THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY

2010 SITE ENVIRONMENTAL REPORT

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EXECUTIVE SUMMARY

The purpose of this annual report is to document the U.S. Department of Energy's (DOE) Thomas Jefferson National Accelerator Facility's (more commonly "Jefferson Lab" or "JLab") active environmental protection program and its performance in 2010. 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 the impact of radioactive and non-radioactive pollutants, if any, resulting from 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: JLab's mission is to make available a research facility to support goals of the global nuclear physics community and the nation.

At the Continuous Electron Beam Accelerator Facility (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 experimental 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 measured precisely.

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. This work continued in 2010, including major progress on the construction of the Hall D complex and additional site infrastructure.

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 Jefferson Lab'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 Oct. 30, 2006, an important wavelength for both the optimal transmission of laser light through the atmosphere and for materials processing. The lab also operates an ultraviolet FEL which on August 31, 2010 lased in the spectral region down to 363 nm with 100W average power levels. The FEL also holds the world's record in generating terahertz wavelengths.

Research Areas

Staff and visiting scientists continued using the 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 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 provide support to line management and share their expertise with Jefferson Lab as a whole.

Integrated Safety Management (ISM) System
Through ISM, Jefferson Lab 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.

Environmental Management System (EMS)
Jefferson Lab's EMS 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 lab practices environmental stewardship. The EMS is discussed further in 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. Jefferson Lab 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 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 Upgrade and other activities identified in the lab'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 2010. 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 doses from all pathways to the maximally exposed individual (MEI) from JLab operations in 2010 is 0.126 millirem (mrem). The MEI dose is predominantly from direct radiation.

ESH&Q Performance Measures
The DOE/JSA contract-based measures are used to evaluate Jefferson Lab's ES&H performance. The 2010 measures included integration of the EMS with a focus on waste minimization and pollution prevention.

Inspection
Jefferson Lab'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 are being performed effectively. Inspection results, including detailed comments on JLab's record of compliance with applicable laws and regulations, are provided in this report.

GENERAL COMPLIANCE

Jefferson Lab's environmental compliance performance is discussed further in the "Compliance Summary" section of this report. Radiation-related issues, especially those dealing with water resources and public health, are highlighted in the "Environmental Radiological Protection Program & Dose Assessment" section. JLab's ES&H Manual facilitates integration of new environmental compliance initiatives into site operations.

AWARDS AND RECOGNITIONS

DOE's Office of Science recognized JLab for its "2010 Noteworthy Practice in Environmental Sustainability" for a cutting-edge project that significantly reduced our greenhouse gas footprint. The lab also received a Gold Pretreatment Excellence Award and a Pollution Prevention Partnership certificate from the Hampton Roads Sanitation District (HRSD) for the Lab's 2010 performance.

Cumulatively through the end of 2010, research at the Lab produced more than 95 patents.

JEFFERSON LAB SITE

SITE LOCATION

Jefferson Lab is located in an industrial park within the City of Newport News, Virginia. The facility's location and buildings are depicted on Figure 1.1 – Regional and Site Map of Jefferson Lab.

GENERAL ENVIRONMENTAL SETTING

A 1987 Environmental Assessment (EA), performed by the National Environmental Policy Act (NEPA) yielded a "Finding of No Significant Impact (FONSI)" associated with the initial construction of the CEBAF.

