effluents that potentially contain radionuclides are monitored or evaluated at the point of discharge by a combination of direct measurement and/or sample extraction and analysis. Brief summaries of analytical results are presented in this chapter; complete data sets, as well as maps which show sampling locations, can be found in tables on the CD housed inside the back cover of this report. Tables on the CD ("Environmental Data/Maps - 2011") are referred to in this chapter as "data table 4-X." Tables in the chapter itself are referred to simply as "table 4-X."

Data tables 4-1 and 4-2 provide a summary of analytical results for radioactive air and liquid effluent measurements taken at SRS in 2011. Radioactive atmospheric and liquid release data by facility are contained in data tables 4-3 and 4-4.

Unspecified alpha and beta radiation releases in airborne and liquid emissions make up a large percentage of the offsite doses. The unidentified alpha and unidentified beta radiation releases are listed separately in data tables 4-3 and 4-4. They are determined by subtracting the identified individual radionuclides from the measured gross activity. Conservatively, unidentified alpha and unidentified beta releases include small amounts of unidentified manmade radionuclides and also include naturally occurring radionuclides, such as uranium, thorium, and potassium-40. For dose calculations, the unspecified alpha and beta radiation releases were assigned the plutonium-239 and the strontium-90 dose factors, respectively (Chapter 6, "Radiological Dose Assessments").

Airborne Emissions

Process area stacks that release, or have the potential to release, radioactive materials are monitored by an inline system, periodic sampling system or utilize approved calculation methods to estimate the emissions.

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.

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 contained in data table 4-3. A diffuse source is defined as an area source, such as a pond or disposal area. A fugitive source is defined as an undesigned localized source, such as an open tank or naturally ventilated building.

Diffuse and fugitive releases are calculated using 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 monitored airborne effluent release points, (2) estimates of diffuse and fugitive sources, and (3) estimates for unmonitored air sources based on approved EPA calculation methods using periodic sampling and analysis of the source.

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 2011. The remaining one percent is detailed in data table 4-3. Approximately 28,100 Ci of tritium were released from the site in 2011, compared with approximately 40,500 Ci in 2010. About 94 percent of the releases came from the site's tritium facilities and the remainder is split between the Reactor Areas and the estimated diffuse and fugitive releases from ongoing remediation and restoration activities. A significant reduction in tritium emissions is reported for 2011 as a result of refinement in the calculation methodology for the Mixed Waste Management Facility (MWMF) Phytoremediation project. Historical emissions from this source were conservatively based on a maximum possible throughput of 108 million gallons of water with a tritium concentration at 7,440 pCi/mL. SRS reported a 2011 tritium throughput of 12.7 million gallons and a lower tritium concentration of 5,440 pCi/mL. The change to the less conservative and more accurate calculation method reduces the calculated percent of tritium released due to remediation activities from 32% to approximately

3% of the total site release.

The amount of tritium released from SRS fluctuates because of changes in the site's missions and in the annual Tritium Facility production schedules. For the past 10 years, the amount has ranged between 25,000 to 60,000 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 appropriate and effective. DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. DCGs are applicable at the point of discharge.

Data table 4-5 provides the 2011 atmospheric effluent annual-average concentrations, comparisons against the DOE DCGs, and the estimated quantities of radionuclides released by monitored discharge point. With the exception of tritium releases, the stack emissions reported in data table 4-5 represent only the emissions that occur during periodic sampling events. The emissions for other periods including any time when continuous tritium monitors malfunction and intervals between stack samples are not included. In addition, any emissions estimated using calculations are not provided in this table. Also, not included in the table are gross alpha and gross beta results.

Official year-end estimates are presented in data table 4-3. These estimates include monitored, fugitive, unidentified alpha and beta, calculated releases, and annual totals based on actual operation time. Data table 4-5 provides the 2011 atmospheric effluent annual average concentrations and their comparisons against the DOE DCGs. This DCG comparison is based on concentrations; therefore, only significant isotopic releases occurring during sampling periods are used to determine representative concentration.

