# Jefferson Lab's 2007 Site Environmental Report

Aerial view of the Continuous Electron Beam Accelerator Facility at Jefferson Lab

JSA Jefferson Lab

Thomas Jefferson National Accelerator Facility (Jefferson Lab) is managed by Jefferson Science Associates, LLC for the U.S. Department of Energy Office of Science
www.jlab.org • 757.269.7100 • Jefferson Lab, 12000 Jefferson Avenue, Newport News, VA 23606

Thomas Jefferson National Accelerator Facility
U.S. Department of Energy
12000 Jefferson Avenue
Newport News, VA 23606

# The Thomas Jefferson National Accelerator Facility
# SITE ENVIRONMENTAL REPORT
# For Calendar Year 2007

Prepared by:
ESH&Q Division
Jefferson Science Associates, LLC
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**TJNAF'S SITE ENVIRONMENTAL REPORT**
**FOR CALENDAR YEAR 2007**

## EXECUTIVE SUMMARY

The purpose of this annual report is to document the U.S. Department of Energy's (DOE) Thomas Jefferson National Accelerator Facility (TJNAF or Jefferson Lab) active environmental protection program and its performance in 2007. This report presents the results of environmental activities and monitoring programs that are within the scope of Jefferson Lab's EMS (environmental management system). The report provides the DOE and the public with information on radioactive and non-radioactive pollutants, if any, added to the environment as a result of Lab operations.

Jefferson Lab is managed and operated for the DOE by Jefferson Science Associates, LLC (JSA), which is a joint venture of the Southeastern Universities Research Association, Inc. (SURA) and Computer Sciences Corporation.

### *Major Scientific and Research Programs*

TJNAF's main purpose is to make available a research facility to support the nuclear physics community and the nation.

> ***The Continuous Electron Beam Accelerator Facility (CEBAF) at TJNAF provides an electron beam to three experimental halls, where a variety of basic physics experiments are conducted.***

*CEBAF* At CEBAF, the electron beam begins its first orbit at the injector and proceeds through the underground racetrack-shaped accelerator tunnel at nearly the speed of light. The accelerator uses superconducting radio frequency (SRF) technology to drive electrons to higher and higher energies. The accelerator's electron beam can be split for simultaneous use by the three experimental halls, which are circular, partially buried domed chambers. Special equipment in each hall records the interactions between incoming electrons and the target materials. A continuous electron beam is necessary to accumulate data at an efficient rate yet ensures that each interaction is separate enough to be fully observed.

***Work continued on a planned upgrade of CEBAF***, doubling the beam energy from 6 GeV (Giga-electron Volts) to 12 GeV, making improvements to the experimental apparatus in the three existing experimental halls, and building a fourth hall to serve as another research

tool. TJNAF reached a significant milestone for the project in November 2007, when the DOE authorized the final design phase of the project to begin.

*FEL* The Free-Electron Laser (FEL) supports basic science research and serves universities, private industry, NASA (the National Aeronautics and Space Administration), the U.S. Navy, the U.S. Air Force, and the U.S. Army. Designed and built with TJNAF's expertise in SRF accelerator technology, the FEL provides intense, powerful beams of laser light that can be tuned to a precise wavelength or color. ***The FEL is the most powerful tunable laser in the world*** and has produced well beyond its design level of 10 kilowatts (kW) average power. It attained a record 14.2 kW at a wavelength of 1.61 microns on October 30, 2006, an important wavelength for both the optimal transmission of laser light through the atmosphere and for materials processing. The FEL also holds the world's record in generating terahertz wavelengths.

*Research Areas* Staff and visiting scientists continued using TJNAF's Center for Advanced Studies of Accelerators (CASA), the Institute for SRF Science and Technology, and the Lattice Quantum Chromodynamics (LQCD) Computing Project to perform research and development (R&D) programs to lead the world in both SRF and energy-recovering linac technologies. This research also provides technology and associated experience for the construction of new accelerators for DOE Office of Science research projects at other laboratories in nuclear physics, basic energy sciences, and possibly high energy physics.

### *The "E" in Environment, Safety, and Health (ES&H)*

Ultimate responsibility for protection of the environment and public health rests with the Lab Director, while line management implements identified objectives within their areas of responsibility. ES&H staff situated within both the line organizations and in the Environmental, Safety, Health, and Quality (ESH&Q) Division provides support to line management and share their expertise with the Lab as a whole. TJNAF's ES&H program is implemented in numerous ways.

*Integrated Safety Management (ISM) System* Through ISM, TJNAF incorporates ES&H requirements into all work procedures. The primary objective of ISM is to make safety, health, and environmental protection a part of routine work at TJNAF.

*Environmental Management System (EMS)* Since its inception, TJNAF has had an environmental protection program. The Lab's EMS was formally recognized by the Department of Energy in December 2005 and is a part of the Lab's broader ISMS.

*Work Smart Standards (WSS) Process* The goal of the WSS process is to provide a means to implement ES&H in a manner that is both effective and cost-efficient. The WSS Set is comprised of the laws, regulations, and standards necessary and sufficient to ensure worker and public health and safety, and to protect the environment.

*Implementation of the National Environmental Policy Act (NEPA)* Most facility construction activities and all accelerator upgrades are subject to review under the NEPA. The initial TJNAF construction, two upgrades to CEBAF, and some major new buildings have been the subject of Environmental Assessments (EAs). An EA published in January 2007 focused on both the planned 12 GeV CEBAF upgrade and other activities identified in the Lab's Ten-Year Master Plan. Routine Lab activities and special projects are usually covered under site-specific NEPA Categorical Exclusions (CXs).

*Radiological and nonradiological releases to the public from site operations* ***There were no unusual radiological or nonradiological releases to the public due to accelerator operations during the year.*** Releases from normal operations, such as cooling tower waters discharged to the surface, were within permit and regulatory limits and had very minor impact to the public and no health or safety implications.

*ESH&Q Performance Measures* The DOE/JSA contract-based measures are used to evaluate TJNAF's ES&H performance. The fiscal year 2007 measures included avoiding exceeding any permit limits and performing a causal analysis for any incident. Also addressed are metrics involving worker safety and health. The Lab received an excellent "A-" rating in ES&H. Environmental performance received an "A" rating, due in part to the benefits of Jefferson Lab cryogenic improvements* that won a White House Closing the Circle award in 2007.

*Inspections* TJNAF's commitment to protection of the environment, public health, and safety are demonstrated through its inspection programs. Both key Lab staff and external agencies, including the local sanitation district and DOE Site Office staff, conduct inspections to ensure operations and activities at TJNAF are being performed effectively. Inspection results, including detailed comments on the Lab's record of compliance with applicable laws and regulations, are provided in this report.

*Awards and Recognitions* The Lab received a gold award for pretreatment excellence for CY2007 from the local sanitation district. The Lab also applied for inclusion in the Virginia Environmental Excellence Program in 2007, and the Lab passed the final hurdle for acceptance when the Virginia Department of Environmental Quality visited the site on December 21, 2007.

* An innovative helium refrigeration process that substantially reduces the amount of electricity and cooling water required (by as much as 35 to 45 percent), was developed and demonstrated. At TJNAF, costs of approximately $1,000 per day can be avoided by fully integrating this process. As of 2006, the process was already being put into practice both at other DOE facilities and in general industry.

### *General Compliance*

***TJNAF complied with all applicable Federal, State, and local environmental laws and regulations, and DOE guidance, during 2007. As a result, TJNAF operations had no discernable impact on public health or the environment.***

The Lab's environmental compliance performance is detailed in Section 2 of this report. Radiation-related issues, especially those dealing with water resources and public health, are highlighted in Section 3. Non-radiological environmental issues, such as water sampling and monitoring, are addressed throughout this report. The TJNAF ES&H Manual, which covers many environmental topics, including the WSS Set, facilitates integration of new environmental compliance initiatives into site operations.

### *Special Item: Eco-Friendly Cluster Computer*

A supercomputer, dubbed 7N, runs powerful computer simulations to shed light on how one of the basic forces of nature, the strong force, builds protons, neutrons and other particles from the basic building blocks of matter: quarks and gluons. 7N is a cluster of individual units wired together to function as one. Each of the 396 nodes contains two Advanced Micro Devices (AMD) quad-core 1.9 GHz (gigahertz) processors with four Gigabytes (GB) of onboard random access memory (RAM). The switch from dual-core systems to quad cores produced a more eco-friendly cluster. ***The cluster consumes about 20 percent less power than it would have had it been assembled with dual cores.*** Besides winning a DOE Best in Class pollution prevention award, the cluster qualified for the TOP500 Supercomputer Sites list by successfully running the Linpack Benchmark, a calculation used as a yardstick for supercomputer performance.

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# SECTION 1
# INTRODUCTION

## *1.1 PURPOSE OF THIS REPORT*

The U.S. Department of Energy (DOE) requires its facilities to establish and annually report on environmental programs and performance. This report summarizes the status and results of the Lab's environmental protection (EP) program, including public health results, for calendar year (CY) 2007. It serves to inform TJNAF staff, DOE, regulators, and the public about site environmental performance, and provides a historical record of particular items of interest or concern.

The SER is available in a viewable, downloadable pdf file. The CY 2007 SER, along with the earlier reports, can be found by going to TJNAF's web page at http://www.jlab.org/ehs/ser/.

***This document marks the 14th year that Thomas Jefferson National Accelerator Facility (TJNAF) prepared a Site Environmental Report (SER).***

## *1.2 LABORATORY MISSION*

TJNAF is a national accelerator facility managed and operated over the course of 2007 by Jefferson Science Associates, LLC (JSA) for the DOE. The accelerator complex portion of the Lab includes an underground electron accelerator, the Continuous Electron Beam Accelerator Facility (CEBAF), which is TJNAF's primary research tool. CEBAF operates at energies up to about 6 GeV (Giga (billion) electron volts) and provides beam to three underground halls that house physics program experiments. ***The CEBAF accelerator is used to conduct physics user driven research into how nucleons are built from quarks and gluons, and how this structure leads to the standard nucleon-based picture of the nucleus.***

TJNAF's basic mission is to provide forefront scientific facilities, opportunities, and leadership essential for discovering the fundamental nature of nuclear matter; to partner with industry to apply its advanced technology; and to serve the nation and its communities through education and public outreach, all with uncompromising excellence in environment, safety, and health.

## *1.3 SITE OPERATIONS*

As a world-class research institution, TJNAF attracts resident and visiting physicists and other scientists. ***Approximately 630 full-time physicists, engineers, technicians, and support staff work at the Lab.*** More than 1,200 academic and industrial researchers from across the United States and from approximately 30 countries and 187 institutions participate in scientific collaborations at TJNAF. Since TJNAF first began running experiments with CEBAF in 1994, data have been gathered for 138 experiments, and partial data have been gathered on another thirteen experiments. TJNAF research has been the basis for the theses of 25 to 30 percent of all new U.S. nuclear physics Ph.D.s each year for the last several years. The Lab has thus far produced more than 240 patent disclosures. Of those, 153 were submitted for patents from which seventy-five (75) had been granted by the end of 2007. There are six major facilities and program areas on the DOE site:

- ***CEBAF***, a superconducting radio frequency (SRF) electron accelerator;
- ***End Stations A, B, and C*** (large halls that house physics experiments), which make use of beams from CEBAF;
- the ***Institute for SRF Science and Technology***, which serves primarily as an R&D (research and development) center for SRF accelerator cavities;
- the ***Center for Advanced Studies of Accelerators (CASA)***, which supports the site accelerators and evaluates future opportunities;
- a ***Free-Electron Laser (FEL)*** User Facility, which produces laser beams to serve university, industry, and military partners; and
- a ***Lattice Quantum Chromodynamics (LQCD) Computer***, a 1/4 Teraflop commodity-PC-based machine.

The facility's buildings and end stations are depicted on Figure 1.1, a site map of Jefferson Lab.


Sign at Main Entrance to TJNAF

## *1.4 SITE HISTORY AND DESCRIPTION*

Prior to the construction of TJNAF, there were several occupants of this general area of Newport News. The ***U.S. Department of Defense (DOD) acquired most of the Oyster Point area***, including the land presently used by TJNAF. The U.S. Air Force later acquired the land and installed a Bomarc missile site on a portion of the property. After closure of the Bomarc site, the DOD started disposing of the property and conveyed some land to the Commonwealth of Virginia, the National Aeronautics and Space Administration (NASA), and others. Ownership of the NASA property, including 100 acres of undeveloped land, was conveyed to the DOE in 1987. An additional 52 acres of land was also transferred to the DOE from other sources. The total DOE-owned parcel upon which TJNAF is built is 163 acres.

In 1986, an adjacent 44 acres were conveyed to SURA by the City of Newport News. A SURA residence facility is located on a portion of this land. Adjacent to this property is the former Bomarc site. During 2007, approximately seven acres of SURA land were conveyed to DOE, for a total 170 acres. The land transfer will support the building of a new experimental hall, which is part of the CEBAF 12 GeV Upgrade.

