Jefferson Lab's 2008 Site Environmental Report

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

U.S. DEPARTMENT OF ENERGY | JSA Jefferson Lab

Thomas Jefferson National Accelerator Facility is managed by Jefferson Science Associates, LLC for the U.S. Department of Energy's Office of Science
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The Thomas Jefferson National Accelerator Facility
SITE ENVIRONMENTAL REPORT
For Calendar Year 2008

Prepared by:
ESH&Q Division
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TJNAF'S SITE ENVIRONMENTAL REPORT (SER)
FOR CALENDAR YEAR 2008

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 2008. This report presents the results of environmental activities and monitoring programs that are within the scope of Jefferson Lab's EMS (environmental management system) and compliance status with environmental requirements. 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 Jefferson 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 September 2008, when the DOE authorized the start of construction for the project.

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 TJNAF's 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 shares their expertise with Jefferson Lab as a whole.

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) Jefferson Lab's EMS was formally recognized by the Department of Energy in December 2005 and is a part of the broader ISMS. It has been established and maintained to meet International Organization for Standardization (ISO) 14001 and DOE Order requirements. The principle is to continually improve the manner in which the TJNAF practices environmental stewardship. A discussion of the EMS appears in Section 2 of this report.

Requirements Identification Process Requirements are comprised of the laws, regulations, and standards necessary and sufficient to ensure worker and public health and safety, and to protect the environment. TJNAF continually identifies new and changing requirements for inclusion into its programs.

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 TJNAF's Ten-Year Master Plan. Routine Jefferson Lab activities and special projects are usually covered under site-specific NEPA Categorical Exclusions (CXs).

Radiological and non-radiological releases to the public from site operations There were no unplanned radiological or non-radiological releases to the public due to accelerator operations during 2008. Releases from normal operations were within permit and regulatory limits and had very minor impact to the public and no health or safety implications. The maximum postulated does from all pathways to a member of the public from TJNAF operations in 2008 is 0.136 millirem (mrem).

ESH&Q Performance Measures The DOE/JSA contract-based measures are used to evaluate TJNAF's ES&H performance. 2008 measures included improving pollution prevention and waste minimization results.

Inspection TJNAF's commitment to protection of the environment, public health, and safety is demonstrated through its inspection programs. Both key 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 TJNAF's record of compliance with applicable laws and regulations, are provided in this report.

General Compliance

TJNAF complied with all applicable Federal, State, and local environmental laws and regulations, and DOE guidance, during 2008. As a result, TJNAF operations had no discernable negative impact on public health or the

Jefferson Lab's environmental compliance performance is detailed in Section 3 of this report. Radiation-related issues, especially those dealing with water resources and public health, are highlighted in Section 4. The TJNAF ES&H Manual facilitates integration of new environmental compliance initiatives into site operations.

Awards and Recognitions The DOE awarded Jefferson Lab two Best in Class Environmental Sustainability Awards for fiscal year 2008 for two projects spearheaded by TJNAF staff: *Circuit Board Saves Cable* and *Refurbished Sodium Iodide Crystals Serve New Use*.

In the first project, Jefferson Lab's Fast Electronics and Data Acquisition Groups designed a circuit board and developed the needed computer code to replace miles of electronic cabling inside Jefferson Lab's experimental halls. The cables are used to delay the signals from each of the detector devices until the trigger system issues the command to convert these analog signals to digital data. While the work was done for the TJNAF's new experimental hall, which is part of the 12 GeV Upgrade, the advancement could result in environmental benefits at physics research laboratories around the world. As an example, the Time-of-Flight detector system used on CLAS (CEBAF's Large Acceptance Spectrometer) needs an additional 250 feet of cable to delay each input signal. There are a total of 672 signals from the TOF system, so approximately 168,000 feet of cable could have been saved if the flash Analog-to-Digital Converter was available when CLAS was implemented. This translates roughly to $132K in cost savings, plus this amount of cable would not have been produced, so less cable would have been stored as waste once the experiment is completed and removed.

In the second project, sodium iodide crystals were refurbished for a major Jefferson Lab experiment. The experiment needed a detector made with sodium-iodide (NaI) crystals that was too expensive to purchase new. A suitable 20-plus year-old detector was found at DOE's Brookhaven Lab. The Jefferson Lab team moved it to Newport News, disassembled it and refurbished each of the 300 plus crystal blocks. After the detector was used for the experiment, it was then given to Duke University for use in an experiment there.

Cumulatively through the end of 2008, research at the Jefferson Lab produced more than 250 patent disclosures. Of those, 158 had been submitted for patents and 79 patents had been granted.

TABLE OF CONTENTS

FIGURES

TABLES

SECTION 1
INTRODUCTION

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 Jefferson Lab's environmental protection program, including public health results, for calendar year (CY) 2008. 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 2008 SER, along with the earlier reports, can be found by going to TJNAF's web page at http://www.JeffersonLab.org/ehs/ser/.

This document marks the 15th year that Thomas Jefferson National Accelerator Facility (TJNAF) has prepared a Site Environmental Report.

1.1 LABORATORY MISSION

TJNAF is a national accelerator facility managed and operated over the course of 2008 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 user driven physics 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.

1.2 SITE OPERATIONS

As a world-class research institution, TJNAF attracts resident and visiting physicists and other scientists. Approximately 670 full-time physicists, engineers, technicians, and support staff work at the Jefferson Lab. More than 1,300 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 148 experiments. TJNAF research has been the basis for the theses of nearly 30 percent of all new U.S. nuclear physics Ph.D.s each year. Jefferson Lab has thus far produced more than 250 patent disclosures. Of those, 158 were submitted for patents from which seventy-nine (79) had been granted by the end of 2008.

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 Superconducting Radio Frequency (SRF) Science and Technology***, which serves primarily as an R&D 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

1.3 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.

In 1986, an adjacent 44 acres were conveyed to Southeastern Universities Research Association (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. The land transfer will support the building of a new experimental hall, which is part of the TJNAF 12 GeV Upgrade. The total DOE-owned parcel upon which TJNAF is built is 170 acres.

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 TJNAF operations. This area, the DOE-owned site, and other nearby properties are considered part of the City's Jefferson Center for Research and Technology.