Most of the SRS radiological stacks/facilities release small quantities of radionuclides at concentrations below the DOE DCGs. However, because of the nature of the operations and the application of DCGs at the release point, tritium DCGs are exceeded routinely at K-Area, L-Area, and the Tritium Facilities. The DCG



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

Sum of Fractions (i.e., sum of the fractional DCG values for each radionuclide detectable in the effluent based on rolling twelve-month averages) was exceeded for airborne releases from H-Canyon (291 H) stack in 2011. The H-Canyon exceedance occurred due to releases of Pu-238 and Pu-239 associated with dissolver operations during highly enriched uranium processing and transuranic waste repackaging activities. 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 Effluents

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

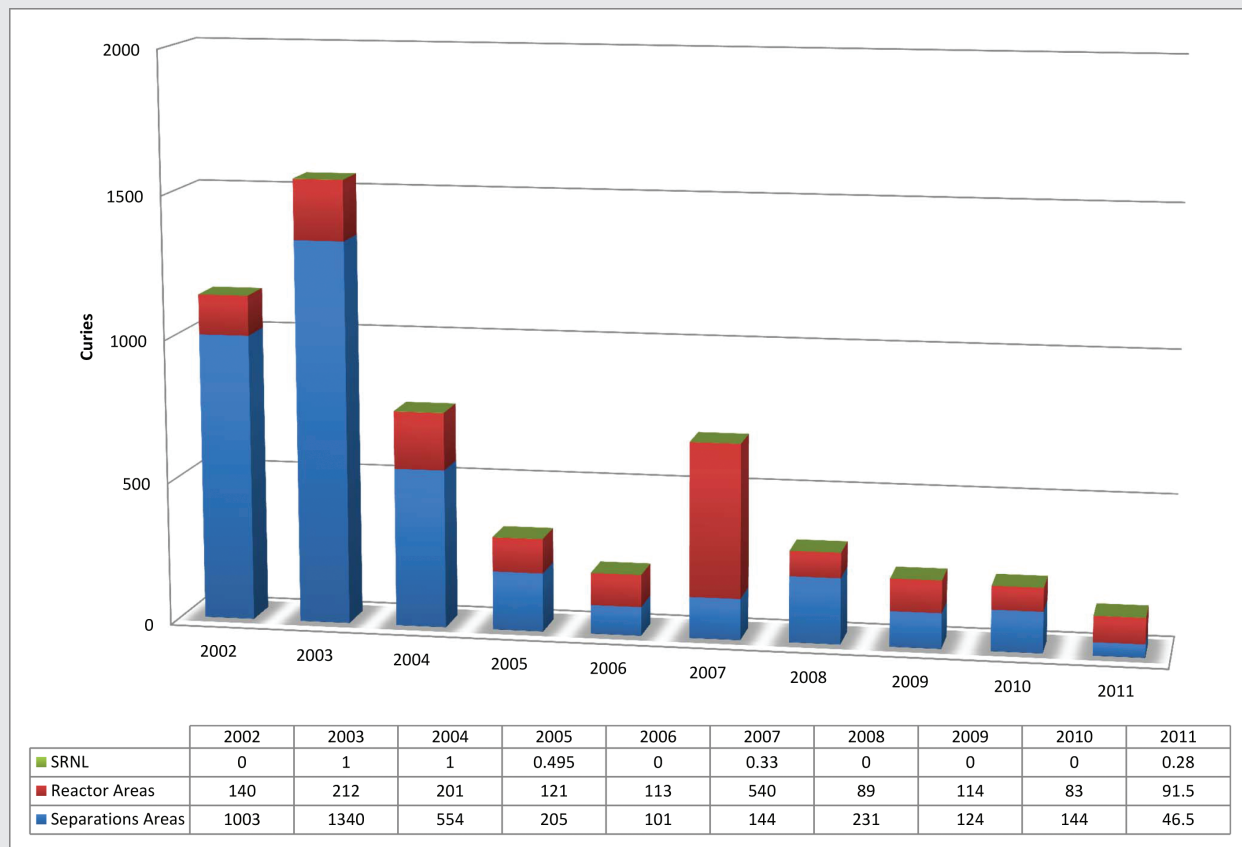
Depending on the processes involved, liquid effluents also may be monitored with real-time instrumentation to ensure that releases are below DOE established limits. Because the instruments have limited detection sensitivity, online monitoring systems are not used to quantify SRS liquid radioactive releases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



Environmental Monitoring Field Technician Picks Up a Radiological Sample for Analysis

Monitoring Results Summary

Data from monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility (SWDF) migration release

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

estimates to quantify the total radioactive material released to the Savannah River from SRS operations. Data table 4-4 provides SRS liquid radioactive releases for 2011. This data are a major component in the determination of offsite dose consequences from SRS operations.

Discharges of Liquid Effluents

Discharges of liquid effluents are quantified at the point of release. The release totals are based on measured concentrations and measured flow rates. Tritium accounts for nearly all the radioactivity discharged in SRS liquid effluents. The total amount of tritium released directly from process areas to site streams during 2011 was 138 Ci. Direct releases of tritium to site streams for the years 2002-2011 are shown in figure 4-2.