Also adjacent to the DOE-owned site is a 10.7-acre parcel owned by the Commonwealth of Virginia and leased to the City of Newport News. The Applied Research Center (ARC) is located on this property and is used by TJNAF, industry, and universities. Other adjacent land owned by the Commonwealth of Virginia is leased to JSA and the DOE for use in support of Lab operations. This area, the DOE-owned site, and other nearby properties are considered part of the City's Jefferson Center for Research and Technology.

## *1.5 FACILITIES AND 2007 ACTIVITIES*

The 170-acre DOE site is primarily divided into ***two main areas***. One includes R&D labs, fabrication facilities, and administrative offices and is referred to as ***the campus***. The second is about a 40-acre fenced area, termed ***the accelerator site***, where the CEBAF and FEL accelerators and related structures that accommodate experiment support functions are located. The accelerator site is located on the south end of the DOE property, and right of entry is restricted to one access-controlled entrance. The front view of the main administration building, CEBAF Center, located on the campus, is shown in the photo preceding this text.

**Facilities**

There are four major facilities that have more than minimal environmental protection or public health-related implications. They are CEBAF, its experimental halls (End Stations), the SRF Facility, and the FEL User Facility. A short description of each follows. Factors involving these facilities and other activities that have potential environmental implications, such as the use of chemicals and oil products, are discussed elsewhere in the report.

*CEBAF* This accelerator provides continuous wave electron beams with energies of 0.5 to 5.7 GeV. CEBAF is used as a tool for exploring the transition area or range where strongly interacting (nuclear) matter can be understood as bound states of protons and neutrons, and the regime where the underlying fundamental quark-and-gluon structure of matter is evident. The nature of this transition is at the frontier of our understanding of matter.

*End Stations (Halls A, B, and C)* Each hall (or end station) has its own set of complementary experimental equipment. Hall A has a pair of superconducting, high-resolution magnetic spectrometers optimized for precision electron scattering coincidence experiments. The CEBAF Large Acceptance Spectrometer (CLAS), which supports studies of both electron- and photon- induced reactions, is housed in Hall B. The third end station, Hall C, contains a pair of moderate resolution spectrometers, with one capable of high momentum particle detection, and the second optimized for the detection of short-lived reaction products.

*The SRF Facility* The SRF Facility houses or refers to the Lab's Institute for SRF Science and Technology. The Institute's strength is in R&D and large-scale applications of SRF, including improvements to CEBAF and the FEL. The Applied Research Center (ARC) also contributes to state-of-the-art surface science and SRF R&D to improve accelerator capabilities.

*FEL User Facility* The FEL is an accelerator that was initially designed to provide 1,000 watts (1 kilowatt (kW)) of infrared (IR) light with picosecond pulse length for use by TJNAF, industrial, DOD, and university partners. The accelerator has since been upgraded, to operate from 1,000 watts of ultraviolet (UV) light to 10,000 watts (10 kW) of IR light. The ARC also supports FEL research.

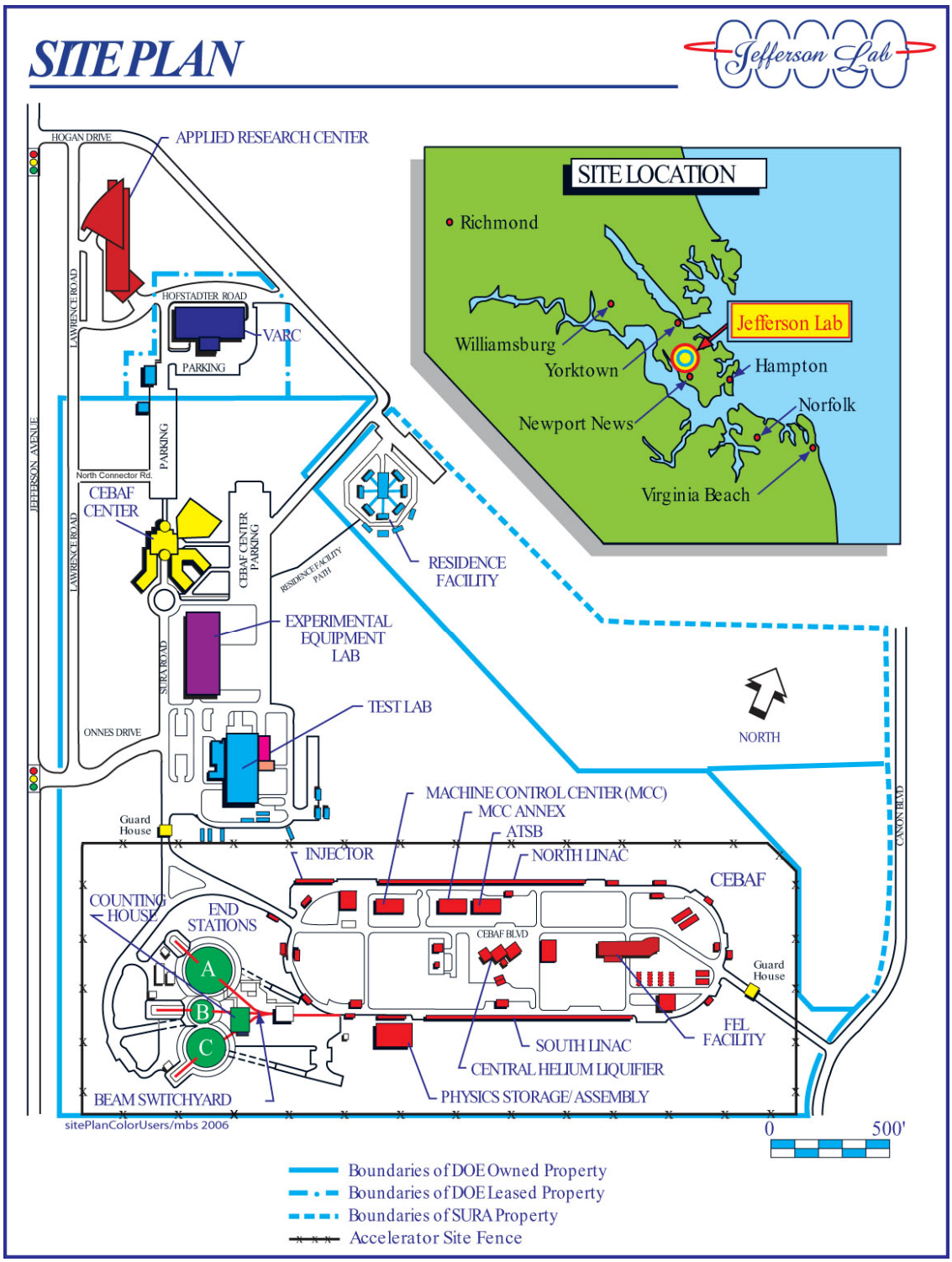
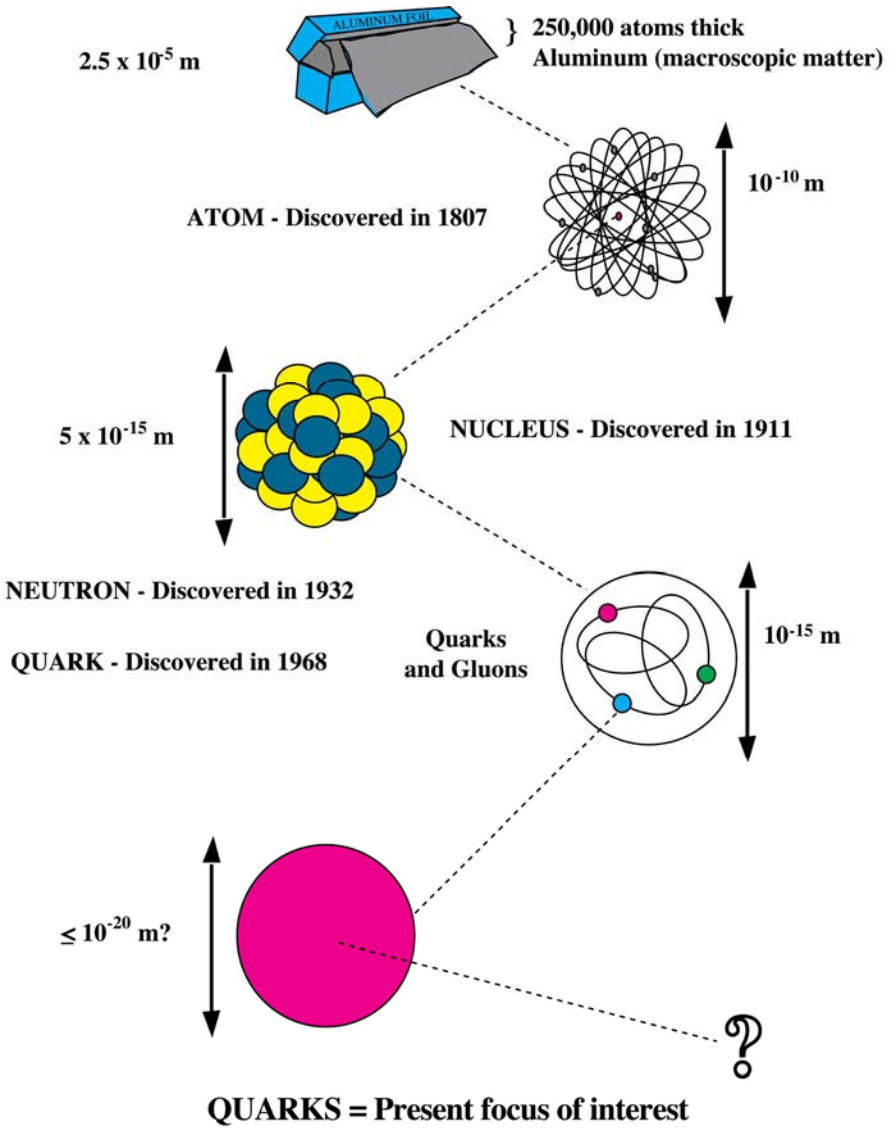



**Figure 1.1**
**Site Map**




**Achievements and Future Planning**

The FEL, unparalleled in its capability as a light source, is opening up new applications in national security, materials science, photobiology, photochemistry, and high sensitivity spectroscopy. These applications hold such exciting research potential that the TJNAF FEL is being replicated at a number of institutions.

Progress on the proposed upgrade of CEBAF to 12 GeV continued in 2007. This upgrade in electron beam energy levels, improved equipment in the three existing experimental halls,

and a future experimental hall, Hall D, will support experiments that test the strong force that holds atomic particles together.

## *1.6 ENVIRONMENT, SAFETY, AND HEALTH*

**Environmental Review**

An environmental assessment (EA), performed as required by the National Environmental Policy Act (NEPA), prior to the construction of the original CEBAF project, yielded a Finding of No Significant Impact (FONSI). In 1997 and 2002, EAs of a CEBAF upgrade, an FEL upgrade, and five building construction projects also yielded FONSIs. Existing NEPA-related documentation is periodically reviewed. In April of 2005, the DOE prepared an Environmental Assessment Determination Proposal associated with upgrades and operation of the CEBAF and FEL accelerators, and construction and use of buildings associated with the TJNAF's 2005 Ten Year Site Plan, and the 12 GeV CEBAF Upgrade. DOE/EA-1534 was prepared and resulted in a FONSI in January 2007. Consequently, an Environmental Impact Statement was not required for the construction projects and accelerator upgrades and operations reviewed.

**ES&H Resources**

To ensure that staff, employees, subcontractors, and users implement ES&H principles, ES&H responsibilities are incorporated into each position description. The facility makes available to every employee, user, and visitor, a variety of ES&H resources to ensure everyone on site is fully informed. Local resources include: 1) ES&H staff who support specific line organizations; 2) ESH&Q program specialists who serve the entire facility in their area of expertise; 3) groups and committees that address Lab-wide concerns, develop policy, and resolve problems; and, 4) the TJNAF ES&H Manual, the primary source of ES&H implementing procedures. Other ES&H resources provided to program managers include: DOE subject matter experts; DOE program specialists who deal with policy issues at all levels; and colleagues at other DOE facilities who share expertise and lessons learned from their own unique experiences.

## SECTION 2
## ENVIRONMENTAL PROTECTION PROGRAM

There are many facets to TJNAF's Environmental Protection (EP) program. As stated in Section 1, the Lab's mission, along with worker health and safety, includes protection of the environment and public health. Various controls, such as the Lab's Integrated Safety Management (ISM) System, including the Environmental Management System (EMS), were used in 2007 in fulfillment of the EP mission.

***The Lab was not cited for any administrative or technical environmental protection program violations during 2007.***

The site's EP program provides guidance and requirements for implementing environmental programs, for making environmentally preferable choices, and for the review of performance through assessments and inspections. Compliance with applicable EP and public health-related laws and regulations is required in Lab work procedures.