CEBAF Center

1.4 FACILITIES AND 2008 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 above this text.

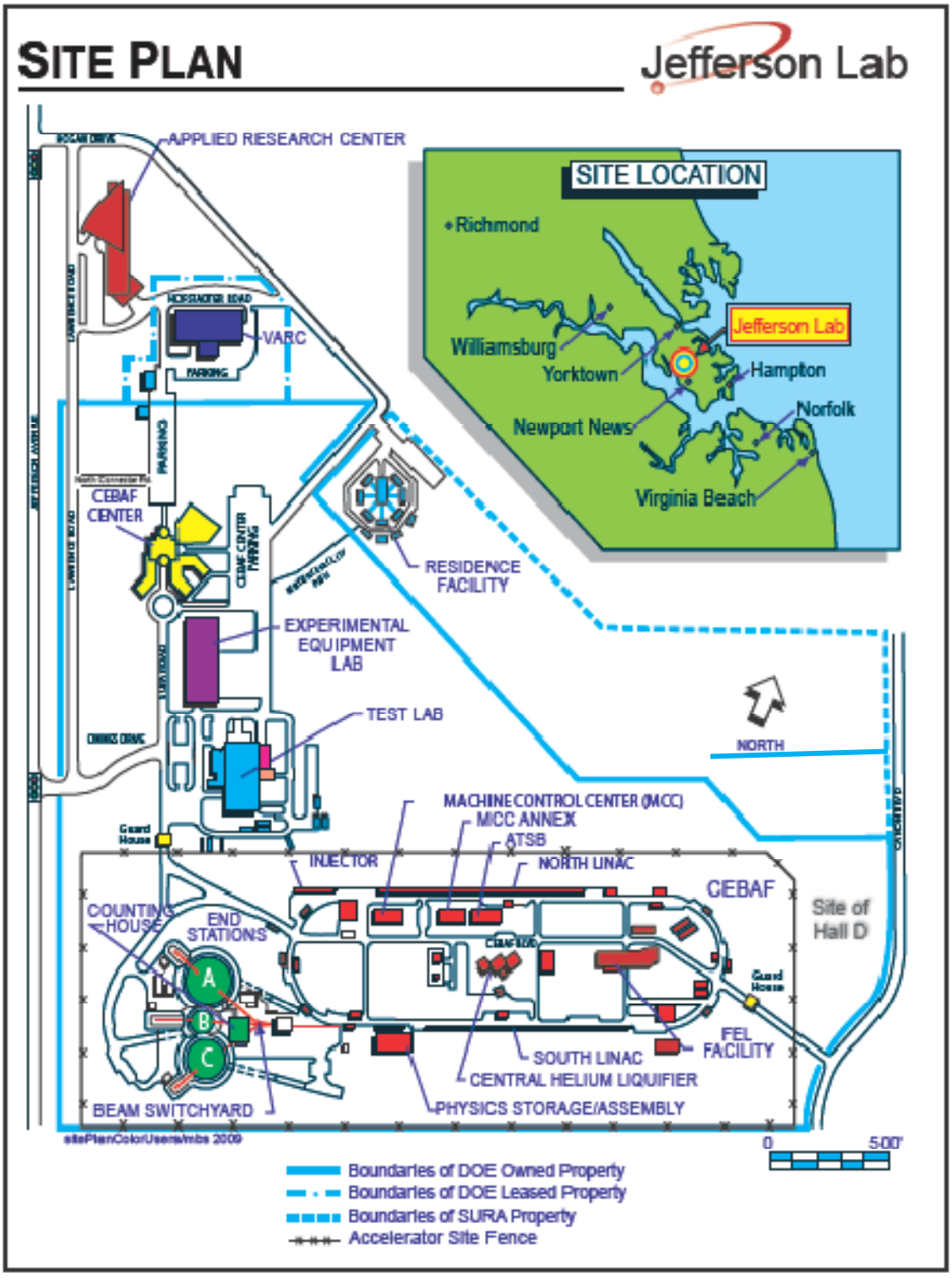
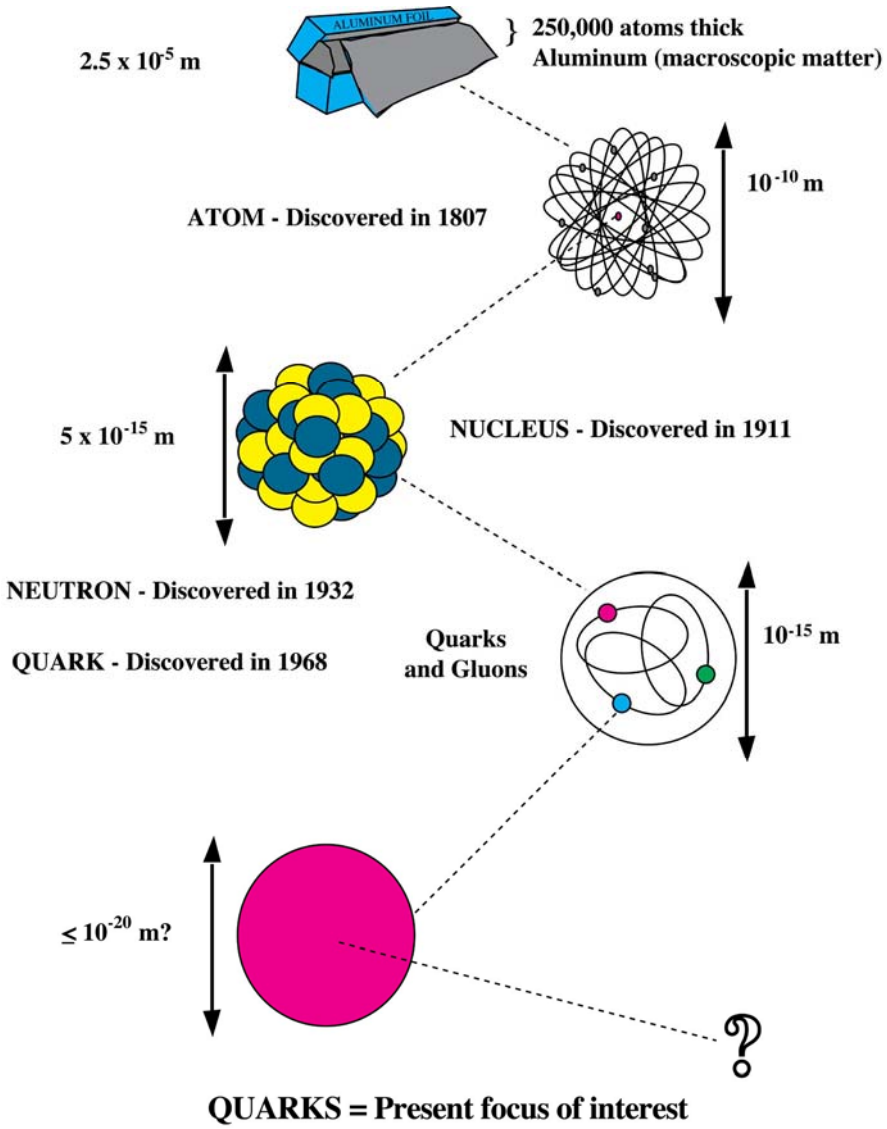


Figure 1.1
Site Map

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 is the Jefferson Lab's Institute for SRF Science and Technology. The Institute's strength is in research and development (R&D) and large-scale applications of SRF, including improvements to CEBAF and the FEL. Work performed in 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.

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 2008. 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.

1.5 ENVIRONMENT, SAFETY, AND HEALTH

Environmental Review

A 1987 environmental assessment (EA), performed as required by the National Environmental Policy Act (NEPA), yielded a Finding of No Significant Impact (FONSI) associated with the initial construction of the CEBAF. 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, 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 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 that support specific line organizations; 2) ESH&Q program specialists that 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.