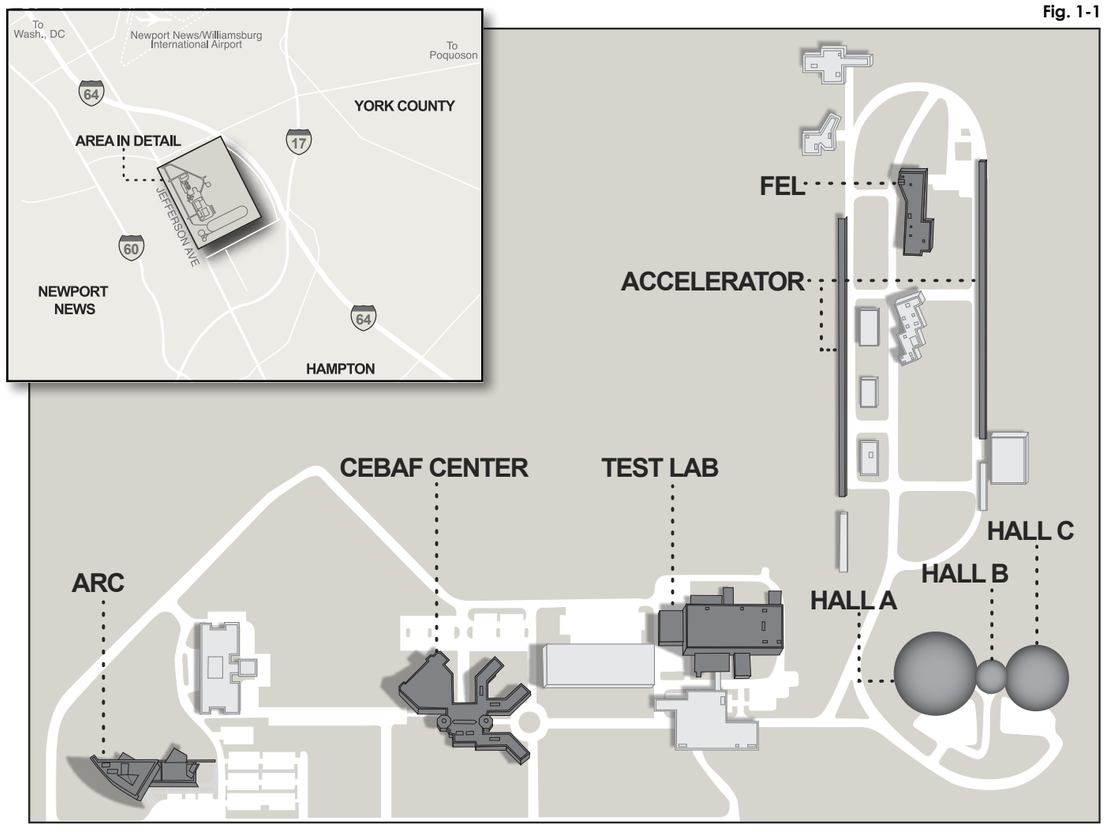
EAs performed in 1997 for a CEBAF upgrade; and in 2002 for an FEL upgrade, and five building construction projects also yielded FONSIs.

In 2007, Jefferson Lab received a FONSI from the Department of Energy (NEPA EA for the Proposed Upgrades and Construction Projects at Jefferson Lab) in relation to the then proposed construction for Jefferson Lab's 12 GeV Upgrade Project. Consequently, an Environmental Impact Statement was not required for the upgrade and operations reviewed. Construction has commenced with environmental considerations monitored and reviewed in accordance with permit requirements.

SITE MISSION

Jefferson Lab's overall operating mission is "… to provide forefront scientific facilities, opportunities and leadership essential for discovering the fundamental

Fig. 1-1



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, health and safety." [Excerpt from Jefferson Lab's Visitor's Information Center.]

Jefferson Lab's Environment, Safety, and Health (ES&H) programs play an important role in support of this mission by:

·Enforcing its ES&H policy statement, which is: "… no activity [is] so urgent or important that standards for environmental protection, safety, or health may be compromised." [excerpt from ES&H Manual Chapter 1100 Environment, Safety, and Health Policy.]

·Identifying and adhering to all applicable ES&H laws, regulations, standards, and Department of Energy's contractual commitments.

·Integrating safety management (ISM) principles in the planning and execution of all work including:

- ·Defining the scope of work
- ·Analyzing the hazards
- ·Developing and implementing hazard controls
- ·Performing work within controls
- ·Providing feedback and continuous improvement

·Empowering employees, subcontractors, and users with the responsibility and expectation - without reprisal - to stop work that endangers people, environment or quality.

·Involving all levels of the organization in establishing ESH&Q objectives and targets.

·Ensuring that employees at all levels of the organization have defined processes and procedures commensurate with work activities; and are appropriately trained and authorized prior to performance.

PRIMARY OPERATIONS AND ACTIVITIES AT THE SITE

The primary operations and activities performed at Jefferson Lab include:

Continuous Electron Beam Accelerator Facility (CEBAF)

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)

Hall end stations have complementary experimental equipment to support their primary functions.

