EPS 11-T1

Appendix EPS 11-T1
Environmental Monitoring Program

Introduction

This appendix presents the Environmental Monitoring Program at Jefferson Lab, and includes the program's purpose and objectives. It also reviews the general elements, activities, and regulatory requirements that make up the program.

Program Objectives

This program documents a comprehensive sitewide monitoring and surveillance plan for the purposes described in Chapter **6711** *Environmental Monitoring*.

To accomplish its purpose, the following program objectives have been identified.

- Meet regulatory requirements.
- Determine background and site contributions to radiation sources.
- Examine the effectiveness of effluent treatment and controls in reducing effluents and emissions.
- Examine the validity and effectiveness of models to predict the concentration of pollutants in the environment.
- Observe any long-term buildup and predict environmental trends from site-released radioactive material.
- Provide the means of detection and quantification of unplanned releases.

In addition to meeting program objectives, environmental monitoring shall also be conducted to:

- Demonstrate that applicable federal, state, and local effluent regulations and contractual requirements have been met.
- Operate in accordance with commitments made in Environmental Assessments or other official documents.
- Identify potential environmental problems and evaluate the need for remedial actions or mitigative measures.

Determining sampling frequency and type shall be based on specific facility needs. Sampling shall be conducted in a way that adequately characterizes effluent streams. Standard collection and analysis methods shall be used. Sampling guidelines and protocols are covered in *Appendix EPS 11-R1 Environmental Monitoring Procedures*.

Auditable monitoring records will be kept in accordance with the requirements of the Jefferson Lab Quality Assurance Program Manual.

General Program Elements

Jefferson Lab provides the capabilities to detect and quantify planned and unplanned releases of chemicals, oils, and radionuclides, consistent with the potential for off site impact, as well as to support consequence assessments as necessary.

Even for releasable effluents, monitoring may be necessary to determine volumes and concentrations of the effluent so release permits may be requested from the proper authority. Additionally, environmental monitoring may, over time, provide useful information about Jefferson Lab's operational performance.

Environmental monitoring is accomplished in two parts: effluent monitoring and environmental surveillance. This program is reviewed annually and updated every three years or more frequently as determined by ESH&Q Reporting. Quality assurance is also an integral part of the program. Quality assurance elements as they relate to the environmental monitoring program are covered in *Appendix EPS 11-T2 Environmental Monitoring QA Guidance*.

The potential for airborne or liquid releases is evaluated and documented in this program. Based on this documentation, effluent streams that do not have the potential for harmful releases need no further discussion. Effluent streams with the potential for environmental contamination shall be monitored in accordance with regulatory and program requirements.

The following subsections describe the components of the environmental monitoring program. The portion of the program involving radiological concerns is addressed in Chapter **6315** *Environmental Monitoring of Ionizing Radiation*.

Effluent Monitoring - Airborne

All airborne emissions are evaluated and their potential for release of harmful materials to the environment is assessed. Based on air emission calculations conducted by Jefferson Lab, the potential for the release of chemical air emissions in quantities that would trigger monitoring for these substances is very low. Therefore, chemical emissions monitoring for substances such as volatile organic compounds is not performed. See Chapter **6720** *Air Quality Management* for further information.

Jefferson Lab has not established a formal meteorological program to serve the site and does not directly monitor or collect any meteorological data. However, meteorological measurements are continuously monitored at Langley Air Force Base (LAFB), located approximately 7.5 miles southeast from the Jefferson Lab site. Since the topography in the surrounding area is flat and because of the close proximity of the base, measurements taken at LAFB are believed to be suitable for any Jefferson Lab requirements.

Airborne effluent monitoring is conducted to detect conventional air pollutants and airborne radioisotopes and to assess the possible effects of a potential release of activated air particles as a result of Jefferson Lab activities. For greater detail on radiological airborne effluent monitoring, including site boundary issues, refer to Chapter **6315** *Environmental Monitoring of Ionizing Radiation*.