Jefferson Lab Experimental Facility

SECTION 2
ENVIRONMENTAL MANAGEMENT SYSTEM

An Environmental Management System (EMS) ensures that environmental issues are systematically identified, controlled, and monitored. Moreover, an EMS provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement. Jefferson Lab's EMS was designed to implement its ESH&Q policy, meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Systems, with additional emphasis on compliance, pollution prevention, and community involvement.

Jefferson Lab ESH&Q Policy (excerpt)

Jefferson Lab considers no activity to be so urgent or important that we will compromise our standards for environmental protection, safety, or health.

Hugh Montgomery, Director

As an integral part of Jefferson Lab's Integrated Safety Management System (ISMS), the EMS manages risk to the environment in a similar fashion as risk to the workers and public.

The EMS is based on the continual improvement model of plan-do-check-act and procedures have been established to execute this process. Communication across organizational and functional lines is a fundamental feature of the EMS. This EMS communication network is crucial for:

- Ensuring that management is aware of environmental issues, as well as improvement opportunities identified by any member of the organization, so that they can be addressed and implemented.
- Managing change, so that environmental issues associated with business decisions are identified and dealt with in the planning process to avoid delays and other impediments to achieving goals.
- Facilitating the formation of teams necessary to meet environmental challenges successfully.

Identification of Environmental Aspects and Impacts

A critical planning process occurs annually – the identification (and review) of environmental aspects and impacts. Staff from throughout the organization systematically reviews every activity and service occurring at TJNAF. Potential environmental impacts from these activities and services are also identified. The causes of these potential impacts (Environmental Aspects) are prioritized to allow for risk-based management decisions.

Environmental Objectives and Targets

Jefferson Lab operates within the DOE/JSA contractual requirements, including compliance with environmental conditions specified in permits. Also, as TJNAF implements its EMS, it regularly identifies environmental objectives and targets that would improve site programs, including those that would enhance the Lab's focus on the pollution prevention (P2) efforts.

Jefferson 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 TJNAF to improve management of the minor accelerator-related radioactivity in sump water discharges under its industrial wastewater discharge permit.

Operational Controls

Working Safely

The DOE/JSA contract and environmental permits define the environmental protection terms and conditions for the operation and performance of TJNAF. Procedures and work instructions that govern how activities and services are to be conducted, including environmental protection activities, describe roles, responsibilities, are implemented by the Lab's ES&H Manual. Operational controls are assessed for effectiveness annually during the EMS planning cycle.

One key operational control is the review of projects and activities in light of NEPA and other laws, regulations, and contract requirements. Line management provides notification of actions and impacts of new activities to the ESH&Q Division for review. This review assures compliance with contract and regulatory requirements and identifies opportunities for enhanced environmental protection and stewardship. If subcontractors will be executing work, TJNAF will provide appropriate ES&H and quality requirements, through contract provisions. These documents typically contain environmental requirements and the associated mitigation measures in the event problems arise.

Waste Minimization and Pollution Prevention (WMin/P2).

TJNAF's WMin/P2 Awareness program, as implemented by the EMS, 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 ensure that recommendations to minimize waste streams are brought to the manager's attention.

These practices benefit the environment, protect employees and public health, reduce site waste disposal costs, and foster good community relations. Jefferson Lab's programs were effective in 2008, as evidenced by the following accomplishments:

- Hampton Roads Sanitation District (HRSD) Pollution Prevention Partner - Recognition for significant pollution prevention achievements. JSA received recognition when it applied for a CY 2008 HRSD P2 award for installing new control units in some cooling towers and at an acidic rinse water processing unit.

- Two DOE Best in Class Award for Environmental Sustainability:
    - Refurbishment and reuse of experimental equipment, deemed excess by another DOE lab, eliminated the need to build and eventually dispose of new equipment and saved Jefferson Lab in excess of $1 million.
    - The design of new circuit boards in experimental equipment allowed for the elimination of miles of electrical cable, valued at $132,000. The pollution prevention benefits are associated both with the cable manufacture and its disposal.

Environmental Performance Measurement and Continuous Improvement

Quarterly reviews of contract performance are conducted for various topical areas, including the implementation of the environmental program. In 2008, the Lab received a score of A- for its ability to "Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health, and Environmental Protection."

During 2008, the lab participated in 13 ISMS related reviews (inspections, assessments, etc.) conducted by both internal and external teams, including DOE Headquarters. Other system improvements occurred as a result of the change to DOE Order 450.1A, implementation of EO 13423, and both internal and external lessons-learned.

In summary, TJNAF's EMS is in-place and positively impacting the environment and mission. Although all of the EMS elements are continually evaluated for improvement opportunities, TJNAF has:

- Issued an EMS Policy Statement
- Provided EMS training to staff, users and subcontractors
- Identified its significant aspects
- Established and documented measurable environmental objectives and targets

- Established environmental management programs specifically to achieve each the objectives and targets
- Developed and implemented a program for EMS awareness training
- A formal system for conducting and tracking EMS awareness training
- Established procedures for executing the EMS
- Completed DOE's Self-Declaration Protocol

SECTION 3
COMPLIANCE SUMMARY

The following sections summarize Jefferson Lab's CY 2008 compliance status related to local, state, federal and DOE requirements.

3.1 ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

Environmental Restoration and Waste Management
Jefferson Lab waste management activities were conducted in accordance with all standards and requirements in 2008. There were no environmental restoration activities.

Waste Management
Waste streams at TJNAF 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. Jefferson Lab endeavors to reduce its waste generation and is continually moving forward with its efforts in recycling. TJNAF 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.

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 Environmental Protection Agency (EPA) with the authority to regulate solid waste, from minimization and recovery to collection and disposal.

In FY 2008, about 4.5 tons of routine RCRA hazardous wastes and approximately 257 tons of general refuse were generated. 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 organization, respectively.

The two largest-volume hazardous wastes generated were a waste acid mixture used for niobium cavity processing 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 Jefferson Lab (not covered under RCRA) include radioactive, medical, and recyclable wastes.

Radioactive waste is managed in accordance with DOE Order and Manual 435.1-1, *Radioactive Waste Management*. The requirements continue to be phased into TJNAF's waste management programs under an implementation plan agreed to by DOE and Jefferson Science Associates. Approximately 10 cubic meters of low-level radioactive waste were shipped from the site to a commercial radioactive waste treatment and disposal facility in 2008.

Only a minimal amount of medical waste is generated at TJNAF, and its disposal is in accordance with TJNAF'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 2008 was approximately 145 tons, which included comingled office recyclables and 50 tons of scrap metal. TJNAF also recycled 70 tons of electronic computers and monitors.

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 can provide chemical emergency response services. TJNAF is also responsible for meeting applicable reporting requirements, such as toxic chemical usage and environmental releases, if there are any. Table 2-1 summarizes Jefferson Lab's reporting requirements and status.

Table 3-1 Status of EPCRA Reporting in 2008

EPCRA Section	***Description of Reporting***	***Status***
EPCRA § 302-303	Planning Notification	Yes
EPCRA § 304	EHS Release Notification	Not required
EPCRA § 311-312	MSDS/Chemical Inventory	Yes
EPCRA § 313	Toxic Release Inventory Reporting	Not required

Note: A "Yes" entry in the Status column indicates that TJNAF reports in accordance with the referenced section.