### *2.1 ENVIRONMENTAL MANAGEMENT SYSTEM*

The Lab's EMS contains management-level programs that provide direction to the Lab on activities that could affect the environment. The EMS includes an organizational structure, planning activities, responsibilities, procedures, processes, and resources for developing, integrating, achieving, reviewing, and maintaining the environmental commitments made in the Lab's Safety, Health and Environmental Protection Policy.

The DOE formally recognized the Lab's EMS in December 2005. The EMS serves within the framework of the Lab's previously-established ISM System. The objective of ISM is to make safety, health, and environmental protection a routine part of performing work at TJNAF. ***The EMS is based on International Organization of Standardization (ISO) 14001 and DOE Order 450.1, Environmental Protection Program.*** In 2007, elements of the EMS continued to be incorporated into existing site documents, such as the Lab's ES&H Manual and workplace standard operating procedures (SOPs).

**Safety, Health and Environmental Protection Policy**
TJNAF's policy reflects the current ES&H commitments to the Lab population (staff, users, and visitors) and to local community neighbors.

A portion of TJNAF's ES&H Policy follows:

> "Jefferson Lab considers no activity to be so urgent or important that we will compromise our standards for environmental protection, safety, or health. It is Jefferson Lab's policy to identify and meet all applicable ES&H laws, regulations, standards, and our contractual commitments to the Department of Energy…"
>
> Christoph Leemann, TJNAF Director
> July 2006

**Environmental Planning and Analysis Procedures**

Environmental planning and analysis are accomplished by documenting and reviewing EMS aspects of projects and activities in light of NEPA and other laws, regulations, and contract requirements. Line management is responsible for providing notification of actions and impacts of new activities to the ESH&Q Division's environmental staff for review and authorization as applicable. TJNAF provides appropriate ES&H and quality requirements, through contract provisions, to its subcontractors. These documents typically contain environmental requirements and the associated mitigation measures in the event problems arise.

**Environmental Objectives and Targets**

The Lab operates within the DOE/JSA contractual requirements, including compliance with environmental conditions specified in permits. As TJNAF implements its EMS, environmental objectives and targets that would improve site programs, including those that would enhance the Lab's focus on pollution prevention (P2) efforts, are identified and implemented.

The Lab develops Target Implementation Plans (TIPs) under its EMS. A TIP is a plan developed to address an environmental objective or target. One active TIP, for example, enabled the Lab to improve management of the minor accelerator-related radioactivity in sump water discharges under the Lab's industrial wastewater discharge permit.

**Implementation and Operations Controls**

The DOE/JSA contract and environmental permits define the environmental protection terms and conditions for the operation and performance of TJNAF. ISM (including environmental protection) roles, responsibilities, and implementation procedures are implemented by the Lab's ES&H Manual. EMS awareness training for Lab staff continued in 2007. Lab management also provided EMS awareness training to subcontractors and visiting scientific users during 2007.

**Identification of Environmental Aspects and Impacts**
The Lab updated the EMS aspect identification process in 2007. The primary environmental aspects are water quality and resource conservation issues that reflect the demand for electricity and water to operate a particle accelerator.

**Performance Measurement**
Reviews of contract performance measure results are made on a regular basis for various topical areas, including ES&H. The Lab's performance at meeting measurable objectives, including best management practices (BMPs) implemented under the general site storm water permit, was reviewed in 2007. The Lab's overall EMS implementation progress was measured via a Jefferson Lab management self-assessment.

**Corrective Action and Self-Assessment Procedures**
In 2007, the Lab continued to work on the opportunities for improvement identified in the EMS management audit/assessment conducted in September 2006. One other program assessment was made in FY07. No findings were recorded, but opportunities for improvement were noted and are being tracked.

**Management Review Process**
The Director's Safety Council, comprised of senior management, reviews the ISM System Program Description periodically. An annual EMS management review measures progress made over the previous year, identifies improvements that are needed, and identifies issues that need further attention. The 2007 EMS Review concluded that the Lab's EMS program was effective; identified no major gaps in ISO or DOE Order compliance; and confirmed that all program elements were being addressed. This review was categorized as a management self assessment and minor opportunities for improvement are being tracked.

## *2.2 MAJOR ENVIRONMENTAL PROTECTION PROGRAMS*

### 2.2.1 Environmental Monitoring Program

***Environmental monitoring is one of the primary methods the Lab uses to assess environmental conditions.*** The Lab conducts monitoring to: verify compliance with applicable regulations and other requirements; evaluate the Lab's impact on the environment and public health; identify potential environmental problems; provide data as required by permits and to support management decisions; and evaluate the need for remedial actions or mitigative measures.

The site program implements guidelines for assessing the impact of environmentally harmful materials such as chemicals, oils, and radioactive materials that are present at the

facility. An integral part of the program is routine sampling and tracking of air emissions, wastewater, and groundwater. These are monitored to ensure that environmental releases, if any, are within applicable permit or other regulatory limits.

Both permit-required and routine monitoring practices center on the potential environmental exposure pathways associated with medium-energy particle physics laboratories. These pathways include personnel exposure to external and internal radiation, a major focus of the site's monitoring program. The Lab has programs to assess any on-site and offsite radiation. Refer to Section 3 for a discussion on radiation exposure potentials.

Standard sample collection and analysis methods are documented in program and departmental procedures. Routine environmental monitoring is performed under the direction of responsible line management and is overseen by the Lab's ESH&Q Division's environmental staff. General program information is provided below.

**Monitoring Water Conditions**

Both ground and surface water quality protection are high priorities at TJNAF. Protecting groundwater quality is important due to the potential for groundwater activation from the underground CEBAF accelerator. Surface water pollution is another general concern as a consequence of normal site activities and civil construction projects.

Rain Garden at TJNAF

Standards used to protect water quality include Virginia regulations, the Clean Water Act (CWA), and others identified in the Lab's Work Smart Standards (WSS) Set. TJNAF complies with all requirements and performs monitoring under applicable water quality permits. ***The Lab held five active water permits in 2007: one for groundwater quality, two for surface storm water quality, one for dewatering groundwater, and one for industrial sanitary wastewater discharges.***

Groundwater quality is maintained during operations through use of controls such as shielding and other measures. Surface water quality is maintained by discharging only unpolluted waters, such as rainwater, permitted cooling tower effluent, and groundwater. Operational control measures include minimizing the use and storage of products that could pollute ground and surface water. All environmental permit conditions were met in 2007. Other site water quality programs that do not involve monitoring are also important and are described in Section 2.2.2.

Information on general water quality parameters is included in the rest of Section 2.2, and radiological information is presented in Section 3.

**Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA 0089320**

Facilities in Virginia that directly discharge to waters of the United States must obtain a VPDES Permit, which satisfies Federal National Pollutant Discharge Elimination System requirements. The Virginia program is designed to protect surface waters by limiting primarily non-radiological releases into streams, lakes, and other waters, including wetlands. This site permit administered by the Virginia Department of Environmental Quality (DEQ), covers: the groundwater present in identified monitoring wells; groundwater withdrawn at the end stations and pumped to the surface; and effluent from one cooling tower.

**Groundwater**

This coverage includes the groundwater flowing across the site, including groundwater that is discharged to the surface in a dewatering operation to prevent damage to the experiment apparatus in the partially buried experimental halls (also referred to as end stations).

Groundwater monitoring for both non-radiological and radiological contamination is performed at fifteen monitoring wells and at the groundwater dewatering collection point. Reports for wells are provided on a quarterly, semi-annual, or annual basis. The wells and groundwater samples are tested for general water quality parameters of pH, conductivity, and total dissolved solids (TDS). Monitoring for radioactivity is discussed in Section 3.

Because of the potential for activation of groundwater from accelerator operations, baseline water quality values were obtained prior to accelerator operation. The present well monitoring program enables the comparison of current and baseline values to verify that TJNAF site activities are not degrading the quality of local groundwater.

***Non-radiological and radiological sampling data collected in 2007 are consistent with previous baseline measurements.***

**Cooling Water Discharge Monitoring**

This cooling water is effluent from the CHL (Central Helium Liquefier) Building (Building 8) cooling towers. Quarterly sampling was performed and flow information as well as sampling results for pH, temperature, ammonia, total hardness, total dissolved copper, total dissolved zinc, and total residual chlorine were reported. The permit stipulates a very low chlorine limit of 0.019 mg/l (milligrams/liter), a level at which no acceptable analytical techniques exist. According to the DEQ, the lowest quantification level recognized by the DEQ, 0.1 mg/l, remains satisfactory for reporting and permit compliance. The products that TJNAF uses for cooling water treatment are approved by the DEQ.

**Hampton Roads Sanitation District Permit No. 0117**

Facilities in Virginia that discharge to the Hampton Roads Sanitation District (HRSD) must obtain an industrial wastewater discharge permit. The HRSD program is designed to fulfill all Virginia effluent limits. Standard industrial wastewater, cooling tower effluent for all but the Building 8 tower mentioned earlier, and a small quantity of activated water are authorized for release per permit conditions.

HRSD conducted an inspection on March 14, 2007. The inspection covered several TJNAF buildings and a review of monthly and quarterly records. No problems were found that required any response to HRSD. ***TJNAF received a Gold pretreatment excellence award for its 2007 performance.***

To meet monitoring requirements, TJNAF performs monthly sampling at two sanitary sewer outflow streams to verify that pH levels are within permit limits. Besides the discharges noted above, there are three special discharges to the sanitary sewer system. TJNAF has three elementary neutralization systems that record pH information electronically and have built in safeguards to prevent release of any acidic effluent below a set pH value. The primary system in Building 31 handles waste acid from cryomodule research and development, cavity production, and some general maintenance activities. A small elementary neutralization tank in Building 31 handles waste acid rinse water, and a third system handles rinse water from a small chemistry lab in Building 58.

Activated water collected and discharged in 2007 was a combination of the output from dehumidification equipment in the experimental halls and small withdrawals from accelerator area sumps and various beam dump cooling water systems. The activated water program is managed by the Radiation Control (RadCon) Department to comply with all permit requirements. The total radioactivity discharged to the sanitary sewer in 2007 was 0.197 Curie (Ci) of tritium (approximately 4% of the

5 Curie total allowed under the permit), and 0.00042 Ci of gamma-emitting radionuclides (approximately 0.042% of the total 1 Curie allowed under the same permit).

Subcontracted analytical laboratory personnel perform the sampling at the prescribed sampling points, except for certain radiological parameters (which are sampled and analyzed by qualified RadCon staff). HRSD independently performs periodic sampling of all discharge streams for a full complement of metals and other parameters to validate TJNAF's compliance with permit and regulatory requirements. This includes an annual seven-day period of monitoring flows and sampling to assess discharge consistency and determine whether changes to the permit are necessary. The HRSD report provided data for permitted pollutants, including Total Phosphorus and Total Suspended Solids. All values were within permit effluent limits.

**Monitoring Air Emissions**

TJNAF complies with Commonwealth and Federal air pollution regulations. The Federal Clean Air Act (CAA) and its 1990 Amendments (CAAA) regulate the air emissions from DOE's processes and facilities. TJNAF has no processes that require air permitting. Emission estimates on the site's natural gas-fired boilers and emergency generators are derived from consumption and emission factors and provided to the DEQ upon request.

There have been no major changes in TJNAF's minimal level of air emissions since the 1995 review of non-radiological emission sources. ***Therefore, TJNAF remains below any air permitting or reporting thresholds.*** Compliance with all applicable clean air standards continued through 2007.

**National Emission Standards for Hazardous Air Pollutants (NESHAP)**

NESHAP governs air emissions that contain hazardous components, such as radionuclides and asbestos.

**Radionuclide Emissions**

The Environmental Protection Agency (EPA) administers the radionuclide program in Virginia. Radionuclide emissions from CEBAF and FEL operations fall under NESHAP requirements. (Refer to Section 3 for discussion of direct radiation, the primary form of radiation generated onsite.)

To comply with NESHAP, ***TJNAF uses sampling results and calculations to demonstrate that Lab operations remain below the EPA permit threshold of 10 millirem per year*** (mrem/yr) potential effective dose equivalent to any member of the public. Airborne concentrations of radionuclides are below detectable levels; therefore, routine monitoring at the site boundary is not

required. However, the Lab does make periodic confirmatory measurements at the boundary to verify that radionuclide concentrations are not quantifiable.

In accordance with the CAA, TJNAF models estimated releases and submits the results to the EPA each year. The estimated dose equivalent to the Maximally Exposed Individual from airborne releases in conjunction with the Lab's accelerator operations during 2007 was 0.0122 mrem. Refer to Section 3.9 for more information.

**Asbestos Removal**

The NESHAP standard requires that approved procedures and work practices be followed to prevent release of asbestos to the air. An abandoned section of asbestos pipe was uncovered in 2007 during the construction of the East Retention Pond (found near Canon Boulevard). The pipe was properly disposed of through an authorized waste handler.