Prior to making modifications to Jefferson Lab systems that produce airborne emissions (i.e., the cavity production process), or to facilities that could impact airborne emission quantities or quality (i.e., a change in heating fuel), or to the installation of any new facility with such a potential, the project shall be evaluated and the monitoring needs assessed.

NESHAP

The National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations set forth emission limits, as well as monitoring, recordkeeping, and operational requirements, for processes and activities generating emissions containing certain hazardous air pollutants. The standards for asbestos and radionuclides are the only two NESHAP standards that currently affect Jefferson Lab operations.

Asbestos activities

Asbestos removal on-site is done in strict accordance with the NESHAP regulations, per the Jefferson Lab Asbestos Management Plan. Refer to Chapter **6681** *Asbestos Management*.

Airborne radionuclide emissions

Airborne radionuclide emissions from Jefferson Lab are subject to provisions of 40 CFR 61 Subpart H and contractual requirements. This portion of the monitoring program is designed to conform with those regulations and requirements. Radionuclide emissions result from the radioactivation of air due to interactions of the accelerated electron beams (from CEBAF, the FEL, and other machines) with matter in the course of performing physics research.

The research program accelerates electrons up to 6 GeV and delivers the beam to three experimental areas. The accelerator delivers the electrons to stationary targets in each of the three experimental areas. The principal production of airborne radionuclides occurs unavoidably when the medium energy electron beams strike the targets in the end stations. These stations generally consist of a relatively thin target followed by a more massive beam absorber which stops most of the beam. The beam absorber is an aluminum and water assembly positioned downstream of the target station. The beam absorber collects the beam energy and contains the vast majority of radioactivity produced by the electron beam.

The air in the vicinity of these targets becomes radioactive for two reasons. First, the electron beam often traverses a small amount of air in interacting with the target, since it is impractical to operate some targets in vacuum. The interactions result in generation of radioactivity. Second, the electrons interacting with the target produce large numbers of “secondary” particles which are emitted in all directions (although primarily in the direction of beam travel) and hence produce activation in the air surrounding the target station.

The principal airborne radionuclides expected to be produced, shown with their half lifes, include the following: Ar-41 (2 hr. half life), Be-7 (53.1 days), C-11 (20 min.), Cl-38 (37 min.), Cl-39 (55 min.), H-3 (12.6 yr.), N-13 (9 min.), and O-15 (123 sec).

The regulatory limit [40 CFR §61.92] for annual effective dose to members of the public residing off site from airborne emissions is 10 mrem/year (0.1 mSv). The EPA limit for dose to the public from all sources of radiation is 100 mrem/year. The laboratory operations envelope, defined in the Final Safety Assessment Document, shows a level of 10 mrem/calendar year, but this value includes both airborne emissions and exposure from penetrating radiation. Refer to the Environmental Surveillance section of this appendix for information on penetrating radiation.

To comply with the EPA and to stay within Lab commitments, Jefferson Lab must demonstrate that any airborne emissions are under the EPA 10 mrem limit. This is a very small value to measure and Jefferson Lab uses an established practical method to establish our compliance status. This method requires that Jefferson Lab monitor the emissions as they leave a typical ventilation stack and then use the values to calculate the effective dose equivalent at off site locations using an approved computer program, CAP88-PC.

Measurements at receptor locations are rejected as being technically infeasible given the small effective dose equivalent off site. Calculated results are provided annually to the EPA and are documented in the annual Site Environmental Report (SER). The program for radiological issues is presented in Chapter **6315** *Environmental Monitoring of Ionizing Radiation*.

Conventional air emissions

Monitoring of conventional emissions shall be in accordance with the requirements of applicable federal, state, and local regulations authorized by the Clean Air Act. No operating permits are required by the USEPA or the Commonwealth of Virginia. Jefferson Lab is an insignificant source of air pollutants as documented in an Air Emission Report prepared on July 16, 1995. For additional information see Chapter **6720** *Air Quality Management*.