- ·Hall A has a pair of superconducting, high-resolution magnetic spectrometers optimized for precision electron scattering coincidence experiments.
- ·Hall B houses the Large Acceptance Spectrometer (CLAS), which supports studies of both electron- and photon- induced reactions.
- ·JLab's Hall C contains a pair of moderate resolution spectrometers. One is capable of high momentum particle detection, and the second is optimized for the detection of short-lived reaction products.

Institute for Superconducting Radio Frequency (SRF) Science and Technology

This is Jefferson Lab's primary research and development facility that includes improvements to the CEBAF and the FEL. Work includes:

- ·Support of the operation, improvement, and upgrade of the CEBAF.
- ·Development of SRF-based drivers for free electron lasers for possible industrial applications.
- ·Exploration of techniques for producing improved-performance SRF systems.

Center for Advanced Studies of Accelerators (CASA)

Supports the site accelerators and evaluates future opportunities. Its primary mission is to generate, investigate deeply, and distribute forefront knowledge about advanced accelerator and beam physics, especially that knowledge generated as a result of work at Jefferson Lab. A secondary goal for the organization is to provide an organized archive for retaining information generated by Jefferson Laboratory's Accelerator Division activities, so that such information is available to guide future projects.

Free-Electron Laser (FEL)

The 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 JLab'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.

RELEVANT DEMOGRAPHIC INFORMATION

Jefferson Lab is a world-class research institution that attracts resident and visiting physicists and other scientists from around the world. Approximately 720 full-time physicists, engineers, technicians, and support staff work at Jefferson Lab and more than 1,300 academic and industrial researchers, from across the United States and approximately 30 countries and 187 institutions, participate in scientific collaborations.

Jefferson Lab has been the basis for the theses of nearly 30 percent of all new U.S. nuclear physics PhDs each year. Cumulatively through the end of 2010, research at Jefferson Lab produced more than 95 patents.

COMPLIANCE SUMMARY

The following sections summarize Jefferson Lab's 2010 compliance status related to local, state, Federal, and DOE requirements.

ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

Jefferson Lab's waste management activities were conducted in accordance with all standards and requirements in 2010. Waste streams at JLab include RCRA (Resource Conservation and Recovery Act of 1976) hazardous waste, non-hazardous solid waste, and non-RCRA low-level radioactive and medical wastes. There were no required environmental restoration (CERCLA) activities.

Jefferson Lab endeavors to reduce its waste generation and is continually moving forward with its efforts in recycling. Jefferson Lab encourages the reuse or recycling of previously used or discarded materials wherever possible. Some environmental programs, however, do apply and they are discussed below.

Emergency Planning & Community Right to Know Act (EPCRA)

Under EPCRA, as aligned with the Superfund Amendments and Reauthorization Act (SARA), JLab is responsible for providing information on hazardous material quantities so that local entities can provide chemical emergency response services.

The Lab is also responsible for meeting applicable reporting requirements, such as toxic chemical usage and environmental releases, if there are any. Figure 2-1 summarizes Jefferson Lab's reporting requirements and status.

Resource Conservation and Recovery Act (RCRA)

RCRA promotes the protection of health and the environment and the conservation of valuable material and energy resources. In 2010, about 5162 pounds of routine RCRA hazardous wastes were generated. JLab generates such a small volume of hazardous waste per month that it is considered a "Small-Quantity Generator."

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

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 JLab 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 stormwater channels, JLab 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 JLab property. Only small amounts are mixed on site.

Fig. 2-1

STATUS OF EPCRA REPORTING IN 2010

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

National Environmental Policy Act (NEPA)

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). In 2010, JLab conducted several NEPA reviews, mostly associated with the construction activities occurring on-site during this period. In all cases, these reviews indicated that the environmental impacts of the activities were well understood and in control and categorically excluded from NEPA regulations.

Other Wastes

Other wastes generated at Jefferson Lab include radioactive, medical and solid wastes. The vast majority of this waste is general solid waste (approximately 3,000 tons in 2010). This consists of routine office trash and material and debris from construction activities. JLab has an extensive recycling program that segregates paper, metal, aluminum cans, etc. This program resulted in the recycling of over 88% (2,470 tons) of this material in 2010. JLab also recycles almost 100% of its used oil and computer equipment.