### 2.2.2 Other Programs with Compliance Commitments

**General Water Programs**

**General Permit for Small Municipal Separate Storm Sewer Systems (MS4s) – No. VAR040079**

This Virginia Department of Conservation and Recreations (DCR) permit authorizes operators of MS4s to discharge storm water to surface waters within Virginia. The permit's intent is to keep surface waters free of sediment and other pollutants. Under this permit, the Lab maintains a storm water management program, as noted in Chapter 6733 of the TJNAF ES&H Manual. The permit also requires that the Lab implement appropriate best management practices (BMPs) and set related measurable goals for the control measures identified in the permit. One of the BMPs is to track by FY the number of incidents, such as spills, that might impact storm water. There were no spill incidents that had the potential to affect storm water quality in 2007. A minor storm water issue noted during an EPA compliance inspection in June, 2006 (an eroding storm water channel) was promptly remedied and all concerns were resolved early in 2007.

**General Permit for Storm Water Discharges of Storm Water from Construction Activities –VPDES Permit No. VAR103277 (Terminated Sept. 17, 2007) and VSMP Permit No. DCR01-08-100332 (Effective August 15, 2007)**

The main requirement under either permit is that the Lab has a documented Storm Water Pollution Prevention Plan (SWPPP) for all projects disturbing one or more acres of land. The permit authorizes TJNAF to discharge storm water from areas disturbed by such construction activities. Though no monitoring is required under this permit, strict erosion and control measure inspection and maintenance

requirements are incorporated into subcontractor specifications. TJNAF's Facilities Management and Logistics Division oversees civil construction projects, ensuring that subcontractors adhere to permit and other contract-specified standards.

All construction activity under VAR103277 was completed and the permit was terminated when all areas had been fully stabilized. When new projects were scheduled later in 2007, a new general Virginia Storm Water Management Permit (VSMP) was issued.

**Permit to Withdraw Groundwater - No. GW0047200**

Pumping to control the water table will be necessary for the life of the facility to prevent the partially buried experimental halls from taking on water, which could damage hall equipment. A network of tile fields and drains collects local groundwater into a sump, from which it is pumped to the surface. The only parameter regulated under this DEQ permit is the quantity of water pumped. This authorization enables TJNAF to pump a maximum of 775,000 gallons monthly and 7,074,000 gallons annually.

The quantity of water pumped from these tile fields is reported to the DEQ. All withdrawals, both monthly and annually, were well within permit limits. The collected groundwater is sampled for water quality parameters under VPDES Permit No. 0089320. There were no unusual issues regarding groundwater discharge in 2007.

**Spill Prevention, Control, and Countermeasure (SPCC) Plan**

The TJNAF SPCC Plan is reviewed annually and is scheduled to be updated in 2009. This plan covers all oil-containing storage tanks and equipment on-site. Oil inventory at TJNAF comprises numerous oil-filled electrical transformers, ranging in volume from 2 gallons to about 4,800 gallons, and emergency generators (including one holding 5,000 gallons). The Lab's total volume of oil is estimated to be about 40,000 gallons, with about 6,000 gallons of this total under the control of Dominion Virginia Power, the regional electric service provider. The Lab maintains a used oil collection area. To ensure proper handling and response (in the event of a spill or release), all staff who work with oil receive SPCC Training.

Potential oil spill sources are located, to the extent possible, away from surface water discharge spillways. The sluice gates located near the site boundary could be effectively used to prevent any oil spills from leaving the site. Most DOE transformers incorporate secondary containment, while the Dominion Virginia Power transformers have none. Like TJNAF, Dominion Virginia Power maintains a SPCC Plan that includes its oil-containing items at the Lab.

***There were no spills in 2007. Minor leaks were promptly addressed, and there was no adverse impact on public health or the environment.***

Secondary Containment in Use

**General Air Programs**

**National Ambient Air Quality Standards (NAAQS)**

The EPA has established NAAQS for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. In 2007, the Hampton Roads Area (including Newport News) remained in attainment status for all NAAQS pollutants. The ozone non-attainment designation of prior years was revised to attainment in 2006.

Monitoring of air emissions is not required at TJNAF. There are no applicable NAAQS emissions sources present on the site, although accelerator operations do result in the generation of small quantities of ozone. There are no environmental or public health effects from this generation; however, ozone is monitored as appropriate for worker protection and is subject to controls.

**Stratospheric Ozone-Depleting Substances (ODSs)**

To comply with the CAAA and an objective in Executive Order (EO) 13148, Greening the Government through Leadership in Environmental Management, ***TJNAF minimizes the use of ODSs by using safe, cost-effective, environmentally preferable alternatives***. ODS-containing items used at TJNAF include refrigerants, degreasers,

cleaners, and aerosol can propellants. The phase out of these substances will have a minor impact on the site. To reduce ODSs and ODS-containing items, TJNAF utilizes trained and licensed subcontractors and staff to perform all work involving ODS-containing refrigeration and air conditioning equipment. Also, TJNAF has one ODS recovery machine on-site. The one remaining chlorofluorocarbon (CFC)-based chiller on-site receives preventive and corrective maintenance by a qualified mechanical subcontractor to ensure optimal performance and minimal CFC losses.

TJNAF has four 150-pound Halon fire extinguishers for delicate electronic equipment in the experimental halls. They release no ODSs unless used, and there has been no such use to date. They will require hydrostatic testing in 2008, and minor releases can be expected at that time.

The Director of Facilities Management & Logistics must approve all purchases of equipment containing ODSs.

**Waste Programs**

**Waste Management**

Waste streams at the Lab include RCRA (Resource Conservation and Recovery Act of 1976) hazardous waste, non-hazardous solid waste, and non-RCRA low-level radioactive and medical wastes. TJNAF is a Small-Quantity Generator of hazardous waste. Site programs implement applicable Federal requirements, which the state of Virginia has adopted. The Lab endeavors to reduce its waste generation and is continually moving forward with its efforts in recycling. Lab staff encourages the reuse or recycling of previously used or discarded materials wherever possible. Waste generation and recycling quantities are tracked and reported annually to the DOE.

There have been no waste management activities associated with spills or cleanup actions in 2007 under other Federal programs such as the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

**Resource Conservation and Recovery Act (RCRA**)

RCRA promotes the protection of health and the environment and the conservation of valuable material and energy resources. RCRA provides the EPA with the authority to regulate solid waste, from minimization and recovery to collection and disposal.

RCRA wastes include the Lab's hazardous and non-hazardous special waste streams and waste that is recycled or sent to a landfill. In June of 2006, the EPA conducted a multimedia compliance inspection, with DEQ assistance. Some RCRA issues were discussed but no violations were noted. One item that was resolved in 2007 was the

removal of the EPA posting of a violation on its Enforcement and Compliance History Online (ECHO) website. EPA had acknowledged that the posting was an error.

***In FY 2007, about 4.1 tons of generated routine RCRA hazardous wastes and approximately 212 tons of general refuse were reported to the DOE.*** RCRA hazardous and normal landfill wastes are managed for disposal by the assigned staff in the ESH&Q Division and in the Facilities Management & Logistics Division, respectively.

The three largest-volume hazardous wastes generated were a waste acid mixture used for niobium cavity processing, some lead-related debris, and waste solvents from cleaning operations. TJNAF neither transports hazardous wastes nor operates any regulated treatment or disposal units. All wastes are disposed of through licensed waste handling transporters and facilities.

Reductions in hazardous waste generation rates have been achieved with the use of performance measures. TJNAF has made notable progress in meeting hazardous waste minimization objectives, primarily through the use of an efficient acid neutralization system. ESH&Q Division representatives working with staff regularly using chemicals, continued to emphasize substitution, reduction, and reuse of hazardous materials in the workplace.

**Other Wastes**

Other wastes generated at the Lab (not covered under RCRA) include radioactive, medical, and recyclable wastes. Only a minimal amount of medical waste is generated at TJNAF, and its disposal is in accordance with the Lab's program and all applicable regulations. Other non-hazardous wastes are disposed of in landfills, reused on-site, recycled, or used for other purposes offsite.

***The quantity of material recycled through offsite facilities in FY 2007 was approximately 112 tons, which included comingled office recyclables, 32 tons of scrap metal and 13 tons of electronic computers and monitors.***

Radiation Control (RadCon), Facilities Management & Logistics Division, and Occupational Health disposed of other wastes. There were no compliance issues in any of these programs in 2007.

**Low-Level Radioactive Wastes (LLW)**

The only radioactive waste the Lab generates is LLW; there are no higher level wastes or any that would be categorized as special nuclear materials. In 2007, 7.5 $m^3$ (cubic meters) of LLW was shipped from TJNAF. Used protective equipment, contaminated materials from throughout the Lab, and waste oil are typical LLWs. To date, there has been no generation of mixed (hazardous and radioactive) waste.

**Emergency Planning & Community Right to Know Act (EPCRA)**

Under EPCRA, as aligned with the Superfund Amendments and Reauthorization Act (SARA), TJNAF is responsible for providing information on hazardous material quantities so that local entities could provide chemical emergency response services. TJNAF is also responsible for applicable reporting requirements, such as toxic chemical usage and environmental releases, if there are any. TJNAF files an annual SARA Tier II report with three emergency planning and response groups (EPRGs): the DEQ, a local planning group, and the Newport News Fire Department. The items reported for inventory purposes in 2007 were nitric, hydrofluoric, and sulfuric acids; bromine; argon; buffered chemical polish; helium; nitrogen; lead; propylene glycol; stabilized bromine chloride in solution; and hydraulic oil. The Lab's inventories of chemicals that are designated as toxic, persistent, or bioaccumulative do not exceed the designated quantity thresholds for Toxic Release Inventory reporting. Under EPCRA, the Lab must also have a MSDS (Material Safety Data Sheet) available for every chemical on-site. TJNAF has had no releases to date that meet the CERCLA or SARA release reporting criteria.

**National Environmental Policy Act (NEPA)**

NEPA outlines the Federal policy to restore and enhance the environment and to attain the widest range of beneficial use without degradation. NEPA-related actions are handled in conjunction with the DOE, which is committed to following both the DOE and EPA-related regulations. TJNAF assists the DOE by preparing documents and performing NEPA assessments of applicable site actions.

NEPA requires that projects with potentially significant environmental impacts be evaluated and alternative actions explored. These evaluations are to be performed and reported as either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). Besides the site's EAs, TJNAF meets routine NEPA requirements by reviewing construction and other activities for compliance. Activities in 2007 fell under the site's active DOE-approved Categorical Exclusions (CXs), EAs, and internal CX reviews. During 2006, an EA (DOE/EA-1534) was prepared for the CEBAF 12 GeV Upgrade, and its Finding of No Significant Impact (FONSI) was issued by the DOE in January 2007.

**Compliance with Other Regulations and Federal Standards**

**Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)**

FIFRA applies to the storage and use of herbicides and pesticides. Use of these substances has environmental implications, especially where water quality is concerned. Consequently, the application of herbicides and pesticides at TJNAF is performed by subcontractors who have completed the Commonwealth-administered certification program.

In order to minimize the chances of herbicides and pesticides washing into local storm water channels, TJNAF requires that there be no outdoor application of these compounds when rain is expected. To further minimize the chances of pollution, no industrial-strength herbicides or pesticides are stored or disposed of on TJNAF property. Only small amounts are mixed on site. The subcontractor is further responsible for handling any waste disposal through an authorized disposal facility. Small containers of household pesticides are stored on-site and applied per manufacturer's recommendations.

**Applicable Executive Orders (E.O.)**

There were numerous activities conducted throughout the Lab in 2007 that furthered environmental stewardship, especially in waste minimization and pollution prevention. Some actions were related to E.O. requirements, others were staff-initiated, and some a combination of the two.

***E.O. 13423, Strengthening Federal Environmental, Energy, and Transportation Management,*** was issued on January 24, 2007 and revoked E.O. 13101, E.O. 13123, and E.O. 13148 listed below. Its purpose is to better integrate and update practices and provide a strategic approach to further ensure enhanced performance with statutory and other legal requirements. E.O. 13423 was not fully implemented in 2007, but elements of the order were addressed throughout the Lab. [The E.O.s that were in place on January 1, 2007 are addressed in this report.]

**E.O. 11990, Protection of Wetlands**

E.O. 11990 ensures that adverse impacts to wetlands from construction activities are avoided or responsibly mitigated. Evaluation of TJNAF activities involving potential wetlands is accomplished through the NEPA review process.

**E.O. 11998, Floodplain Management**

E.O. 11988 relates to the occupancy and modification of floodplains. There is localized flooding during significant rain events, but no part of the site is within the 100-year floodplain.

**E.O. 13101, Greening the Government through Waste Prevention, Recycling and Federal Acquisition (revoked by E.O. 13423)**

E.O. 13101 encourages agencies to implement Affirmative Procurement (AP) by promoting the purchase of products made with recycled materials. The purchase of these materials helps "close the loop" in the recycling process.

To comply with this E.O., the DOE has set goals and performance standards, including a DOE complex-wide FY 2007 procurement target of 100% for purchasing recycled content EPA-listed products. The Lab continued its 100% performance in FY 2007.