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 that alternative actions are explored. These evaluations are to be performed and reported as either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). Besides the EAs, TJNAF meets routine NEPA requirements of reviewing construction activities for compliance. Activities in 2008 fell under the site's active, DOE-determined Categorical Exclusions (CXs), EAs, and internal CX reviews.

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 Virginia 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 also 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.

3.2 RADIATION PROTECTION

Radiation Protection

All Jefferson Lab activities in 2008 were in full compliance with applicable limits for radiation protection

The Radiation Protection Program is managed in accordance with DOE Order 5400.5, *Radiation Protection Program of the Public and the Environment.* The requirements continue to be phased into TJNAF's waste management programs under an implementation plan agreed to by DOE and Jefferson Science Associates. Activities and results associated with TJNAF's radiation protection program are summarized in Section 4.

3.3 AIR QUALITY AND PROTECTION

Air Quality and Protection

All Jefferson Lab activities were in compliance with air quality standards and requirements and all emissions were below reportable thresholds.

TJNAF complies with Virginia Commonwealth and Federal air pollution regulations. The Federal Clean Air Act and its 1990 Amendments 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 are derived from consumption and emission factors and provided to the Virginia Department of Environmental Quality (DEQ) upon request. This would also apply to emissions from emergency generators.

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 reporting thresholds. Compliance with all applicable clean air standards continued through 2008.

National Emission Standards for Hazardous Air Pollutants (NESHAP) and Radionuclide Emissions

NESHAP governs air emissions that contain hazardous components, such as radionuclides and asbestos. There were no Jefferson Lab activities associated with asbestos handling in 2008. Refer to Section 4 for discussion of direct radiation, the primary form of radiation emissions.

National Ambient Air Quality Standards (NAAQS)

The EPA has established NAAQS for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. In 2008, the Hampton Roads Area (including Newport News) remained in attainment status for all NAAQS pollutants.

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)

TJNAF minimizes the use of ODSs by using safe, cost-effective, environmentally preferable alternatives where possible. ODS-containing items used at TJNAF include refrigerants, fire extinguishers, degreasers, cleaners, and aerosol can propellants.

To reduce the potential for emissions of ODSs, 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.

3.4 WATER QUALITY AND PROTECTION

Water Quality and Protection

The Lab held five active water permits in 2008; no regulatory limits were exceeded and all water quality programs were effective.

Both ground and surface water quality protection are high priorities at TJNAF.

Rain Garden at TJNAF

Standards used to protect water quality include Virginia regulations, the Clean Water Act (CWA), and others identified in ES&H Manual. TJNAF complies with all requirements and performs monitoring under applicable water quality permits. Jefferson Lab held five active water permits in 2008: 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, along with rainwater, permitted effluent from a cooling tower and dewatered 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 2008.

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 covers groundwater quality monitoring; groundwater withdrawn at the end stations and pumped to the surface; and effluent from one cooling tower.

Groundwater

This coverage includes the groundwater flowing beneath the site, including groundwater that is collected from under the experimental halls and discharged to the surface.

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 to the state as requested and on a quarterly, semi-annual, and annual basis. The wells and groundwater samples are tested for general water quality parameters of pH, conductivity, total suspended solids (TSS), and total dissolved solids (TDS). Monitoring for radioactivity is discussed in Section 4.

Cooling Water Discharge Monitoring

Cooling tower discharge is sampled on a quarterly basis. Information collected includes flow rate, pH, temperature, ammonia, total hardness, total dissolved copper, total dissolved zinc, and total residual chlorine.

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

This permit authorizes TJNAF operators of MS4s to discharge storm water to surface waters. The permit's intent is to keep surface waters free of sediment and other pollutants. Under this permit, TJNAF maintains a storm water management program, as noted in Chapter 6730 of the TJNAF ES&H Manual. The permit also requires that TJNAF 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 2008.

General Permit for Storm Water Discharges of Storm Water from Construction Activities – VSMP Permit No. DCR01-08-100332 (Effective August 15, 2008)

The main requirement under this permit is for TJNAF to have 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 organization oversees civil construction projects, ensuring that subcontractors adhere to permit and other contract-specified standards.

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 collect local groundwater into a sump pit from which it is pumped to the surface. The only parameter regulated under this 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 quantities of water pumped from these tile fields are reported to the DEQ. All withdrawals, both monthly and annually, were well within permit limits. The affected groundwater is sampled for water quality parameters under VPDES Permit No. 0089320. There were no unusual issues regarding this discharge in 2008.

Hampton Roads Sanitation District Permit No. 0117

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

HRSD conducted an inspection on February 21, 2008. The inspection covered several TJNAF buildings and a review of monthly and quarterly records. HRSD also provided Jefferson Lab with some helpful materials on preventing oil and grease from potentially impacting the sewer system. No problems were found that required any response to HRSD. TJNAF received a Gold pretreatment excellence award for its 2008 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 acid rinse water from a small chemistry lab in Building 58.

Pollution Prevention Award

For all monitoring, subcontracted analytical laboratories and/or trained TJNAF staff (for some radiological parameters only), perform the sampling at the prescribed sampling points. 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.

Secondary Containement in Use

Spill Prevention, Control, and Countermeasure (SPCC) Plan

The TJNAF SPCC 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 Jefferson 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. Jefferson 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 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.

Permit Summary

TJNAF held five active water permits in 2008

PERMIT NUMBER	PERMIT TYPE
GW0047200	Groundwater withdrawal
VA0089320	Ground and surface water discharge
VAR40079	Storm water discharge
DCR-01-08-100332	Storm water discharge
HRSD 0117	Discharges to sanitary sewer

3.5 ENVIRONMENTAL COMPLIANCE /EMS AUDITS

Environmental Compliance / EMS Audits
TJNAF conducted numerous compliance reviews and found no permit violations in 2009

The DOE Site Office, the DOE Oak Ridge Office, and various Commonwealth and local authorities provide external oversight of the TJNAF environmental program. Program effectiveness is also measured through self-assessments, inspections, and work observation programs. TJNAF complies with all applicable laws, regulations, and permits. Actions of note undertaken in 2008 are described here.

DOE Review of TJNAF

The DOE Site Office's 2008 Performance Evaluation Report (October 1, 2007 through September 30, 2008) 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."

External Inspections

HRSD staff inspected Jefferson Lab on February 2, 2008, 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 2008 documents. No discrepancies were recorded.

3.6 EXECUTIVE ORDERS

Executive Orders

All relevant Executive Orders were implemented within Jefferson Lab programs in 2008.

Applicable Executive Orders (E.O.)

There were numerous activities conducted throughout TJNAF in 2008 that furthered environmental stewardship, especially in energy management. Some actions were related to E.O. requirements, others were staff-initiated, and some a combination of the two.