Radioactive waste is managed in accordance with DOE Order and Manual 435.1-1, Radioactive Waste Management. Approximately 8 cubic yards of low-level radioactive waste was transferred for off-site disposal in 2010. Only a minor amount of medical waste is generated from the on-site clinic, and its disposal is in accordance with all applicable regulations.

RADIATION PROTECTION

All Jefferson Lab activities in 2010 were in full compliance with applicable limits for radiation protection. Activities and results associated with JLab's radiation protection program are summarized in the "Environmental Radiological Protection Program and Dose Assessment" section (below).

AIR QUALITY AND PROTECTION

JLab has no processes that require air permitting. Internal calculations are conducted routinely to confirm our status and all emissions remained below reportable thresholds in 2010.

Stratospheric Ozone-Depleting Substances (ODSs)

JLab minimizes the use of ODSs by using safe, cost-effective, environmentally preferable alternatives where possible.

Fig. 2-4

Jefferson Lab's Active Water Permits 2010

Permit Type	Outfall	Parameters	# of Permit Exceedances	# of Samples Taken	# of Compliant Samples	Percent Compliant
Industrial Wastewater Discharge to Surface	4*	•Radionuclides •Inorganic Chemicals •Organic Chemicals •pH •Flow	0	38	38	100
Construction Stormwater Discharge	0**	NA	0	NA	NA	100
Municipal Separate Storm Sewer System (MS4)	0***	NA	0	NA	NA	100
Industrial Wastewater Discharge to Sewer	1	•Radionuclides •Inorganic Chemicals •Organic Chemicals •pH •Flow	0	12	12	100****
Groundwater Withdrawal	NA	•Flow	0	12	12	100

JLab's Virginia Pollutant Discharge Elimination System permit includes 3 outfalls and the collection and reporting or radionuclide monitoring data from 15 groundwater monitoring wells located throughout the site. This system of wells is considered one outfall for the purpose of this table.

****Virginia's General Permit for Discharges of Stormwater from Construction Activities does not require the sampling, analysis, and reporting of chemical constituents. Instead, it requires a series of protective measures that are applied to construction activities and routine site inspections.***

*****Much like the General Permit for Construction Activities, the MS4 program requires JLab to implement a wide variety of pollution prevention activities across the site to prevent contamination from entering the stormwater system and leaving the site. No sampling, analysis, and reporting of chemical constituents is required.***

******The regulatory body responsible for this permit (HRSD) presented Jefferson Lab with several awards for its 2010 program.***

To reduce the potential for emissions of ODSs, the lab utilizes trained and licensed subcontractors and staff to perform all work involving ODS-containing refrigeration and air conditioning equipment. Also, the lab 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.

Greenhouse Gas Emissions

During 2010, Jefferson Lab and DOE have continued to assess its greenhouse gas (GHG) emissions. Our efforts to understand these various emissions will allow us to develop ways to minimize them. Additional information on our efforts to reduce greenhouse gas emissions and other environmental performance improvement activities is described in the "Department of Energy/Executive Orders" section below.

WATER QUALITY AND PROTECTION

Jefferson Lab complies with all water quality protection requirements and performs monitoring under applicable water quality permits. Groundwater quality is maintained during operations through use of controls such as shielding and other measures. Surface water quality is maintained by discharging only controlled process wastewater, and significant stormwater controls are in place. Operational control measures include minimizing the use and storage of products that could pollute ground and surface water.

The lab held five active water permits in 2010 (Figure 2-4). No regulatory limits were exceeded and all water quality programs were effective.

DEPARTMENT OF ENERGY/EXECUTIVE ORDERS

E.O. 13423, Strengthening Federal Environmental, Energy, and Transportation Management and E.O. 13514 Federal Leadership in Environmental, Energy, and Economic Performance.

These Executive Orders are 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.

JLab is an active participant in these efforts. In 2010, the Lab issued its Site Sustainability Plan (SSP). The plan addresses each specific goal in the Executive Orders, assesses the lab's current status, and lays out actions and schedules for meeting all the goals. Major 2010 activities associated with this program are summarized in Figure 2-5.

Reductions in the generation and/or toxicity of hazardous waste through pollution prevention

The lab'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.