Groundwater migration and transport of radionuclides from site seepage basins and the 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 groundwater 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 the requirement to keep radioactive emissions and external exposures as low as reasonably achievable (ALARA). DOE DCG compliance is demonstrated when the sum of the fractional DCG values for all radionuclides detected in the effluent is less than 1.00, based on consecutive 12-month-average concentrations. Data table 4-6 provides the 2011 liquid effluent annual-average

concentrations, the quantities of radionuclides released compared to the DOE DCGs by discharge point.

Nonradiological Monitoring

Airborne Emissions

SCDHEC regulates both radioactive and nonradioactive criteria and toxic air pollutant emissions from SRS sources. Each source of air emissions is permitted, regulated or exempted by SCDHEC in the SRS Part 70 Air Quality operating permit. The permit sets emission limits and monitoring requirements for air emission sources at SRS. This section will cover nonradioactive emissions.

The bases for the limitations and monitoring requirements specified in the Part 70 Air Quality Permits 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 and toxic air pollutants. 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/Regulation-SIPManagement/reg61-62index.asp>.

Monitoring Program

Major nonradiological emissions of concern from SRS facility stacks include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter smaller than 10 micrometers and smaller than 2.5 micrometers, volatile organic compounds (VOCs), toxic and hazardous air pollutants. The SRS Part 70 Air Quality Permit has numerous 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 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 SRS processes, however, are unique sources requiring nonstandard, complex calculations. The hourly and total actual annual emissions for each source are then compared against their respective permit limitations.

SRS is required to perform stack compliance tests every two years at the A-Area biomass boiler and D-Area Powerhouse facility. The tests include sampling of boiler exhaust gases to determine particulate matter. In addition, opacity emissions are monitored and recorded during times of operation and a weekly visual inspection is conducted. A compliance stack test was conducted at the A-Area biomass boiler in February 2011, and test results are included in table 4-2. The next test is required prior to March 31, 2013. Only one compliance stack test was required and conducted at the D-Area facility. Boiler #3 was tested in May 2011. Due to permanent shutdown of the D-Area facility in 2012, no additional compliance tests will be performed at the D-Area powerhouse.

Compliance with sulfur dioxide standards is required for all fuel oil fired equipment operated on site. The sulfur content of the fuel oil used at SRS must be below 0.05 percent, and compliance reported to SCDHEC semiannually. Compliance is verified by analysis, and fuel supply vendor certification is required for each delivery. 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 are currently reported to SCDHEC on a quarterly basis.

Several SRS sources have pollutant control devices, such as electrostatic precipitators, baghouse dust collectors, or condensers, which must be monitored continuously or during operation and 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 regional office. 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 at the D-Area Powerhouse facility in September, 2011 and found no instances of noncompliance. SCDHEC did not perform a general site air compliance inspection in 2011.

Monitoring Results Summary

SRS is required to report its emissions inventory for all site air emission sources annually. Operating data are compiled and emission data are calculated for each calendar year. Data table 4-7 provides a list of the 2007-2011 estimated emissions.

The total SCDHEC air emission estimates for all SRS permitted sources, as determined by the air emissions inventory conducted in each of the past five years, are provided in table 4-1. A review of the calculated emissions for each source for each calendar year determined that SRS sources had operated in compliance with permitted emission rates. Some toxic air pollutants (e.g., benzene) regulated by SCDHEC are also, by nature, particulate matter or VOCs. As such, the total for VOCs in table 4-1 includes applicable toxic air pollutant emissions.

Four pulverized coal-fired boilers are maintained by SRS at the D-Area Powerhouse facility. Each of the boilers has a steam generation rating of 330,000 lbs per hour (3,960,000 Btu/hr capacity). The D-Area Part 70 Air Quality Permit requires that a biennial stack test be conducted for each of the boilers. D-Area Powerhouse boiler D#3 was source tested in 2011; these test results, as well as the 2010 test results for boilers D#1, D#2, and D#4, are shown in table 4-2. The particulate matter, sulfur dioxide, and visible emissions of these boilers were found to be in compliance with their permitted limits.

SRS also operates a biomass boiler and an oil-fired backup boiler in A-Area. These two boilers are substantially smaller and burn cleaner than the two coal-fired boilers which they replaced. The biomass boiler and oil-fired backup boiler each produce significantly less particulate matter, sulfur dioxide, and nitrogen dioxide emissions than coal-fired boilers.