**E.O. 13123, Greening the Government through Efficient Energy Management (revoked by E.O. 13423)**

This initiative focuses on energy efficiency (E2) as a means of pollution prevention. The DOE seeks a 2005 energy use reduction of 20%, and a 2010 energy use reduction of 25% for industrial/lab category facilities from a 1999 baseline. ***For fiscal year (FY) 2007, TJNAF documented a 47.1% energy use reduction in all reportable industrial/lab category buildings compared to the 1999 baseline year.*** The site's highly energy intensive production-related buildings and the CEBAF Center's Computer Center are in a separate "exempt" reporting category.

TJNAF's energy savings in FY 2007 came not from the industrial/lab reportable buildings, but were found in the accelerator operations and beam production facilities. Energy consumption can be reported in Btu/square feet of building type. A comparison of the 2006 and 2007 consumption shows a 2.6 percent decrease in the energy used by the "exempt" facilities (which comprise the majority of energy consumption at TJNAF). More significantly, this comprises a 19,210 Btu/square foot decrease in energy consumption.

**E.O. 13148, Greening the Government through Leadership in Environmental Management (revoked by E.O. 13423)**

This E.O. contains a number of tasks for Federal Agencies, including developing an Environmental Management System (EMS), reducing the use of Ozone Depleting Substances (ODS) and toxic chemicals, and reporting under EPCRA.

In 2007, TJNAF implemented E.O. 13148 and general P2 and E2 goals by: further developing its EMS (see Section 2.1); working to reduce ODS use (see Section 2.2.2); minimizing chemical use, not only in day-to-day Lab operations but also in grounds maintenance; reusing and recycling various items, from chemicals to cardboard boxes (to the extent practical) (see Section 2.2.3); and disposing of wastes in the most environmentally practical and safe manner. TJNAF continues to make progress in meeting the requirements of this E.O., as described throughout this report.

Dogwood Blossoms

### 2.2.3 Environmental Stewardship at TJNAF: Other Site Programs

**Waste Minimization and Pollution Prevention (WMin/P2)**

***Waste minimization, in combination with other P2 strategies, is recognized as the most cost-effective form of environmental protection (EP).***

TJNAF's WMin/P2 Awareness Plan fosters the philosophy that waste prevention is superior to paying either for special disposal or for remediation. The goal of the program is to incorporate WMin/P2 into the decision-making process at every level throughout the organization. This is accomplished by having line managers, assisted by both line and ESH&Q Division staff members, ensure that staff are knowledgeable about the benefits of WMin/P2; consider the waste implications of a new or modified process during the planning stage; and insuring that recommendations to enhance EP are brought to their manager's attention. These practices benefit the environment, protect employees and public health, reduce site waste disposal costs, and foster good community relations.

**EP in Product and Service Life Cycles**

A variety of products and materials are purchased or otherwise obtained for on-site use. When the materials have served their purpose, they are disposed of in accordance with TJNAF policy. When ES&H risks are identified, TJNAF has programs and procedures in place that include EP and sustainability considerations.

**Environmentally Preferable Purchasing and Planning**

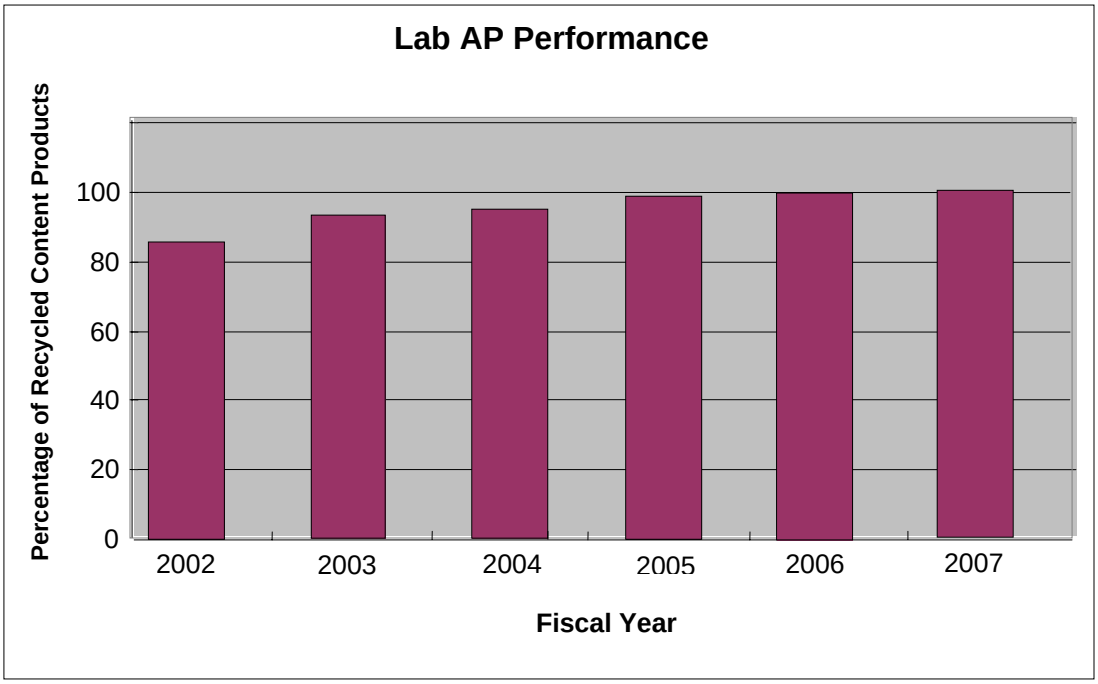
TJNAF is committed to integrating environmentally preferable purchasing and sustainability considerations into the acquisition of products, services, and construction projects when feasible. This responsibility is founded on the Lab's commitment to P2 and sound environmental stewardship. Lab efforts go beyond the affirmative procurement requirements regarding EPA-designated products under E.O. 13101, and include the active avoidance of purchasing items that contain ozone-depleting substances.

TJNAF continues to make steady and consistent progress toward meeting the DOE affirmative procurement (AP) goals and requirements and in implementing other environmentally preferable purchasing measures (refer to Section 2.2.2). Refer to Figure 2.1, which shows the Lab's consistent progress. The percentages of products purchased with recycled content that meet EPA definitions are indicated. The numbers shown include those purchased that met "exclusion" criteria (such as an unavailability of recycled content products or unsatisfactory pricing).

***The Lab's Affirmative Procurement program met its 100% performance goal in 2007 for the second straight year.***

The Procurement Department continues to increase employee awareness of EPA-designated products and provide ready access to these recycled content/remanufactured products. Office supply purchases made using Purchase Cards (PCards) have been restricted as a full line of AP items is available using the Lab's e-commerce system. Facilities Management & Logistics and other staff continue to explore opportunities to find users or vendors that will recycle items that are no longer needed for Lab operations.

**Figure 2.1 Affirmative Procurement Performance**




**EP Consideration in Building and System Design and Construction Activities**

Though the CEBAF accelerator complex is the site's primary energy user, energy management is applied throughout the Lab. Subcontractors and staff who are involved with the design of new buildings, or with changing and modifying existing buildings or utility systems, incorporate energy and water conserving strategies where feasible. In 2007, TJNAF continued this effort.

**Environmentally Preferable Use**

In addition to selecting the environmentally preferred product or service for the desired activity, staff and users of TJNAF are responsible for following safe and environmentally sound use, storage, and waste management practices.

Standard requirements, e.g., secondary containment and proper ventilation for a process are provided, and minimize exposure to potential hazards. Lab staff and subcontractors are encouraged to minimize energy and water use.

*Energy Management* - With an increased emphasis on energy management, selected mechanical and electrical improvements have been made to building and process systems and equipment in order to improve their performance and reliability. The Lab exceeded the energy goals prescribed by applicable standards in 2007. Facilities Management & Logistics incorporates energy efficiency provisions during the design process of all new buildings.

*Water Conservation* - TJNAF uses about 56 million gallons of water annually, with 79% directly related to process or facility heat rejection. Much of this water is evaporated in cooling towers for process cooling and air conditioning. With an increased emphasis on water conservation, various techniques are used to minimize water use, including a regular maintenance program. New projects that need water are reviewed to minimize water use. Existing water-using activities are evaluated to reduce water usage as much as possible based on a life cycle cost. Implementing programs for water use reductions at the cryogenic plant and for landscaping continued in 2007. Planning also began on a cooperative project with HRSD that will allow TJNAF to use reclaimed water in place of potable water for some applications.

**Environmentally Preferable Disposal**

Today's rapidly changing technologies, products, and practices carry the risk of generating materials and wastes that, if improperly managed, could threaten public health and the environment. In this regard, ***TJNAF encourages, and, where appropriate, requires the purchase and use of products and services whose waste products will have minimal impact on the environment and public health.*** Once the waste is generated, Lab staff members are responsible for ensuring proper segregation and disposal of waste items.

The range of options for disposition of materials includes recycling, neutralizing, scrapping, or providing unneeded chemicals or equipment to co-workers on-site or to other DOE facilities for reuse, or disposal. The Lab intends that all items be disposed of in the most environmentally acceptable manner, meeting all applicable regulatory and contractual requirements.

The Lab continues to implement waste reduction strategies and to educate and encourage staff on the proper disposition of recyclable materials. Lab staff, users, and subcontractors continued to utilize Lab-wide office product recycling centers. Products collected at these local centers are: aluminum cans, small batteries, cardboard, copier/fax/inkjet/laser cartridges, paper wastes, telephone books, and plastic and glass bottles. The commingled collection of recyclables in all offices and the presence of local recycling centers has considerably increased staff recycling awareness and participation. In FY 2007, with scrap metal and automatic data processing equipment included in the total, TJNAF recycled about 112 tons of materials.

## *2.3 APPRAISALS, ASSESSMENTS, AND INSPECTIONS*

The DOE Site Office, the DOE Oak Ridge Office, and various Commonwealth and local authorities provide external oversight of the TJNAF EP Program. Assurance that on-site processes do not adversely affect the environment is achieved through self-assessments, inspections, and oversight by the DOE, DEQ, and the HRSD. TJNAF complies with all

applicable laws, regulations, and permits. Actions of note undertaken in 2007 are described here.

**DOE Review of TJNAF**

The DOE Site Office's 2007 Performance Evaluation Report (October 1, 2006 through September 30, 2007) of Jefferson Science Associates, LLC, includes the general category of Integrated Safety, Health and Environmental Protection. The numerical score awarded was 3.64, which equates to a grade of "A-." However, within this general category, is a sub-category covering Waste Management, Minimization, and Pollution Prevention. Here, the numerical score was 4.0, equating to an "A." ***The report mentions receipt of the White House Closing the Circle Award for the operational efficiencies in cryogenic system operation as an example of environmental stewardship, noting that it is the highest award to be received by a Federal Agency in pollution prevention. It places TJNAF in select company, as this was in direct competition with agencies beyond the DOE.*** In addition to the reduced greenhouse gas emissions associated with the reduced consumption of electrical energy from this improvement, other laboratories and private industries are also enjoying the reduced utility costs through TJNAF's partnerships.

**External Inspections**

***HRSD staff inspected the Lab on March 14, 2007***, with the objective of visiting all pre-treatment discharge areas and as many permitted meter locations as possible. In addition, a records review was performed covering 2006 and 2007 documents. No discrepancies were recorded.

**External Recognition**

HRSD: Jefferson Lab received a Gold Award for pretreatment excellence for CY 2007.

DEQ: The Lab applied for inclusion in the Virginia Environmental Excellence Program in 2007, and the Lab passed the final hurdle for acceptance when the DEQ visited the site on December 21, 2007. The Lab was informed it would be included as an Exemplary Environmental Enterprise participant for CY 2008.

City of Newport News: The Lab participates in the City's Adopt A Spot program by taking care of the section of Jefferson Avenue adjacent to the Lab. The City recognizes all participants in public notices.

DOE: The DOE awarded a Best in Class Award to the Lab's quad core super computer, mentioned in the Executive Summary, for its contribution to pollution prevention.

## SECTION 3
## ENVIRONMENTAL RADIOLOGICAL PROGRAM

### *3.1 RADIATION AT JEFFERSON LAB*

Ionizing radiation and a variety of radioactive materials are produced as byproducts of research activities at TJNAF. Any potential impacts have been significantly reduced by adhering to the philosophy of ***ALARA***, "as low as reasonably achievable", in dealing with potential sources of radiation. The potential dose to members of the public from various pathways, such as inhalation, ingestion, and skin absorption, are evaluated by the RadCon Department to demonstrate compliance with regulatory limits (as required by DOE Order 5400.5, "Radiation Protection of the Public and the Environment").