Reduction or elimination of acquisition of toxic and hazardous chemicals and materials

JLab's ESH&Q staff routinely review purchase requests for hazardous materials to help identify environmentally preferable products.

Environmentally preferable purchasing

Jefferson Lab continues to increase employee awareness of EPA-designated products and provide ready access to these recycled content/remanufac-

Fig. 2-5

Jefferson Lab's Sustainability Goal Performance

DOE Goal	FY10 Site Performance	Site Planned Actions
28% Scope 1 & 2 GHG reduction by FY 2020 from a FY 2008 baseline	16.7% Scope 1&2 GHG emissions increase to-date vs. FY 2008 baseline	Scope 1 – **Vehicles & Equipment-** meet petroleum reduction and AFV fleet goals **Fugitive Emissions –** Complete the planned comprehensive GHG inventory by the January 2011 deadline. Determine any opportunities SF6 and other fugitive emission reduction strategies. Scope 2 – **Purchased Electricity –** Primary strategy – achieves 90% of GHG reduction target through REC purchases. 10% of GHG reduction target from other strategies.
30% energy intensity reduction by FY 2015 from a FY 2003 baseline	19.6% Energy Utilization Intensity (EUI) reduction to-date vs. FY 2003 baseline	30% EUI reduction will be achieved through multiple HVAC and lighting reduction Energy Conservation Measures (ECMs) by FY 2015 end.
7.5% of a site's annual electricity consumption from renewable sources by FY 2010 (2x credit if the energy is produced on-site)	Purchased Renewable Energy Certificates (RECs) to meet renewable energy goal. Submitted on-site renewable waiver request for the 3.75% on-site option.	Continue to meet the 7.5% renewable energy goal through REC purchasing of 7.5% of annual MWh electricity consumption.
Every site to have at least one on-site renewable energy generating system by FY 2010	Installed multiple geothermal systems & procured solar powered exterior lighting equipment.	Continue implementing geothermal systems, solar exterior lighting, solar thermal, and solar photovoltaic (PV) applications.
10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline	In FY10, Jefferson Lab is exceeding the alternative fuel consumption goal (to date). Alternative fuel consumption increased 57% relative to the FY2005 baseline. FY '10 increase from FY '09 = 75%.	Continue to increase Alternative Fuel Vehicle (AFV) fleet by replacing eligible GSA leased vehicles with AFV's to meet the annual 10% increase in alternative fuel consumption by FY 2015.
2% annual reduction in fleet petroleum consumption by FY 2015 relative to a FY 2005 baseline	In FY10, JLab has reduced the fleet petroleum consumption by almost 50% relative to the 2005 baseline.	JLab will continue to decrease its petroleum consumption by replacing petroleum fueled vehicles with hybrid vehicles with low GHG emissions or AFV vehicles as vehicles become eligible for replacement.
75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) by FY 2015	In FY10, 14 of JLab's 21 vehicles are classified as "Light Duty." Of these 14 vehicles, 10 or 72% are AFV.	Replace all light duty vehicles as they become eligible for replacement with AFVs. Achieve 100% AFV's for light duty vehicles by FY2015.
To the maximum extent practicable: advanced metering for electricity (by October 2012), steam, and natural gas (by October 2016); standard meters for water	Jefferson Lab awarded contract in FY'10 for Phase 1 metering plan (install advanced electric, water and gas meters throughout accelerator facilities).	Jefferson Lab will complete Phase 1 installation in FY '11 and award Phase 2 contract of the metering plan (additional site wide water and gas metering) in FY 11. Phase 1 & 2 installation planned to complete by FY '11 end, exceeding the goal deadlines of October 2012 (electric) and October 2016 (natural gas and water) metering
Cool roofs, unless uneconomical, for roof replacements unless project already has CD-2 approval. New roofs must have thermal resistance of at least R-30.	Approximately 25% (193K GSF) of total site roof area (773K GSF) currently comply with cool roof requirements	New construction and major renovation projects currently under construction are designed to meet cool roof requirements. Future roof replacements / upgrades will comply with cool roof requirements as economically feasible.