An annual emission report is submitted to the Virginia Department of Environmental Quality (DEQ). In previous years, the report presented all emissions from many activities at the laboratory. Most emissions were deemed insignificant, so information on those sources no longer needs to be submitted. Presently, only the calculated boiler emissions are submitted. No significant new sources of air emissions are expected. This information is also presented in the SER.

Effluent Monitoring - Liquid

The Jefferson Lab liquid effluent monitoring program monitors all potential releases of contaminated and radioactivated water to the environment. Here are the categories of liquid effluent streams routinely monitored at Jefferson Lab:

- industrial wastewater;
- activated water discharged to the sewer system;
- effluents from a groundwater withdrawal operation; and,
- cooling tower effluents and other occasional surface water discharges.

Each of these liquid effluent streams is discussed briefly below. References to ESH&Q manual chapters containing specific monitoring procedures or related management programs are also included.

Industrial wastewater effluents

The Jefferson Lab industrial wastewater discharge permit requires that the facility monitor liquid effluents discharged to the HRSD sewer system. Three subcategories of discharges are specifically monitored:

- general industrial discharges that include condenser and boiler water treatment activities;
- discharges from acid neutralization systems (Buildings 31 and 58); and,
- activated water discharges at Building 92.

HRSD requires that Jefferson Lab perform quarterly pH monitoring and monitoring for radioactivity at the cool sampling points in Bldgs. 92 and 97. There are also special wastestreams that are sampled and approved for discharge via the sanitary sewer. For more information on HRSD discharge proposals contact ESH&Q Reporting at ext. 7308.

Other Lab discharges to HRSD

- Discharges from Buildings 31(Acid Storage Building) and 58 (Test Lab) are routinely monitored for pH using online chart recorders under the control of designated chemical room staff.
- There are sources of water within the accelerator complex that either are or have the potential for becoming activated. Two of these sources, as covered in the HRSD permit, are the small quantities of beam dump cooling water and other miscellaneous effluents that are discharged through Building 92 and the moderate quantity of effluent from the floor drain sump pit at the Counting House. Note: A third potential source, the dewatered groundwater at the experimental halls, which discharges to the surface, is discussed in the next section.
- All cooling tower effluents not in the general VPDES permit.

HRSD performs periodic monitoring of pH, zinc, and cadmium. On an annual basis, HRSD collects a week-long series of composite samples for each area and analyzes these samples for parameters of concern. These usually include zinc, cadmium, copper, chromium, lead, nickel, silver, biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and phosphorous. The results are provided to appropriate Jefferson Lab staff for use.

Regulatory requirements

Federal

Discharges to the HRSD sewer system are also governed by the Clean Water Act. Conditions in the HRSD permit meet or exceed Clean Water Act requirements.

Local

The HRSD grants permits that allow facilities to discharge to the HRSD sewer system while adhering to conditions set by HRSD. Jefferson Lab is permitted to discharge under Industrial Wastewater Discharge Permit No. 0117, pursuant to the HRSD Industrial Wastewater Discharge Regulations. This permit calls for Jefferson Lab to perform self-monitoring and other responsibilities as described in *Appendix 6730-T1 Discharges to the Sanitary Sewer System*.

Groundwater effluents

Though CEBAF was designed and constructed with additional shielding at locations where prompt radiation had the greatest potential to affect groundwater, there remains a concern that induced radioactivity in groundwater could be transported across the site and eventually show up in off site surface waters.

This water quality concern is addressed at Jefferson Lab under two site permits.

- Permit to Withdraw Groundwater No. GW0047200, that covers withdrawal of the groundwater for dewatering; and,
- VPDES Permit No. VA0089320 that covers both the dewatering effluent and the groundwater moving slowly across the site.

These permits serve as a means to verify that CEBAF and FEL operations, along with other activities, do not degrade the quality of either on-site or off site groundwater. Note that the program for monitoring at the wells is presented in a following section entitled Effluent Surveillance.