> ***radioactivity – a natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy from their nuclei and, thus, change (or decay) to atoms of a different element or to a lower energy state of the same element.***

People are exposed to natural sources of radioactivity constantly: cosmic radiation from extraterrestrial sources; terrestrial radiation from naturally-occurring elements in the earth's crust; and man-made sources of radiation. Radiation dose is formally expressed as annual average dose equivalents in units of millirems (mrem) as shown below:

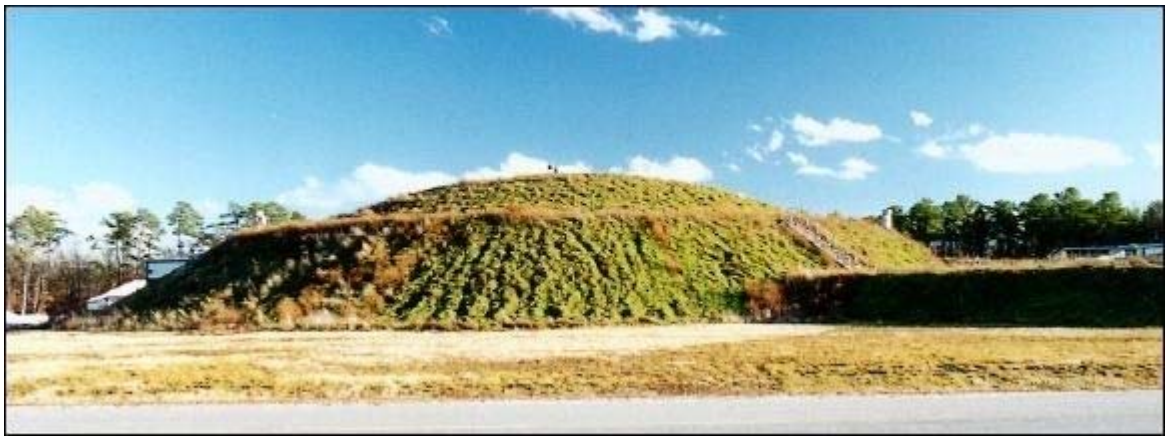
| | |
|---|---|
| ***Cosmic:*** | ***At sea level, 26 mrem (higher at higher elevations)*** |
| ***Terrestrial:*** | ***274 mrem (including radon)*** |
| ***Man-made:*** | ***60 mrem (primarily medical procedures; also includes fallout and other sources)*** |

The DOE limits the potential dose to the public that is attributable to DOE facility operations to 100 mrem per year. ***TJNAF has established an Alert Level of 10 mrem,*** either measured or estimated, for protection of the general public.

### *3.2 RADIATION EXPOSURE PATHWAYS*

Two broadly-defined sources of potential radiation exposure exist at TJNAF: ***direct radiation*** and ***induced radioactivity***. Direct (or *prompt)* radiation and induced radioactivity are produced during accelerator operations. ***Direct radiation has a potential impact only within close proximity to a working accelerator on the site.*** Accelerator operation (i.e., running an electron beam) produces significant levels of direct radiation within the accelerator enclosure. This radiation is produced within the beam enclosure and its production stops when the accelerator is turned off.

Almost all direct radiation is absorbed by extensive shielding, which is an integral part of accelerator design. Any possible exposure to this radiation is at a maximum on-site, decreases with distance, and is insignificant at the site boundary.



**Earthen Berm at Experimental Hall A**

Accelerator enclosures, where direct radiation can be produced, are not accessible during accelerator operations. However, TJNAF has an extensive monitoring network in and around the accelerator. There are approximately ***50 active, real-time radiation monitors*** and a series of associated passive integrating detectors deployed around the accelerator site. The primary purpose of most of these instruments is to shut off the accelerator in case of unusual radiation levels; a secondary benefit is accumulation of long-term, on-site radiation exposure data. The majority of the active monitors are connected to a central computer system that automatically records the radiation levels for subsequent examination. When appropriate, TJNAF employees, subcontractors, and visitors wear detection devices to monitor their on-site radiation exposure***. Six site boundary monitoring stations*** also collected direct radiation data in 2007. These monitoring stations are equipped with specialized detection devices, optimized for measuring radiation at close to background levels.

In addition to prompt radiation, the interaction of the accelerator beam with matter can create radioactive materials through activation of matter. The beamlines, magnets, beamline components, targets, detectors, other experimental area equipment, and the energy dissipating devices (beam dumps) used to contain the beam's energy, may become activated. Cooling water, ground water, lubricants, and air in the beam enclosure may also become activated. These activated items and materials are possible sources of radiation exposure for workers and the public.

Though the direct radiation stops when the accelerator is turned off, the activated equipment, water, and air continue to emit radiation. Such material, when in a physical form that can be transferred to other items, is called *radioactive contamination*. All materials exposed to the beam or to potential sources of transferable contamination are monitored for radioactivity prior to being released from local control. Jefferson Lab adheres to the DOE release limits for surface contamination found in DOE Order 5400.5, and follows DOE guidance for ensuring that materials being released contain no detectable induced radioactivity. See Section 3.7 below for more information regarding release of materials.

Controls are in place to minimize exposure from both direct radiation and radiation from radioactive materials to Lab personnel, the environment, and the public. Access to the accelerator site and to areas storing radioactive material is strictly limited. Fencing, safety interlocks, signs, training, and other engineering and administrative controls prevent inadvertent, non-ALARA exposures to direct radiation and induced radioactivity.

### *3.3 EFFLUENT MONITORING*

Water that could potentially become activated is sampled, analyzed, and discharged under permit. Such wastewater is released under HRSD Permit No. 0117 to the HRSD. These wastewaters can include:

- CEBAF accelerator enclosure and experimental hall floor drainage*
- Free-Electron Laser vault floor drainage and A/C condensate
- Beam dump and target cooling water
- Environmental samples, once analyzed

***TJNAF is limited to discharging a total of 10,000 microCuries (µCi) per day via wastewater, with an average concentration of radioactivity not to exceed 0.1 µCi/ml. These limits were never exceeded in 2007.***

* *The floor drain system is routed to a common sump. The system accumulates water from A/C (air conditioning) condensate drains, spills and leaks from cooling water systems, cleaning activities, and minor in-leakage from surface/ground water.*

Table 3-1 summarizes the 2007 monitoring data for the radiological constituents of TJNAF's wastewater discharge to HRSD.

**Table 3-1. Tritium Concentrations in Discharges to HRSD**

| ***Month, 2007*** | ***Average Tritium Concentration, μCi/ml*** | ***Total Activity Released, μCi*** |
|---|---|---|
| January | 0.0000365 | 63,100 |
| February | 0.0000576 | 66,200 |
| March | 0.0001480 | 58,800 |
| April | 0.0000002 | 364 |
| May | 0.0000002 | 746 |
| June | 0.0000004 | 756 |
| July | 0.0000011 | 3460 |
| August | 0.0000011 | 1420 |
| September | 0.0000005 | 564 |
| October | 0.0000002 | 338 |
| November | 0.0000007 | 1550 |
| December | 0.0000001 | 156 |
| ***Total curies released in 2007: 0.197*** | | |

| ***Quarter, 2007*** | ***Be-7, μCi/ml*** | ***Mn-54, μCi/ml*** | ***Na-22, μCi/ml*** |
|---|---|---|---|
| 1 | 0.00000012 (1.20E-07) | 0.00000000128 (1.28E-09) | 0.00000000808 (8.08E-09) |
| 2 | ND | ND | ND |
| 3 | ND | ND | ND |
| 4 | ND | ND | ND |
| ***Total curies (from these gamma emitters) released in 2007: 0.00042*** | | | |

The concentrations and activity varied based on the quantity of the higher-activity beam dump cooling water discharged during the reporting period.

The total tritium discharge was 4% of the permitted 5 Curies/year. The average tritium concentration was never more than 1/10,000$^{th}$ of the allowable concentration in any month. The total gamma emitter discharge was 0.042% of the permitted 1 Curie/year.

In addition to the local discharge permit, DOE regulates wastewater effluents under DOE Order 5400.5. The Order requires wastewater treatment using the *best available technology* (BAT) to reduce radioactivity content at specified concentration thresholds, in keeping with the ALARA principle. Average discharge concentrations remained a small fraction of the treatment threshold for 2007. In addition, taking into account the radionuclides of concern, the discharge pathway and the total quantity of radioactivity discharged, the potential exposure to a member of the public from this source is an insignificantly small fraction of the annual dose limit.

***The threshold for application of BAT treatment for tritium in sewage discharges is 0.01 µCi/ml monthly average concentration. The highest monthly average discharge concentration in 2007 from Jefferson Lab was 0.000148 µCi/ml.***

## *3.4 GROUNDWATER MONITORING*

Soil activation is a potential source of groundwater contamination. Groundwater quality in the soil surrounding the accelerator complex is the Commonwealth's greatest concern with site operations. The monitoring of VPDES-permitted wells for groundwater quality continued in 2007. Through a combination of engineered controls (e.g. shielding) designed into the CEBAF and FEL facilities, and adherence to each accelerator's operational limits, ***no significant amount of soil or groundwater activation is expected on-site, and no offsite effect is anticipated.***

The TJNAF Groundwater Protection Management Program minimizes impacts to groundwater resources, and is used as a management tool to guide Program implementation. The Program ensures compliance with Federal, Commonwealth, and local regulations, other identified standards, and effective resource management practices. The Lab's groundwater monitoring program serves to assess the effect of TJNAF activities on groundwater quantity and quality.

Figure 3.1 shows the facility's network of groundwater monitoring wells. Fifteen of these wells are routinely monitored for radioactivity, using EPA or other approved sampling and analysis protocols. Wells are designated either as *up-gradient, A-ring, B-ring, or C-ring.* The A-ring wells are located closest to the accelerator and are the most likely to show any effects of soil and groundwater activation. A-ring wells are sampled quarterly. B-ring wells are further from potential sources of activation and are sampled semi-annually. The C-ring wells are positioned to represent conditions near the TJNAF boundary and are sampled annually.

***Groundwater samples are analyzed for the following: tritium ($H^3$), beryllium-7 ($Be^7$), manganese-54 ($Mn^{54}$), sodium-22 ($Na^{22}$), and gross beta activity.*** Results are reported to the DEQ on a quarterly basis, after receipt and review of radioanalytical data. The VPDES permit specifies limits for radioactivity in the wells based on their location with respect to the accelerators. Table 3-2 shows the permit levels associated with the monitoring wells and the end-station dewatering sump discussed below.

**Table 3-2, VPDES Permit Limits for Groundwater**

| Analyte, pCi/l | A-Ring wells | B-Ring wells | C-Ring wells | End Station Dewatering Sump | Highest MDA[4] |
|---|---|---|---|---|---|
| Gross Beta | 50[1] | 50 | 153 | 50[2] | 15.6 |
| Tritium | 5000[1] | 5000 | 1000 | 20,000 | 699 |
| Sodium-22 | NL[3] | NL | 61 | NL | 13.4 |
| Beryllium-7 | NL | NL | 835 | NL | 122 |
| Manganese-54 | NL | NL | 51 | NL | 12.7 |

Notes: 1. Action levels, not permit limits
2. Screening level to trigger $H^3$ monitoring (The Lab routinely monitors this groundwater for $H^3$as a Best Management Practice.)
3. NL= No Limit, but monitoring and reporting are required
4. MDA= Minimum Detectable Activity (the minimum level at which activity can be measured for the analysis performed). The value shown is the highest MDA obtained for the analyte in 2007.

***As in previous years, all monitoring results were within permit limits in 2007, and no accelerator-produced radioactivity was detected in groundwater at TJNAF.*** The nuclide-specific MDA values in Table 3-2 provide a reference for the detection sensitivity. Values listed are the highest MDA values obtained during analysis in 2007. Gross beta activity was occasionally detected, but not above action levels. The detected activity is due to natural background radioactivity in the soil and groundwater. The sensitivity of the measurement allows for the detection of naturally occurring radionuclides at their normal environmental levels.

In 2007, TJNAF identified an interfering agent in some well and sump samples that causes false positive indications of tritium activity. In a few instances, these results were reported

to the DEQ as detectable activity. Follow-up studies have shown that these results were all false positives. TJNAF is working with its subcontracted analytical laboratory to develop procedures for eliminating this interference.

***There is no public or private use of the shallow aquifer in the vicinity of TJNAF***; thus, there is no exposure to the public via contact with or ingestion of groundwater.

In addition to the monitoring wells, TJNAF monitors groundwater that is pumped from around the experimental halls and is discharged under permit to the surface. The majority of the surface water leaving the Jefferson Lab site flows to the Big Bethel Reservoir via Brick Kiln Creek. The remainder flows west to the James River. Neither of these waterways is used for drinking water; the only exposure pathway is through recreational use (swimming, consumption of fish/shellfish). The dewatering effluent exceeds all radiological water quality requirements in DOE Order 5400.5. Permit-required sampling of this effluent was conducted quarterly in 2007. Beyond the requirements of the permit, TJNAF routinely samples this effluent on an ongoing basis, and conducts additional sampling in a variety of locations around the site to verify surface water quality. No accelerator-produced radioactivity was detected in any of these samples. Considering the extremely small quantities of radioactivity potentially present in this groundwater (activity is much less than the MDA at the point where the discharge stream leaves the site property), the potential dose to a member of the public from this pathway is insignificant, and specific dose estimates from this pathway are not necessary or required.