Fig. 2-5 Continued

Jefferson Lab's Sustainability Goal Performance

DOE Goal	FY10 Site Performance	Site Planned Actions
Training and outreach. DOE facility energy managers to be Certified Energy Managers (CEM) by September 2012.	Complete: Facility Energy Manager CEM & LEED AP certified.	Continue to train additional staff and create an organizational structure to improve energy efficiency.
Sulfur hexafluoride (SF6) capture program by September 2012.	Jefferson Lab currently enjoys a successful SF6 capture program that has captured / recycled approximately 862K Mt / C02 equivalent since 1998.	Jefferson Lab will present our SF6 capture program details at the December Fugitive Emissions Working Group meeting to share our successful capture strategies. Further, in FY '11 Jefferson Lab will continue to conduct SF6 system leak testing utilizing far infrared camera technology.
13% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline	17.9% Scope 3 emissions increase from additional staff / commuting and Transmission & Distribution (T&D) losses vs. FY 2008 baseline.	Develop Scope 3 GHG reduction program in FY 11. Potential reduction strategies : T&D losses – on-site renewable energy generation Business Air / Ground Travel - Increase use of web based meetings Staff Commuting - Promote car pooling, analyze telework and compressed work week programs for applicable support staff.
All new construction and major renovations greater than $5 million to be LEED® Gold certified. Meet High Performance and Sustainable Building (HPSB) guiding principles if less than or equal to $5 million.	1 new construction and 1 major renovation project under construction. Both designed to meet or exceed LEED Gold requirements	All new buildings and major renovation to meet or exceed LEED Gold requirements
15% of existing buildings larger than 5,000 gross square feet (GSF) to be compliant with the five guiding principles of HPSB by FY 2015	Initial HPSB assessment complete, targeted buildings will achieve compliance. 3 buildings meeting the GP are required to achieve the 15% HPSB goal. 13 existing buildings exceed 15K GSF.	Achieving 15% of existing building compliance requires three Jefferson Lab buildings comply with 100% of the HPSB guiding principles. Two facilities currently under construction, due for completion prior to FY 2015 and one additional building will comply 100% with the HBSP principles to achieve the 15% goal by FY 2015 end.
16% water intensity reduction by FY 2015 from a FY 2007 baseline, 26% by FY 2020	14.4% increase in potable water consumption vs. FY 2007. Potable water primarily consumed for cooling tower operations	Cooling Tower Water Reduction Strategies: •Waste water treatment/reuse project pending funding approval (approx $13 million). •Evaluate "hybrid" cooling tower systems to capture/recycle evaporation
20% non potable water consumption reduction of Industrial, Landscaping, and Agricultural (ILA) water by FY 2020 from a FY 2010 baseline	Jefferson Lab does not use non potable water for ILA or any purpose	N/A

tured products. 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

Jefferson Lab requires the selection of energy efficient desktop and laptop computers and computer monitors. The laboratory tracks 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

JLab 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 the lab has considerably increased staff recycling awareness and participation. In 2010, with construction debris, scrap metal and automatic data processing equipment included in the total, the lab recycled approximately 2500 tons of materials.

During 2010, JLab sent over 141,000 lbs (70 tons) of scrap metal for recycling. None of this metal contained or was contaminated with radioactive materials. Approximately 34,388 lbs of this had been stored on site for some time waiting for verification that it had not come from a Radiological Area. This verification occurred, and after review by an independent third party, the metals were recycled.

OTHER ENVIRONMENTAL STATUTES

Oil Pollution Control

In 2010, the Lab reviewed and revised its Spill Prevention, Control, and Countermeasure (SPCC) Plan. The SPCC outlines a program to inspect and respond to spills from large oil-containing storage tanks and equipment on-site. Oil inventory at JLab 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). Jefferson Lab's total volume of oil is estimated to be about 40,000 gallons. To ensure proper handling and response (in the event of a spill or release), all staff who work with oil receive SPCC training. There were no significant releases of petroleum products from the Lab in 2010.

UNPLANNED RELEASES

Jefferson Lab did experience one minor unplanned release in 2010. A major on-going construction project requires the extraction of groundwater from the project area in order to keep the work area dry. The groundwater being removed contains very low levels of organic contaminants associated with Department of Defense activities that occurred in this area in the 1950's. JLab environmental permits specify that the extracted water be sent to the City of Newport News storm drain system in the vicinity of Jefferson Avenue and eventually to the James River. Due to a malfunction of the water transfer system, approximately 180 gallons of this water was directed towards Brick Kiln Creek in March 2010. The lab reported this discharge as required and put corrective actions in place to prevent it from recurring.