Groundwater dewatering system

A groundwater dewatering system is used to remove groundwater at and near the three end stations in order to maintain their structural integrity. A gravity collection pit collects water from a shallow tile field below each end station. Three pumps within the pit are used to extract groundwater and discharge it to a surface drainage channel. The dewatering pit and tile fields are constructed in the water table aquifer.The discharge from the end station groundwater dewatering system has been monitored quarterly under the terms of the noted VPDES Permit (see the Environmental Surveillance section below).

The groundwater withdrawal permit grants the withdrawal of up to 7,074,000 gallons per year with a maximum withdrawal of 775,000 gallons per month. This permit requires tracking the quantity of water withdrawn.

Groundwater monitoring at the dewatering discharge

VPDES Permit No. VA0089320 requires groundwater discharge monitoring during normal operations. This permit requires sampling for pH, conductivity, total suspended solids (TSS), total dissolved solids (TDS), and the radionuclides: gross beta, tritium, manganese-54, sodium-22, and beryllium-7. A sample of the dewatered groundwater is collected on a quarterly basis from the collection pit located in the Counting House basement and analyzed for the parameters shown. The monitoring procedures for this activity are contained in *Appendix EPS 11-R1 Environmental Monitoring Procedures*.

Regulatory requirements

State requirements

The dewatering activities fall under the Groundwater Management Act of 1992 and the Ground Water Withdrawal Regulation (9 VAC 25-610-10 et. seq.) as administered by the DEQ.

Occasional surface water discharges

Water being handled under current activities and operations, including groundwater dewatering, does or could result in discharges to local surface waters. These discharges, current and potential, include:

- process water from the CHL cooling towers;
- sources of water within the accelerator complex, which can be mixtures of cooling water, condensate, stormwater, and groundwater, that could collect at sump pumps; and,
- accidental releases of materials, such as oil or chemicals, to the surface.

A primary surface water concern at Jefferson Lab is potential radiological contamination. The concern primarily stems from the fact that our surface waters eventually flow through to the Big Bethel reservoir, a local recreation area. A small portion on the west bound flow goes to Deep Creek and the James River.

A secondary concern is with other pollutants such as sediment, oil, and chemicals.

Discharges from Cooling Towers

Ongoing discharges to surface water channels from the small Test Lab tower and the CHL cooling towers are covered under VPDES general permit VAG250018. The discharges are monitored quarterly (if there is flow) and are sampled for the water quality indicators of temperature, pH, hardness, copper, zinc, and chlorine. Flow is also measured and reported.

Activated water management

Beam dump cooling water from the Hall A and Hall C high power beam dumps are discharged into the local sewer system as set forth in the Virginia Radiation Protection Regulations (12 VAC 5-480-4210). These regulations set the annual disposal limit at 5 curies (185 GBq). Water will be withdrawn from each dump system at a rate of about 25 gallons per day. The quantity pumped and the tritium levels will be recorded by a pumping-metering-scintillation device. The tritium concentration will be monitored before the water enters the sewer system and will

not be allowed to enter the sewer if the concentration is excessive. Also, a second sampling rig will take discrete proportional samples of each discharge. The annual quantities discharged will be tracked against the regulatory maximum of 5 curies per year.

Water collected by sump pits within the tunnels is either pumped directly to the surface or is collected in retention tanks and sampled prior to discharge to on-site surface waters. To provide information to estimate annual on-site and off site releases of radioactive effluents for annual reporting purposes, samples of water are taken routinely from sumps located within the accelerator ring and end stations. Sample sites are selected for their proximity to areas of potential soil radioactivation resulting from accelerator operations, such as target and beam dump locations and to other possible routes of radioactivation of surface waters, such as closed loop cooling systems. Generally speaking, sumps closest to areas of maximum soil activation are to be sampled most frequently for tritium and gross beta. The two sumps in the high power beam dump areas have dedicated sampling equipment.

Activated water that is discharged to the sewer system is described in an earlier section. A detailed description of the activated water management program for the accelerator cooling system and surface water discharges can be found in *Appendix 6730-T2 Activated Water Management*. Surface discharges by sumps outside of radiation areas are not monitored, unless specially requested.