***No accelerator-produced radioactivity that was statistically different than background was detected in site groundwater or surface water in 2007.***

### *3.5 Airborne Effluents*

***Airborne radionuclide concentrations continue to be too low to directly measure at the site boundary.***

Essentially all airborne radionuclide emissions from TJNAF are the result of the release of air from accelerator enclosure vaults containing activation products resulting from electron and secondary beam interactions with the air. The interaction of the beam with air produces short-lived radionuclides such as Oygen$^{15}$, Nitrogen$^{13}$, and Carbon$^{11}$, and smaller amounts of the longer-lived Hydrogen$^{3}$. Airborne radionuclide production (and emission) occurs almost exclusively in the CEBAF accelerator at experimental halls A and C and the beam switchyard (BSY) portion of the accelerator. Other areas of CEBAF and the FEL contribute

only a very small amount to the total emissions. Please see Table 3-3 for a summary of estimated atmospheric releases from TJNAF in 2007.

Compliance with EPA regulations (40CFR61) requires Jefferson Lab to determine the potential for the maximum exposure to this radioactivity by a member of the public. ***Annual calculations, using EPA-approved computer modeling codes, show that TJNAF operational emissions remain several orders of magnitude lower than the EPA's 10 mrem/yr dose limit for a member of the general public.*** TJNAF continued making measurements to verify the very low calculated release rate. The calculated 2007 dose to the maximally exposed individual (MEI) of the public was 0.012 mrem/yr due to airborne releases. The location of the MEI was 300 meters due south of the accelerator, in the Oyster Point office park. Please see Section 3.9 for additional information on exposure and dose estimates.

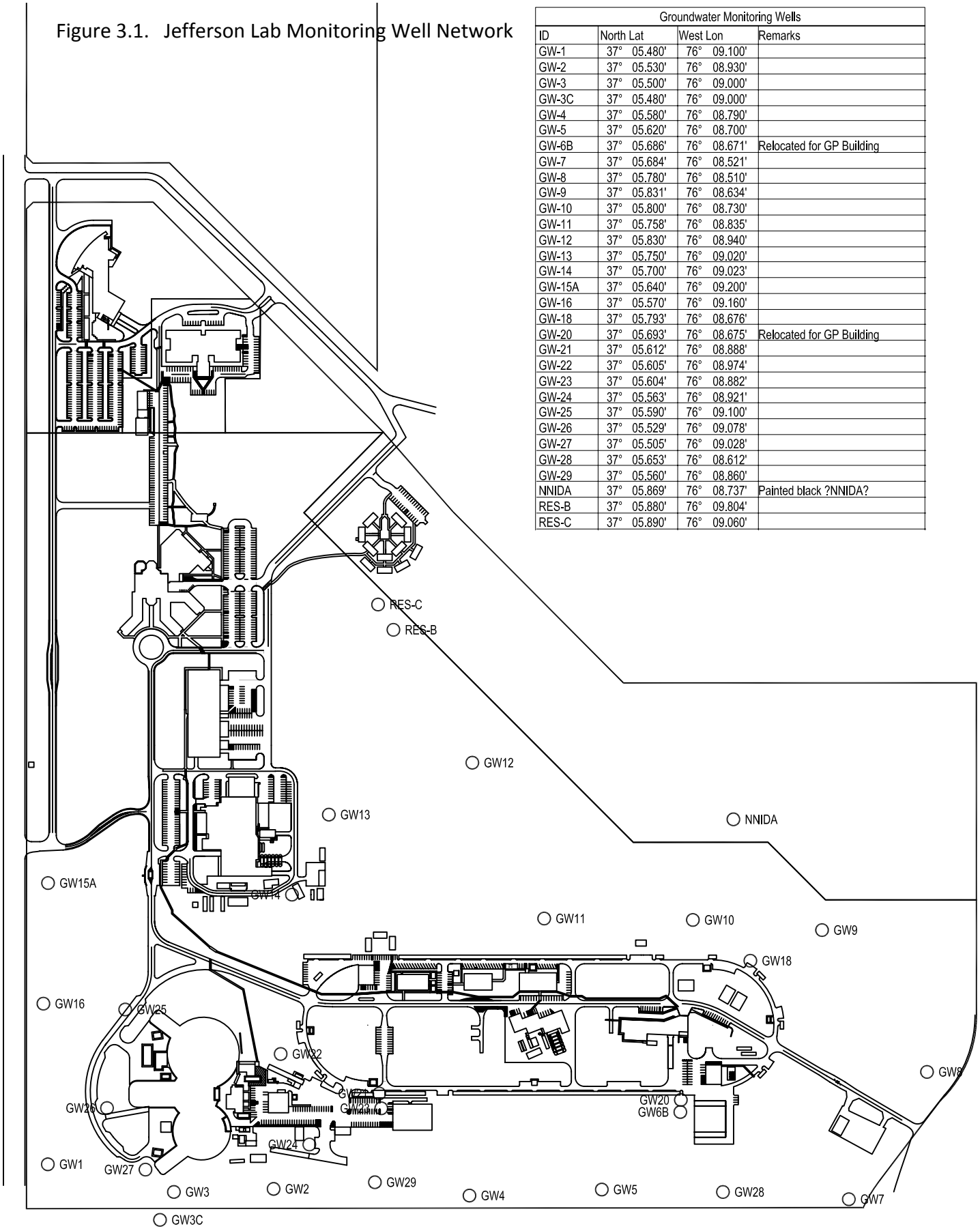
**Table 3-3, Estimated 2007 Radiological Atmospheric Releases from TJNAF**

| ***Radionuclide [half-life*]*** | ***Ci in CY 2007*** |
|---|---|
| Tritium [12.26 yr] | 0.01926 |
| Beryllium-7 [53 .6 days] | 0.00253 |
| Carbon-11 [20.3 min] | 0.643 |
| Nitrogen-13 [9.96 min] | 4.85 |
| Oxygen-15 [123 sec] | 2.57 |
| Chlorine-38 [37.29 min] | 0.0275 |
| Chlorine-39 [ 55.5 min] | 0.336 |
| Argon-41 [1.83 hr] | 0.00138 |

*A radionuclide's half-life is the time it takes for radioactive decay to decrease the activity by one-half.

Figure 3.1. Jefferson Lab Monitoring Well Network

| Groundwater Monitoring Wells | | | |
|---|---|---|---|
| ID | North Lat | West Lon | Remarks |
| GW-1 | 37° 05.480' | 76° 09.100' | |
| GW-2 | 37° 05.530' | 76° 08.930' | |
| GW-3 | 37° 05.500' | 76° 09.000' | |
| GW-3C | 37° 05.480' | 76° 09.000' | |
| GW-4 | 37° 05.580' | 76° 08.790' | |
| GW-5 | 37° 05.620' | 76° 08.700' | |
| GW-6B | 37° 05.686' | 76° 08.671' | Relocated for GP Building |
| GW-7 | 37° 05.684' | 76° 08.521' | |
| GW-8 | 37° 05.780' | 76° 08.510' | |
| GW-9 | 37° 05.831' | 76° 08.634' | |
| GW-10 | 37° 05.800' | 76° 08.730' | |
| GW-11 | 37° 05.758' | 76° 08.835' | |
| GW-12 | 37° 05.830' | 76° 08.940' | |
| GW-13 | 37° 05.750' | 76° 09.020' | |
| GW-14 | 37° 05.700' | 76° 09.023' | |
| GW-15A | 37° 05.640' | 76° 09.200' | |
| GW-16 | 37° 05.570' | 76° 09.160' | |
| GW-18 | 37° 05.793' | 76° 08.676' | |
| GW-20 | 37° 05.693' | 76° 08.675' | Relocated for GP Building |
| GW-21 | 37° 05.612' | 76° 08.888' | |
| GW-22 | 37° 05.605' | 76° 08.974' | |
| GW-23 | 37° 05.604' | 76° 08.882' | |
| GW-24 | 37° 05.563' | 76° 08.921' | |
| GW-25 | 37° 05.590' | 76° 09.100' | |
| GW-26 | 37° 05.529' | 76° 09.078' | |
| GW-27 | 37° 05.505' | 76° 09.028' | |
| GW-28 | 37° 05.653' | 76° 08.612' | |
| GW-29 | 37° 05.560' | 76° 08.860' | |
| NNIDA | 37° 05.869' | 76° 08.737' | Painted black ?NNIDA? |
| RES-B | 37° 05.880' | 76° 09.804' | |
| RES-C | 37° 05.890' | 76° 09.060' | |



### *3.6 DIRECT RADIATION MONITORING*

The six active (real-time) radiation measurement devices installed along the accelerator site boundary continued to be used to measure dose from direct radiation attributable to TJNAF operations. Figure 3.2 shows the approximate locations of these monitors. These electronic detectors - radiation boundary monitors (RBMs) - measure and log radiological information. Additional passive detectors are used for a number of site boundary measurements.

**Figure 3.2. Relative Approximate Locations of Six Radiation Boundary Monitors**

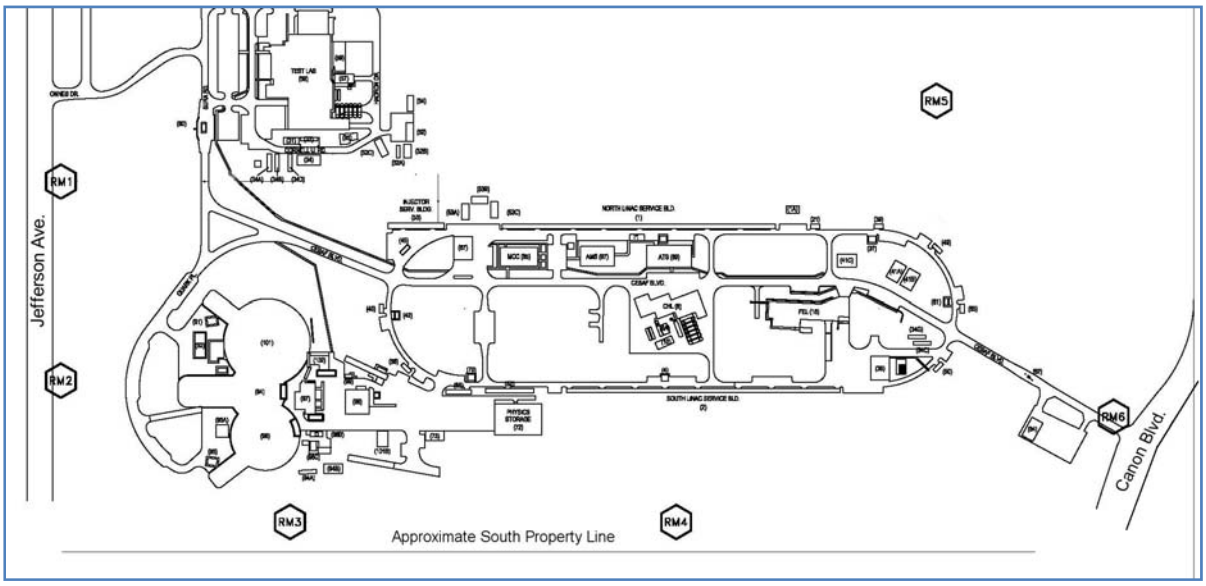



Table 3-4 displays the radiation doses in mrem for 2007 at the detectors that saw the largest dose from accelerator and experimental hall operations in 2007 (RBM-1 in the first half of 2007, and RBM-3 in the second half of the year). This dose represents prompt, or direct, radiation exposure that would be experienced at the actual on-site boundary monitor location during accelerator operations. For reference, a comparison with natural background radiation levels is shown. These background levels do not include contributions from naturally-occurring radon, which typically doubles the natural radiation dose to the public. Note that the boundary dose shown is the total cumulative dose for the year. This does not represent an estimate of the potential dose to a member of the public, which, under any credible scenario, would be a small fraction of this amount. The direct radiation exposure at the boundary showed an increase in 2007, but was slightly less than 50% of the TJNAF design goal of 10 mrem/year (which is one-tenth of the DOE dose limit). See Section 3.9 for estimates of potential doses to the public.

**Table 3-4,. Radiation Boundary Monitor Results for 2007**

| ***Period*** | ***Neutron (mrem)*** | ***Gamma (mrem)*** | ***Total (mrem)*** |
|---|---|---|---|
| Jan-June (RBM-1) | 2.06 ± 0.03 | 0.51 ± 0.01 | 2.57± 0.04 |
| July-Dec (RBM-3) | 1.91 ± 0.02 | 0.48 + 0.01 | 2.39 ± 0.03 |
| TOTAL | 3.97 ± 0.04 | 0.99 ± 0.02 | 4.96 ± 0.05 |
| Natural Background | ~1.8 | ~110 | ~112 |

Notes:

Statistical errors are quoted at 1 sigma.

Systematic errors including calibration (not included) are approximately 30% for neutrons.

Gamma dose equivalent rates are estimated based on best known statistical correlation techniques.