SCDHEC issued a new Part 70 Air Quality Prevention of Significant Deterioration Construction Permit to Ameresco Federal Solutions to construct two biomass boilers, each rated at a maximum heat input rate of 210 million BTU/hr, and one new oil fired auxiliary boiler rated at 150 million BTU/hr, and two additional biomass boilers rated at 14.9 million BTU/hr. This new equipment will replace the D-Area Powerhouse facility. In November 2011, Ameresco began producing steam for use at SRS and closure of the D-Area Powerhouse was initiated.

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 2011, 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 in the

Table 4-1 SRS Estimated SCDHEC Standard 2 Pollutant Air Emissions, 2007-2011

Pollutant Name	Emissions (Tons/Year)				
	2007	2008	2009	2010	2011
Sulfur dioxide (SO _x)	4,250	4,070	4,000	4,110	4,560
Total particulate matter (PM)	417	459	399	803	329
Particulate matter <10 micrometers (PM ₁₀)	245	313	264	637	142
Particulate matter <2.5 micrometers (PM _{2.5})	220	265	222	136	427
Carbon monoxide (CO) _a	76.2	673	40.7	44.6	125
Volatile organic compounds (VOCs) (Ozone Precursors)	16.1	65.3	4.88	4.88	4.60
Gaseous fluorides (as hydrogen fluoride)	12.7	12.2	12.2	12.2	12.3
Nitrogen dioxide (NO _x)	2,630	1,890	1,790	2,060	2,060
Lead (lead components)	0.0191	0.0267	0.034	0.0391	0.0166

^a Increase in CO emissions attributed to decreased combustion efficiency of D-Area Powerhouse facility

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 Effluents Monitoring Program

NPDES—SRS monitors nonradioactive liquid discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES), as mandated by the Clean Water Act. The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES permit program is administered by the State of South Carolina. SCDHEC has issued permits to SRS for discharges to the waters of the United States, including 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.

In 2011, 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 2011. SCDHEC reissued SCR000000, which covers 34 individual stormwater outfalls and became effective January 1, 2011.

NPDES samples are collected in the field according to 40 CFR 136 (“Guidelines Establishing Test Procedures for the Analysis of Pollutants”), 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.

Land Application—The sludge from the sanitary wastewater treatment facility is managed under the requirements contained in Permit ND0072125. Sludge generated at the facility is transferred from the

Table 4–2 2010 and 2011 Boiler Stack Test Results

Boiler ^a	Pollutant	Emission Rates lb/10 ⁶ BTU	lb/Hr
A Area Biomass Boiler	Particulate matter ^b	0.0052	0.306
	Sulfur dioxide ^b	0.0300	1.765
	Opacity ^d	Avg. 2.73%	
D Area Boiler #1	Particulate matter ^b	0.2598	113.28
	Sulfur dioxide ^b	1.52	413.83
	Opacity ^c	Avg. 13.7%	
D Area Boiler #2	Particulate matter ^b	0.258	86.89
	Sulfur dioxide ^b	1.17	336.13
	Opacity ^c	Avg. 13.2%	
D Area Boiler #3	Particulate matter ^b	0.5640	269.79
	Sulfur dioxide ^b	1.56	495.33
	Opacity ^c	Avg. 8.83%	
D Area Boiler #4	Particulate matter ^b	0.189	95.11
	Sulfur dioxide ^b	1.54	482.00
	Opacity ^c	Avg. 6.3%	

^a Boiler #1 source test October 22, 2010; Boiler #2 source test February 3, 2010; Boiler #3 source test May 27, 2011; Boiler #4 source test December 9, 2010

^b SCDHEC’s Title V permitted emission limits are 0.6 lb/million BTU for particulates and 3.5 lb/million BTU for sulfur dioxide.

^c Opacity limit 40%

^d Opacity limit 20%

activated sludge basin to the drying bed prior to the land application of the resulting biosolids. One application of approximately 102 cubic yards of the dried sludge was performed from November 29 through December 7, 2011. All sample results were within permit limits for metals and nutrients.



**Environmental Monitoring Field Technician
Records Data from a Flow Meter at an Industrial
Wastewater Outfall**

Monitoring Results Summary

SRS reports industrial wastewater analytical results to SCDHEC through a monthly discharge monitoring report (EPA Form 3320-1). Results of 5,176 sample analyses performed during 2011 indicated that no NPDES permit exceptions occurred. Data table 4-8 provides a compilation of industrial wastewater analytical data for 2011.

All industrial stormwater outfalls were monitored per the requirements of the permit. There were no noncompliances. Data table 4-9 provides a compilation of stormwater analytical data for 2011.