Accidental Releases or Discharges

In the event of an accident or release of materials to the ground surface or to a surface water channel, sampling is performed to ensure that all clean-up has been effectively completed.

Laboratory staff are trained to report a release and notify the Chemical Assistance Team for assistance in containing a spill or release.

Regulatory requirements

Under the authority of the Clean Water Act, the EPA has promulgated regulations for monitoring liquid effluent discharges to surface waters. Section 402 of the Act establishes the National Pollutant Discharge Elimination System (NPDES) whereby the agency issues permits that control and limit the discharge of any pollutant to the waters of the United States. Federal regulations defining NPDES requirements for monitoring nonradioactive effluents are as follows.

- 40 CFR Part 123 “State Program Requirements”
- 40 CFR Part 124 “Procedures for Decision-making”
- 40 CFR Part 125 “Criteria and Standards for the National Pollutant Discharge Elimination System”
- 40 CFR Part 129 “Toxic Pollutant Effluent Standards”

This program is managed in Virginia under the VPDES program.

Environmental Surveillance

Past monitoring data from other facilities illustrates that the concentrations of radionuclides in environmental samples are detectable on-site near operating facilities and that they decrease with distance from the sources. Samples are collected and radiation is measured in areas that extend from on-site operating areas to the site boundary. Groundwater and surface water are sampled at locations near operating areas, along potential transport pathways, and at site locations far from potential contamination sources.

Groundwater

The only long term groundwater concern is the potential contamination from accelerator operations and physics programs. Thus, the surveillance of radionuclide activity is the primary focus, but other potential contaminants are also monitored.

The National Interim Primary Drinking Water Regulations of the Safe Drinking Water Act apply to the aquifers on the site. There are no drinking wells in the vicinity of the Jefferson Lab site that could require additional restrictions.

Jefferson Lab's commissioning, system testing, and operation of its accelerator to perform physics experiments, requires permitting due to the potential for production of certain radionuclides in the groundwater. Jefferson Lab's VPDES permit VA 0089320 regulates groundwater quality by placing limits on the radioactivity in the groundwater around the accelerator enclosure and experimental halls, an area that includes the FEL facility. Locations of concern are the beam dump areas, especially the two high-power beam dumps in Halls A and C, and the beam spreader and beam recombiner areas located at each end of the South Linac. The initial site permit was issued on June 16, 1989 and has been superseded by the current VPDES Permit No. VA0089320. As a condition of the original site permit, groundwater from specific monitoring wells has been sampled and analyzed to establish a baseline (preoperational) water quality characterization.

Jefferson Lab's groundwater protection strategies are documented in **EPS-31** *Groundwater Protection*.

Water samples taken routinely from permit-identified wells are analyzed for the radionuclides as presented in Chapter **6315** *Environmental Monitoring of Ionizing Radiation*. Current radiological environmental activities are discussed fully in that chapter and in *Appendix 6315-T1 Ionizing Radiation Monitoring Procedures*.

Monitoring under the VPDES Permit

The VPDES permit VA 0089320 requires that a total of 15 wells, including seven new wells, be sampled. The locations include one upgradient well, three A-ring wells, seven B-ring wells, and four C-ring or boundary wells. The groundwater levels at 30 on-site wells will be measured quarterly. The groundwater wells will be analyzed for nine water quality parameters, of which five are radionuclides. The A-ring wells will be sampled quarterly, the B-ring semi-annually, and the C-ring and upgradient wells shall be sampled annually.

The samples acquired will be analyzed for the parameters shown in Table 1.

Table 1: Groundwater Sample Variables

Gross Beta	Beryllium-7	Conductivity
Tritium	Manganese-54	Total Suspended Solids
Sodium-22	pH	Total Dissolved Solids

Refer to *Appendix 6315-T1 Ionizing Radiation Monitoring Procedures* for monitoring procedures and specifics.

Action levels (where mitigation measures must be considered) have been established by the permit for the A wells and B wells as shown below. The C wells shall be monitored to ensure they do not exceed the background levels established during baseline monitoring, which are:

- Tritium 5000 pCi/l (picocuries per liter)
- Man-made Radioactivity 1 mrem/yr (millirems per year)

Wells to be monitored under the VPDES Permit are presented in Table 5 in *Appendix 6315-T1 Ionizing Radiation Monitoring Procedures*.