## *3.7 RELEASE OF MATERIALS AND EQUIPMENT*

All potentially activated or contaminated material and equipment is monitored prior to release from control. Release limits for surface contamination are given in DOE Order 5400.5. The Order does not prescribe a specific limit for release of potentially activated materials; therefore, ***TJNAF has adopted methods and procedures that ensure equipment and materials being released contain no radioactivity distinguishable from background***. Materials with potential for internal contamination or volumetric radioactivity that cannot be reliably assessed are treated as radioactive materials and are not released to the public.

Potential doses to the public from undetected radioactivity in released materials have been assessed and documented as prescribed in various national and international standards. These standards and DOE guidance apply a benchmark value of 1 mrem/y for determining the significance of potential dose to the public. The measurement sensitivity of TJNAF procedures was evaluated against this benchmark as part of its technical basis, confirming that potential dose to a member of the public through this pathway is insignificant.

TJNAF continues to observe the DOE-imposed suspension on recycling of metals that have resided in radiological areas. Therefore, disposal of metals which have been released from control is restricted to provide assurance that these materials do not enter a commercial recycling pathway.

## *3.8 OTHER ENVIRONMENTAL SURVEILLANCE*

TJNAF routinely collects environmental samples not required by any regulation or permit. In addition to the surface water sampling described in Section 3.3, other sample media are routinely collected and analyzed. Sediments from storm drainage channels and soils in areas that could potentially be affected by contaminated runoff or storage and handling of radioactive materials are sampled at a variety of locations on a location-specific frequency.

***Results of sampling continue to show that no significant radioactivity is being released to the environment through these pathways.***

TJNAF does not release any residual radioactive material, such as contaminated concrete or soil, so there are no resulting dose impacts to the public.

The absorbed dose to any local biota (aquatic or terrestrial) from TJNAF operations cannot be reliably quantified. DOE has provided guidance on evaluating the dose that may be received by biota (DOE-STD-1153-2002), in which screening values are presented for both terrestrial and aquatic organisms. All of the monitoring done at TJNAF employs detection sensitivity far below the applicable screening levels. Therefore, with environmental samples at non-detect levels, exposure and dose to local biota cannot approach (by orders of magnitude) the internationally recommended dose limits for terrestrial biota (0.1 rad/day, the lowest limit for any biota).

## *3.9 POTENTIAL DOSE TO THE PUBLIC*

Controls are in place to minimize exposure from both direct radiation and radiation from activated materials to Lab personnel, the environment, and the public. ***Access to the accelerator site and to areas housing radioactive material is strictly limited.*** Fencing, safety interlocks, signage, training, and other engineered and administrative controls prevent inadvertent exposures to direct and induced radiation. The maximum possible dose to members of the public from TJNAF operations is very small compared to natural background radiation and well below all regulatory limits.

***The direct dose and air emissions are the only sources for which any plausible contribution to public dose exists.*** In the preceding discussion, the maximum possible dose to the public is dominated by the contribution from direct radiation. However, it is not credible under any possible conditions for a member of the public to actually receive this dose. One can

construct an exposure scenario in which a more realistic estimate of potential dose to a member of the public is obtained. The potential dose from air releases is modeled using appropriate exposure conditions. But it is not realistic to expect a member of the public to be continually present at the site boundary. ***A reasonably conservative scenario could involve exposure at the boundary in which an individual spent two hours per day walking along the site boundary, and did do so for 200 days of the year.*** We will conservatively assume that the measured average dose rate condition exists everywhere along the boundary, such that the individual is exposed at this rate for the entire two hours per day. This hypothetical case represents a reasonably conservative scenario for the maximally exposed individual (MEI) for this source.

Given these conditions, the MEI for this exposure path would have received 0.226 mrem in 2007 from direct radiation, or about 2.3% of the TJNAF design goal of 10 mrem, and 0.23% of the DOE limit of 100 mrem.

Further, if we combine the dose from this source with the dose to the MEI from air emissions, ***the maximum postulated dose from all pathways to a member of the public from Jefferson Lab operations in 2007 is 0.238 mrem.***

***TJNAF did not contribute significantly to the radiation dose received by the public in 2007.***

Table 3-5 summarizes potential doses to the public from all pathways.

## *3.10 QUALITY ASSURANCE*

Extensive quality assurance (QA) activities ensure that TJNAF's environmental monitoring program is performed in accordance with the principles of the TJNAF QA Program Manual and the requirements of DOE Order 5400.5. The TJNAF QA Program includes:

- Qualification of the laboratories that provide analytical services,
- Verification of certification to perform analytical work,
- Review of performance test results, and
- Assessment of the adequacy of each subcontractor's internal quality control (QC) practices, recordkeeping, chain of custody, etc.

In addition to the internal QA performed by the RadCon Department, independent assessments are performed by the TJNAF QA/CI (Continuous Improvement) Department, the Department of Energy Site Office, other regulators such as the EPA and DEQ, and oversight groups within DOE. ***No QA concerns regarding environmental sampling protocols or results were noted in 2007.***

**Table 3-5 Dose Summary Table for 2007**

| ***Pathway*** | ***Dose to Maximally Exposed Individual, mrem*** | ***% of applicable Limit/(limit)*** | ***Estimated Population Dose person-rem*** | ***Population within 80 km*** |
|---|---|---|---|---|
| Air | 0.0122* | 0.122 (10 mrem) | 0.1342 | 235,000 est. |
| Water | ND† | N/A (4 mrem)** | ND | - |
| Release of materials | ND | N/A (100 mrem) | ND | - |
| Direct radiation | 0.226*** | 0.226 (100 mrem) | ‡ | - |
| Total, all pathways | 0.238 | 0.238 (100 mrem) | 0.029 | 235,000 est. |

*From 2007 EPA-required reporting under 40CFR61, based on atmospheric modeling results.

† ND= Not measurable; insignificant contributor to dose

** Applies to drinking water only.

***This dose determined from Boundary Radiation Monitors, with conservative exposure scenario applied. Dose to nearby residents, workers or visitors would be much smaller, as this source only affects a small region in the vicinity of a portion of the site boundary.

‡ There is no identifiable exposed public population for this source due to its proximity to the facility.

An independent laboratory (Universal Laboratories) collected most VPDES and HRSD permit-related water samples. Other samples that involve radiochemicals, including some required by the HRSD permit, are collected by the RadCon Department and analyzed in the RadCon radiological analysis lab. Eberline Services performed all subcontracted radiological analyses. Audits of Universal Labs' collection procedures were performed, and the field efforts were found to be in accordance with protocol.

Samples collected by external analytical laboratories are analyzed for radiological (and non-radiological) attributes using standard EPA-approved analytical procedures. Both external facilities and Jefferson Lab have a continuing program of analytical laboratory QC. Participation in inter-laboratory crosschecks, analysis of various blanks, and replicate sampling and analysis verify data quality. RadCon, other ESH&Q Division staff, and other responsible Jefferson Lab personnel review all analytical data for the samples analyzed

under their subcontracts. The analytical results are reviewed relative to the accompanying QA/QC results and compared with regulatory limits for acceptability. These reviews include inspection of chain-of-custodies, sample stewardship, sample handling and transport, and sampling protocols. When applicable to the analysis requested, analytical labs must be appropriately certified.

Ongoing precision and accuracy are monitored by analysis of the following with each batch of samples taken under Permit VA0089320: laboratory standards, duplicate determinations, matrix spikes, and matrix spike duplicates. These data are used to calculate the relative standard deviation on all applicable parameters. The quality of the data is then evaluated and compared to regulatory limits to determine acceptability. Satisfactory results from the vendors enable TJNAF to validate compliance with the QA requirements in the permit.

TJNAF participated in two independent, external performance evaluation programs in 2007. One of them, the Mixed Analyte Performance Evaluation Program (MAPEP), is conducted by DOE's Radiological and Environmental Services Laboratory, and is available to all DOE contractors and subcontractors. This program tests the quality of environmental radiological and non-radiological measurements and provides DOE with complex-wide comparability of measurement performance. Performance evaluation samples are distributed semi-annually to participating labs. The results for 2007 can be found at http://www.inl.gov/resl/mapep/reports.html. In 2007, Eberline Services and TJNAF's RadCon lab participated in the MAPEP. Performance results for all Eberline Services' analyses, and the Lab's own RadCon lab, were satisfactory for all relevant radionuclides in 2007. TJNAF also participates in a second performance evaluation program for tritium in water, through Environmental Resource Associates® (ERA). The samples provided through this program are a better match than those from MAPEP for the characteristics of water samples being counted in the RadCon lab. TJNAF results for tritium performance through the ERA program were satisfactory in 2007.

## SECTION 4
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## ACRONYMS and ABBREVIATIONS

These acronyms and abbreviations reflect the typical manner in which terms are used for this specific document and may not apply to all situations.

| | |
|---|---|
| ALARA | As Low As Reasonably Achievable |
| AP | Affirmative Procurement |
| AMD | Advanced Micro Devices |
| ARC | Applied Research Center |
| BAT | best available technology |
| BMP | Best Management Practice |
| BSY | Beam Switchyard |
| CAA | Clean Air Act |
| CAAA | Clean Air Act Amendments |
| CASA | Center for Advanced Studies of Accelerators |
| CEBAF | Continuous Electron Beam Accelerator Facility |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFC | Chlorofluorocarbon |
| CHL | Central Helium Liquefier |
| Ci | Curie |
| CLAS | CEBAF Large Acceptance Spectrometer |
| CWA | Clean Water Act |
| CX | Categorical Exclusion |
| CY | Calendar Year |
| DCR | (Virginia) Department of Conservation and Recreation |
| DEQ | (Virginia) Department of Environmental Quality |
| DOD | U.S. Department of Defense |
| DOE | U.S. Department of Energy |
| E2 | Energy Efficiency |
| EA | Environmental Assessment |

| | |
|---|---|
| ECHO | Enforcement & Compliance History Online |
| ES&H | Environment, Safety, and Health |
| ESH&Q | Environmental, Safety, Health, and Quality |
| EIS | Environmental Impact Statement |
| EMS | Environmental Management System |
| EO | Executive Order of the President of the United States |
| EP | Environmental Protection |
| EPA | Environmental Protection Agency |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| EPRGs | Emergency Planning and Response Groups |
| ERA | Environmental Resources Associates |
| FEL | Free-Electron Laser |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| FONSI | Finding of No Significant Impact |
| FY | Fiscal Year |
| GB | gigabytes |
| GeV | Billion (Giga-) electron Volts |
| GHz | gigahertz |
| HRSD | Hampton Roads Sanitation District |
| IR | Infrared |

| | |
|---|---|
| ISM | Integrated Safety Management |
| ISO | International Organization of Standardization |
| JSA | Jefferson Science Associates, LLC. |
| kW | Kilowatt |
| LQCD | Lattice Quantum Chromodynamics |
| LINAC | Linear Accelerator |
| LLW | Low Level Radioactive Waste |
| MAPEP | Mixed Analyte Performance Evaluation Program |
| MDA | Minimum Detectable Activity |
| $m^3$ | Cubic Meters |
| MEI | Maximally Exposed Individual |
| mg/l | Milligrams per liter |
| µCi | microcurie |
| mrem | Millirem |
| MS4 | Municipal Separate Storm Sewer Systems |
| MSDS | Material Safety Data Sheet |
| NAAQS | National Ambient Air Quality Standards |
| NASA | National Aeronautics and Space Administration |
| N D | Not detectable |
| NEPA | National Environmental Policy Act |
| NESHAPs | National Emission Standards for Hazardous Air Pollutants |
| ODS | Ozone-Depleting Substance |
| P2 | Pollution Prevention |
| | |
| PCards | Purchase Cards |
| pCi/ l | Picocuries per liter |
| QA | Quality Assurance |

| | |
|---|---|
| QA/CI | Quality Assurance/Continuous Improvement |
| QAP | Quality Assessment Program |
| QC | Quality Control |
| RadCon | Radiation Control (Department) |
| RBM | Radiation Boundary Monitor |
| RAM | random access memory |
| RCRA | Resource Conservation and Recovery Act |
| R&D | Research and Development |
| RF | Radiofrequency |
| SARA | Superfund Amendments and Reauthorization Act |
| SER | Site Environmental Report |
| SOP | Standard Operating Procedure |
| SPCC | Spill Prevention, Control, and Countermeasure |
| SRF | Superconducting Radiofrequency |
| SURA | Southeastern Universities Research Association, Inc. |
| SWPPP | Storm Water Pollution Prevention Plan |
| TDS | Total Dissolved Solids |
| TIP | Target Implementation Plan |
| TJNAF | Thomas Jefferson National Accelerator Facility (Jefferson Lab) |
| TSS | Total Suspended Solids |
| VPDES | Virginia Pollutant Discharge Elimination System |
| VSMP | Virginia Storm Water Management Program |
| WMin/P2 | Waste Minimization/Pollution Prevention |
| WSS | Work Smart Standards |



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12000 Jefferson Avenue
Newport News, VA 23606