Solar Powered Motorized Cart

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. 13423, Strengthening Federal Environmental, Energy, and Transportation Management

E.O. 13423 is intended to develop a cohesive, strategic approach to improve the environmental and energy performance of Federal programs. These improvements are centered around more efficient use of electricity and water, minimizing waste and pollution through enlightened purchasing and recycling, and reducing the petroleum consumption of its vehicle fleets. DOE describes its requirements and responsibilities for execution of the E.O in DOE O 450.1A, *Environmental Protection Program* and DOE O 430.2B, *Departmental Energy, Renewable Energy and transportation Management.*

TJNAF is an active participant in these efforts. In December of 2008, Jefferson Lab issued its *Executable Plan for Energy, Renewable Energy, and Transportation*. This plan addresses

each specific goal in EO 13423, assesses TJNAF's current status, and lays out actions and schedules for meeting all the goals. Major 2008 activities associated with this program are summarized below.

Energy Efficiency - Jefferson Lab completed a comprehensive energy audit in 2008 that outlines projects and policies for more efficient energy use lab-wide. TJNAF also conducted several commissioning studies of existing buildings during 2008. These studies evaluate whether a building's various systems are functioning efficiently, and if not, what improvements can be made.

Jefferson Lab exceeded the energy goals prescribed by applicable standards in 2008.

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 2008.

Transportation Fleet Management – TJNAF has focused on replacing its fleet of standard fuel vehicles with those powered by alternative fuels. To date, 6 of 21 have been replaced. Electric powered industrial vehicles are used extensively for on-site transportation of people and materials to the extent practicable.

Sustainable Design / High Performance Buildings - Though the CEBAF accelerator complex is the site's primary energy user, energy management is applied throughout TJNAF. 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 2008, TJNAF continued this effort. The ultimate goal is to have at least 15% of existing buildings meet sustainability standards by 2015.

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, TJNAF 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. TJNAF intends that all items be disposed of in the most

environmentally acceptable manner, meeting all applicable regulatory and contractual requirements.

Adopt-A-Spot Program

There are additional environmental stewardship goals that TJNAF strives to meet including:

- Reductions in the generation and /or toxicity of hazardous waste through pollution prevention - TJNAF's WMin/P2 Awareness program, as implemented by the EMS, fosters the philosophy that waste prevention is superior to paying either for special disposal or for remediation. See Section 2 for specific pollution prevention success stories.

- Reduction or elimination of acquisition of toxic and hazardous chemicals and materials – TJNAF ESH&Q staff routinely review purchase requests for hazardous materials to help identify environmentally preferable products.

- Environmentally preferable purchasing - TJNAF 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 TJNAF'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 operations.

- Electronic stewardship – TJNAF requires the selection of energy efficient desktop and laptop computers and computer monitors. Starting in October, the Lab is tracking the purchase of this type of equipment. Energy savings, based on the rated efficiencies of the equipment, can then be calculated and reported.

- Recycling practices - TJNAF 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 presence of recycling containers throughout TJNAF has considerably increased staff recycling awareness and participation. In FY 2008, with scrap metal and automatic data processing equipment included in the total, TJNAF recycled about 220 tons of materials.

Dogwood Blossoms

SECTION 4 ENVIRONMENTAL RADIOLOGICAL PROGRAM

4.1 RADIATION AT JEFFERSON LAB

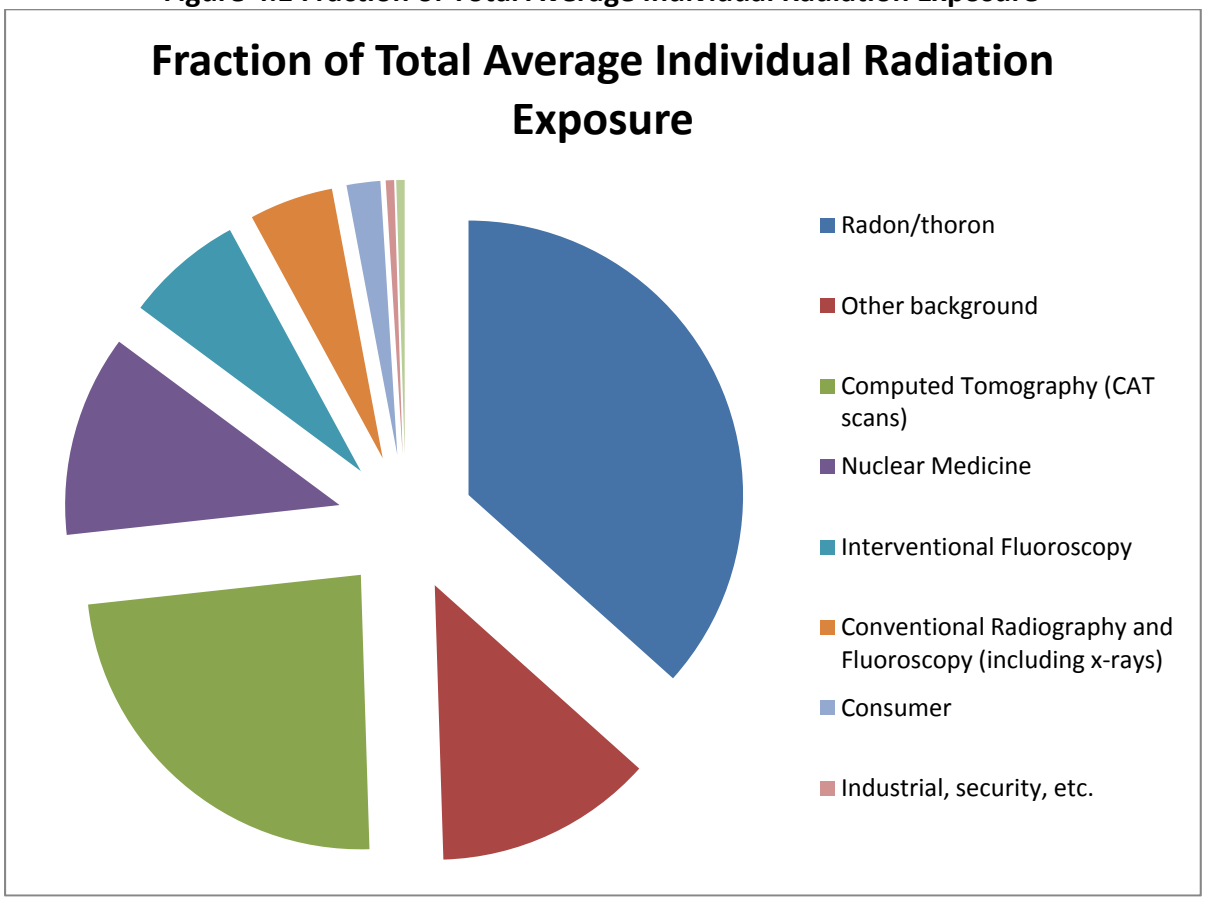
Ionizing radiation and a variety of radioactive materials are byproducts of research activities at TJNAF. Any potential impacts have been significantly reduced by adhering to the philosophy of ***ALARA***, "as low as reasonably achievable", in dealing with potential sources of radiation. The potential dose to members of the public from various pathways, such as inhalation, ingestion, and skin absorption, is evaluated by the ESH&Q Division 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

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, notably from medical procedures. Radiation dose is formally expressed as annual average dose equivalents in units of millirems (mrem). Figure 4.1 shows the relative significance of various sources of radioactivity exposure to the average individual. According to the National Council on

Radiation Protection and Measurements (NCRP), as of 2006, the average individual radiation exposure from all sources now totals 620 mrem per year, up from an estimated 360 mrem in the early 1980s. The increase can be attributed to medical uses of radiation.