Surface water

Although radionuclides associated with Jefferson Lab operations may be routinely identified in sumps discharging into local surface drainage channels, concentrations are well below applicable standards and will likely remain undetectable in the channel and creek sampling locations. Samples are taken periodically from storm channels on-site including locations where creeks enter and exit the site. These samples will be analyzed for accelerator-produced radionuclides (such as H-3, Be-7, Na-22, and Mn-54).

Soil

Radioactivation of soil can occur near the primary beam targeting and dump areas. However, accelerator operations have a minimal, non-measurable effect on soil because beamline designs incorporate massive steel and concrete shields within beam enclosures to minimize local soil radioactivation. Although there is no regulatory requirement to monitor soil at Jefferson Lab, samples of soil are collected as determined necessary by RadCon. Radiation is measured to determine the effectiveness of effluent controls and to ascertain any build-up of radioactive materials from long-term operations.

Sampling and analyzing soil is useful in determining the accumulated amounts of long-lived radioactive contaminants and stable contaminants that deposit on the ground or within sediments. The critical factors necessary to provide this information are sampling location, time of sampling, frequency of sampling, sample size, and maintenance of the integrity of the sample prior to analysis.

Radiochemicals

Soil/sediment shall be sampled periodically by RadCon to determine and to document the radiochemical composition around selected air and water discharge points at Jefferson Lab. These sample sites shall be selected according to their proximity to active operational areas or site boundary discharges. Every effort shall be made to select sampling plots and individual sample cuts that are as homogeneous as possible, avoiding tilled areas or areas of unusual wind influence.

An assessment of the environmental impact from operations will be done by comparing results with baseline values. Comparison of results in this manner provides an indication of trends or increases in the concentration of contaminants in the environment attributable to Jefferson Lab operations.

Chemical and oil spills

Monitoring would be performed as a follow-up activity to ensure adequate remediation for any chemical or oil spill on the ground surface.

Pesticides and herbicides

Pesticides are used on the site to control weeds and insects. These pesticides are applied by personnel licensed by the State. Sampling of neighboring creeks, channels, and adjacent areas is conducted if contaminated runoff is suspected.

Penetrating radiation

The earlier NESHAP section also addresses this topic. Dose estimates when the concentrations are too low to be detected by surveillance are calculated using data from effluent measurement.

Operation of the accelerator will inevitably result in producing some penetrating radiation (primarily neutrons and muons) outside of the accelerator shielding. Although the shielding has been designed to be adequate for foreseeable routine circumstances, there are some locations (usually in the experimental areas) which are thinly shielded and which rely on radiation-activated interlocks for personnel protection. In either case, monitoring for purposes of determining actual radiation levels is necessary. A network of monitors are used to monitor penetrating radiation (e.g., environmental TLDs and data loggers). Refer to Chapter **6315** *Environmental Monitoring of Ionizing Radiation*.

Applicable Permits, Reports, Regulations, and Other Documents

Table 2: Applicable Permits and Reports

Jefferson Lab Documents	Master Record	Location
Jefferson Lab Radiological Control Manual	RadCon Group	ARC, Room 301
Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0089320	ESH&Q Reporting	ARC, Room 340
VPDES Permit No. 253002	ESH&Q Reporting	ARC, Room 340
Radiation Control Group Tech Notes 92-009, 93-016	RadCon Group	ARC, Room 500-20

Table 3: Applicable Regulations and Other Documents

Document	Master Record	Location
National Primary Drinking Water Regulations (40 CFR Part 141)	ESH&Q Reporting	ARC, Room 340
National Secondary Drinking Water Regulations (40 CFR Part 143)	ESH&Q Reporting	ARC, Room 340
Virginia Department of Health, Radiation Protection Regulations, 1988	ESH&Q Reporting	ARC, Room 340