Figure 4.1 Fraction of Total Average Individual Radiation Exposure

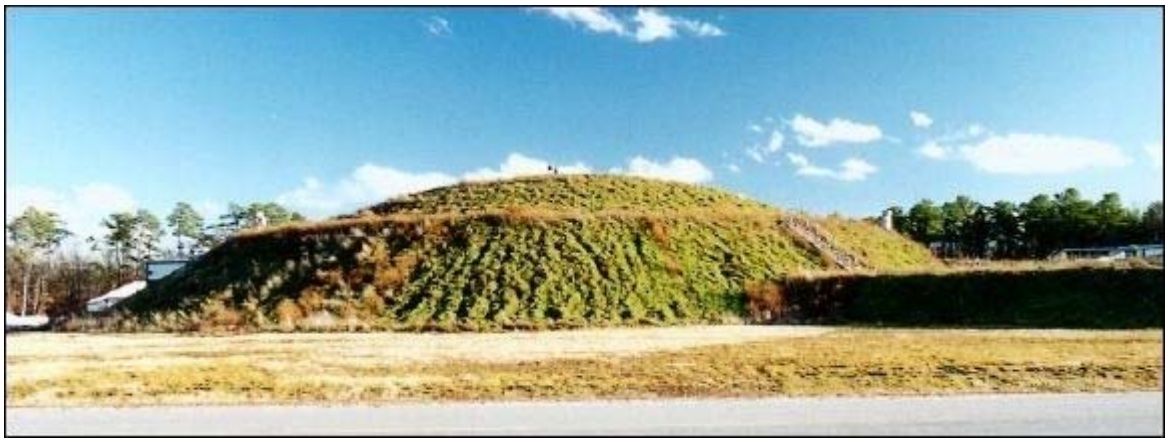


The DOE limits the potential dose to the public that is attributable to DOE facility operations to 100 mrem per year. TJNAF has established an Alert Level of 10 mrem, either measured or estimated, for protection of the general public.

4.2 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 an 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 decreases with distance from the accelerators, and has been shown to be insignificant at the site boundary.



Earthen Beam 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. *Five site boundary monitoring stations* also collected direct radiation data in 2008. 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 cause the formation of radioactive materials through activation of matter. The beam lines, magnets, beam line 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. Strict controls limit possible radiation exposure from these activated items and materials.

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 4.7 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 TJNAF 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.

Potential Radiation Area

4.3 EFFLUENT MONITORING

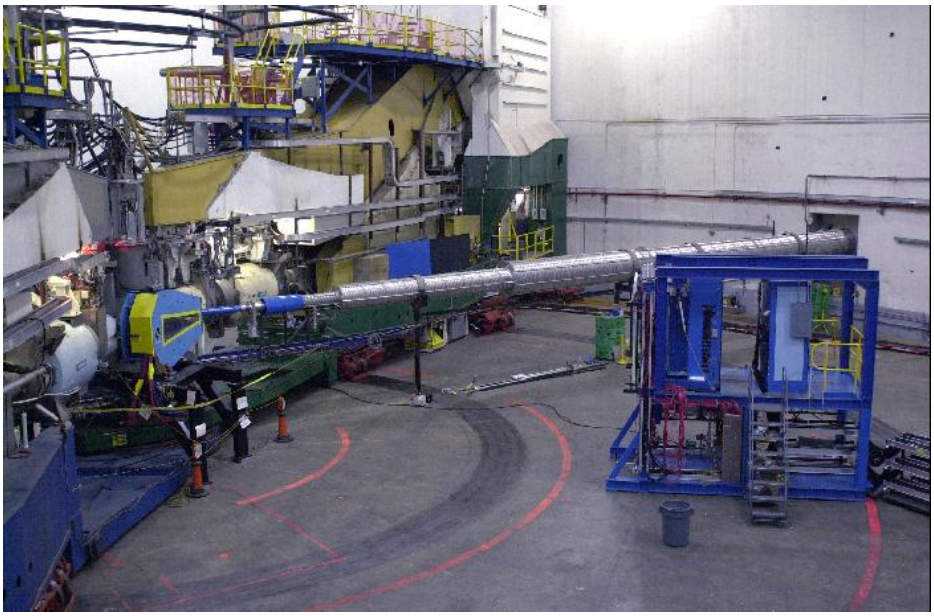
Water that could potentially become activated is sampled and analyzed, and is discharged under permit. Wastewater is released under HRSD Permit No. 0117 to the Hampton Roads Sanitation District (HRSD). HRSD's James River Treatment Plant in Newport News receives and treats potentially activated wastewater from the Lab.

These wastewaters can include:

- CEBAF accelerator enclosure and experimental hall floor drainage*
- Free Electron Laser vault floor drainage and air conditioning (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 monthly concentration of radioactivity not to exceed 0.1 µCi/ml. These limits were never exceeded in 2008.

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



Hall A Beam Line to Beam Dump at Right

Table 4-1 summarizes the 2008 monitoring data for the most common radiological constituent of TJNAF's wastewater discharge to HRSD.

Table 4-1 Tritium Concentration in Discharges to HRSD

Month, 2008	***Average Tritium Concentration, µCi/ml***	***Total Activity Released, µCi***
January	1.00E-07, or 0.000000100	220
February	9.55E-08, or 0.000000096	148
March	8.98E-07, or 0.000000898	1760
April	7.38E-08, or 0.000000074	259
May	1.09E-07, or 0.000000109	411
June	1.27E-07, or 0.000000127	603
July	1.33E-07, or 0.000000127	672
August	1.50E-06, or 0.000001500	411
September	8.50E-06, or 0.000008500	402
October	1.07E-06, or 0.000001070	169
November	5.50E-06, or 0.000005500	104
December	1.62E-06, or 0.000001620	71
Total curies of Tritium released in 2008: 0.005230 (Limit = 5 Ci)		

Quarter, 2008	***Be-7, µCi/ml***	***Mn-54, µCi/ml***	***Na-22, µCi/ml***
1	ND	ND	ND
2	ND	ND	ND
3	5.81E-07	ND	ND
4	ND	ND	1.18E-09
Total curies of Gamma-Emitters released in 2008: 0.0000903 (Limit = 1 Ci)			

The total tritium discharge was 0.1% of the permitted 5 Curies/year. The average tritium concentration was never more than 1/10,000 of the allowable concentration in any month. Total gamma-emitting radionuclides were an insignificant fraction of the 1 Ci annual limit.

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 2008. 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 2008 from Jefferson Lab was 8.50x10^{-6}µCi/ml.

4.4 Groundwater Monitoring

The CEBAF tunnel and experimental end stations are underground, in the Yorktown Formation; soil activation is therefore a potential source of groundwater contamination. Groundwater occurs site-wide at a depth of approximately 7 to 25 feet below grade. 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 2008. Through a combination of engineered controls (e.g. shielding) designed into the CEBAF and FEL facilities, and adherence to operational limits, no significant amount of soil or groundwater activation is expected on-site, and no offsite effect is anticipated.

The Yorktown Formation

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. Jefferson Lab's groundwater monitoring program serves to assess the effect of TJNAF activities on groundwater quantity and quality.

Figure 4.2 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 radio analytical data. The VPDES permit specifies limits for radioactivity in the wells based on their location with respect to

the accelerators. Table 4-2 shows the permit levels associated with the monitoring wells and the end-station dewatering sump discussed below.

Table 4-2, VPDES Permit Limits for Groundwater in pCi/l

Analyte	A-Ring wells	B-Ring wells	C-Ring wells	End Station Dewatering Sump	Highest MDA[4]
Gross Beta	50[1]	50	153	50[2]	14.6
Tritium	5000[1]	5000	1000	20,000	616
Sodium-22	NL[3]	NL	61	NL	10.1
Beryllium-7	NL	NL	835	NL	96.6
Manganese-54	NL	NL	51	NL	10.1

Notes: 1. Action levels, not permit limits
2. Screening level to trigger H^3 monitoring (TJNAF monitors for H^3 regardless)
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 2008. In no sample was the level of radionuclide higher than the highest MDA shown.

The nuclide-specific MDA values in Table 4-2 provide a reference for the detection sensitivity. Values listed are the highest MDA values obtained during analysis in 2008. Gross beta activity was occasionally detected, but not above permit limits. 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.

As in previous years, all monitoring results were within permit limits in 2008, and no accelerator-produced radioactivity was detected in groundwater at TJNAF.

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 recreation area via Brick Kiln Creek. The remainder flows west to the James River.

Crappie Fishing at Big Bethel Reservoir

The quality of the dewatering effluent exceeds all requirements in DOE O 5400.5. Permit-required sampling of this effluent was conducted quarterly in 2008. 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 effluent (activity is much less than the MDA at the point where the effluent stream leaves the site property), the potential dose to a member of the public or biota 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 2008.

4.5 AIRBORNE RADIONUCLIDES

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} (tritium). 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 4-2 for a summary of estimated atmospheric releases from TJNAF in 2008.

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 2008 dose to the maximally exposed individual (MEI) of the public was 0.005 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 4.10 for additional information on exposure and dose estimates.

Figure 4.2 Jefferson Lab's Monitoring Well Network

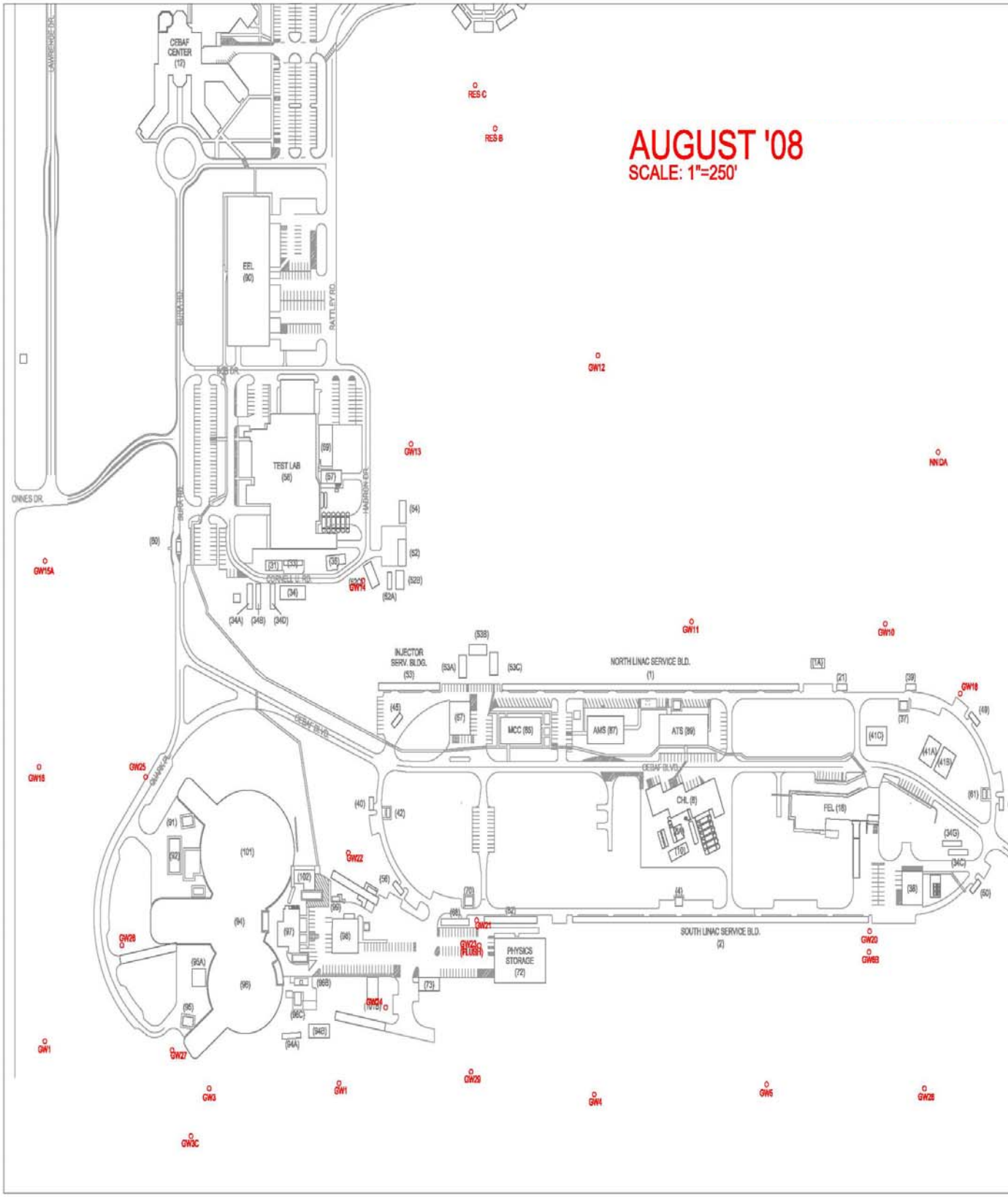


Table 4-3, Estimated 2008 Radiological Atmospheric Releases from TJNAF

Radionuclide [half-life*]	***Ci in CY 2008***
Tritium [12.26 yr]	0.0105
Beryllium-7 [53 .6 days]	0.000582
Carbon-11 [20.3 min]	0.223
Nitrogen-13 [9.96 min]	1.71
Oxygen-15 [123 sec]	0.918
Chlorine-38 [37.29 min]	0.00933
Chlorine-39 [55.5 min]	0.111
Argon-41 [1.83 hr]	0.000470

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

4.6 Direct Radiation Monitoring

The five 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 4.3 shows the approximate locations of these monitors (RBM-5 is in a construction zone and its use has been suspended). 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 4-4. Relative Approximate Locations of Radiation Boundary Monitors

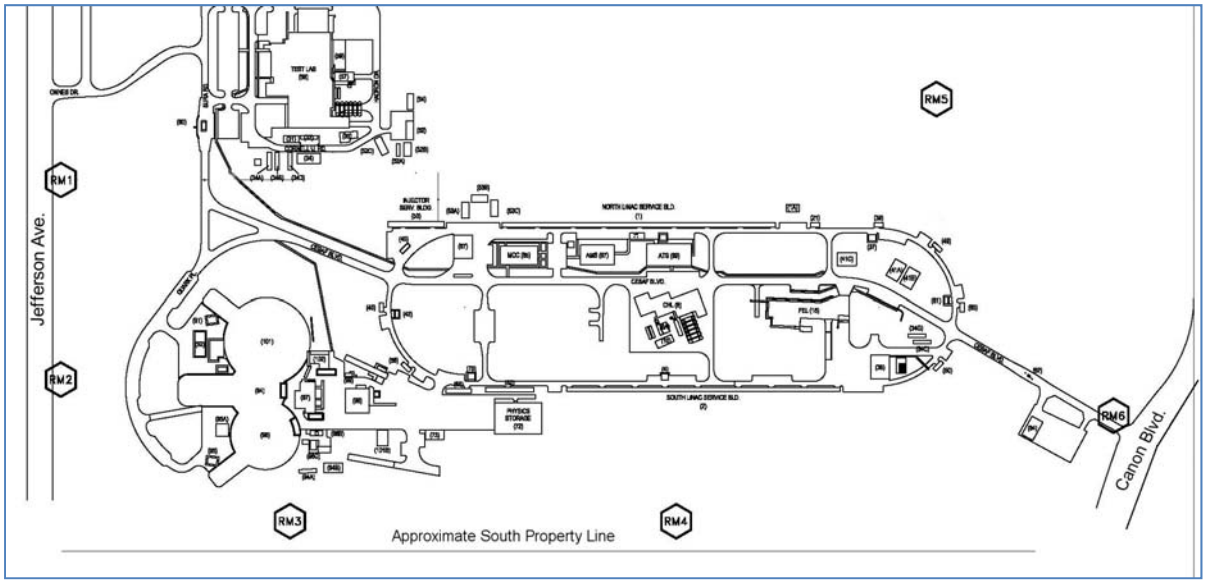


Table 4-4 displays the radiation doses in mrem for 2008 at the detector that saw the largest dose from accelerator and experimental hall operations in 2008 (RBM-3). This dose represents prompt, or direct, radiation exposure that would be experienced at the actual on-site boundary monitor location during 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, however, represent an estimate of the potential dose to a member of the public; under any credible scenario, that dose would be a small fraction of this amount.

The direct radiation exposure at the boundary showed a decrease in 2008 (relative to 2007), due to reduced experimental operations in the second half of the year. The exposure was slightly less than a third of the TJNAF design goal of 10 mrem/year (which is one-tenth of the DOE dose limit). See Section 4.10 for estimates of potential doses to the public.

Table 4-4, Radiation Boundary Monitor Results for 2008

Period	***Neutron (mrem)***	***Gamma (mrem)***	***Total (mrem)***
Jan-June (RBM-3)	2.25 ± 0.02	0.56 ± 0.01	2.81 ± 0.03
July-Dec (RBM-3)	0.04± 0.02	0.01 + 0.01	0.05± 0.03
TOTAL	2.29± 0.03	0.57 ± 0.02	2.86± 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.

4.7 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 volumetrically-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.

Low-Level Radioactive Wastes (LLW)

The only radioactive waste TJNAF generates is LLW; there are no higher level wastes or any that would be categorized as special nuclear materials. In 2008, 10.88 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.

4.8 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 4.3, 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).

Local wildlife

4.9 POTENTIAL DOSE TO THE PUBLIC

Controls are in place to minimize exposure from both direct radiation and radiation from activated materials to TJNAF 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 is 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

(assuming 24 hour a day, 365 day a year exposure to the highest concentration measured at the site boundary) 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 the maximum 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 0.131mrem in 2008 from direct radiation, or .01 % of the TJNAF design goal of 10 mrem, and 0. % 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 2008 is 0.136 mrem.

Table 4-5 summarizes potential doses to the public from all pathways.

Table 4-5 Dose Summary Table for 2008

Pathway	***Dose to Maximally Exposed Individual, mrem***	***% of applicable Limit/(limit)***	***Estimated Population Dose person-rem***	***Population within 80 km***
Air	0.005*	0.05 (10 mrem)		1,743,270 est.
Water	ND†	N/A (4 mrem)**	ND	-
Release of materials	ND	N/A (100 mrem)	ND	-
Direct radiation	0.131 ***	0.131 (100 mrem)	‡	-
Total, all pathways	0.136	0.136 (100 mrem)		1,743,270 est.

*From 2008 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.

Note that the total potentially exposed population (living within 80 km) has increased significantly over numbers previously reported. Jefferson Lab was able to acquire U. S. Census data for the year 2000 in a format that can readily be applied to this analysis. In previous years, 1980 Census data had been scaled up by generic population growth factors.

TJNAF did not contribute significantly to the radiation dose received by the public in 2008.

4.10 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.

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In addition to the internal QA performed by the RadCon Department, independent assessments are performed by the TJNAF QA/CI (Quality Assurance/Continual 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 2008.

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 ESH&Q Division and analyzed in TJNAF's 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. 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 2008. 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 subcontractors. This program tests the quality of environmental radiological and non-radiological measurements and provides DOE with complex-wide comparability of measurement performance. 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 and subcontractor results for tritium performance were satisfactory in 2008.

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
ARC	Applied Research Center
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
DEQ	(Virginia) Department of Environmental Quality
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
E2	Energy Efficiency
EA	Environmental Assessment
EHS	Extremely Hazardous Substance
ES&H	Environment, Safety, and Health
ESH&Q	Environmental, Safety, Health, and Quality

EIS	Environmental Impact Statement
E M S	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
FDS	Floor Drain Sump
FEL	Free-Electron Laser
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FY	Fiscal Year
GeV	Billion (Giga-) electron Volts
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

LQG	Large Quantity Generator
LINAC	Linear Accelerator
LLW	Low Level Radioactive Waste
MAPEP	Mixed Analyte Performance Evaluation Program
MAW	Mixed Analyte Water
MDA	Minimum Detectable Activity
m^3	Cubic Meters
MEI	Maximally Exposed Individual
mg/l	Milligrams per liter
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
NCRP	National Council on Radiation Protection and Measurements
N D	Not detectable
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
ODS	Ozone-Depleting Substance
P2	Pollution Prevention
PBT	Persistent, Bioaccumulative, or Toxic
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
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
SQG	Small Quantity Generator
SRF	Superconducting Radiofrequency
SURA	Southeastern Universities Research Association, Inc.
TIP	Target Implementation Plan
TJNAF	Thomas Jefferson National Accelerator Facility (Jefferson Lab)
TSS	Total Suspended Solids
UV	Ultraviolet
VPDES	Virginia Pollutant Discharge Elimination System
WMin/P2	Waste Minimization/Pollution Prevention
WSS	Work Smart Standards

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