SUMMARY OF PERMITS

JLab held five active environmental permits in 2010:

Environmental Permits in 2010

Permit Number	Permit Type
GW0047200	Groundwater withdrawal
VAR10-101819	Construction Stormwater
VA0089320	Ground and surface water discharge
VAR40079	Stormwater discharge
HRSD 0117	Discharges to sanitary sewer

ENVIRONMENTAL OVERSIGHT

JLab's exemplary environmental performance is due to the constant attention it receives from all the parties involved in laboratory operations. The DOE Site Office, the operating contractor, subcontractors, and various Commonwealth and local authorities provide continuous oversight of the the Lab's environmental program. This includes routine inspections (often daily) of construction projects and waste storage.

Program effectiveness is also measured through self-assessments, inspections, and work observation programs. Actions of note undertaken in 2010 included:

- An inspection by the Hampton Roads Sanitation District (HRSD) of the laboratory's sanitary sewer system resulted in no negative findings.
- The lab's Environmental Management System was assessed in April 2010 and declared fully functional.
- A peer review that was conducted of the laboraory's radiation control program concluded that the lab was effective in implementing a program that was "adequate, appropriate, and provided an effective level of radioactive protection to employees, users and the public."

ENVIRONMENTAL MANAGEMENT SYSTEM

Jefferson Lab's Environmental Management System (EMS) is designed and implemented to:

- Identify lab activities with the potential for environmental impacts.
- Mitigate and otherwise manage the impacts of these activities.
- Maintain compliance with applicable environmental protection requirements.
- Promote the long-term stewardship of the lab's and our neighbors' natural resources.
- Encourage understanding and promote dialogue with interested parties.
- Assess performance, implement corrective actions where needed, and ensure continual improvement.

Jefferson Lab has invested in a multi-dimensional process to assure that its staff and contractors understand the potential impacts (both positive and negative) of their work on the environment and have the tools and training necessary to minimize the negative ones and maximize the positive ones.

As our compliance history and awards demonstrate, that on-going process has been successful.

Because EMS is all about improvement, at least annually, a cross-cutting team of lab scientists, engineers, and other professionals are assembled to discuss how we can do better. This group reviews the previous year's EMS performance, discusses changes to lab operations and what that could mean for the environment, and determines where the lab should focus its improvement activities. This analysis, reviewed by (among others) the laboratory director, identifies major focus areas (Objectives) as well as specific projects to support each focus area (Targets).

One benefit of this annual planning is that the improvement targets can be focused on new activities at the lab. For example, 2010 planning showed that Jefferson Lab would be undergoing the most significant construction since the lab itself was built. That resulted in several EMS targets focusing on the construction program. Figure 4.1 below summa-

2010 Objectives & Targets Summary

EMS OBJECTIVE	EMS ANNUAL TARGETS	COMPLETED
Improve our EMS planning and communication processes	•Review existing EMS related training strategy and tools and recommend improvements •Inform all staff and contractor personnel about the prevention of storm water pollution •Train additional staff on EMS	√ √ √
Improve our stewardship of the environment	•Make environmental education available to the public at the 2010 Open House •Hire and train a new employee to focus on erosion and sediment control for construction projects •Conduct routine environmental inspections of all construction projects	√ √ √
Make more efficient use of energy and water	•Purchase 5.0% of the Labs electricity from renewable sources •Install web-based communication/energy analysis software •Improve the accelerator cooling system efficiency •Implement new energy efficiency policy in all building areas – heating and cooling set points, set back schedules, etc. •Purchase at least 100 new generation, power efficient computers •Replace old, inefficient computer servers with virtual servers •Manage PC energy settings (sleep / hibernation)	√ √ √ √ √ √ √
Enhance our pollution prevention program	•Develop and implement a method to segregate non contaminated waste oil •Reduce radioactive waste volumes (on-going) •Recycle old shielding blocks •Construct a new storage yard to better manage non hazardous materials, recycled materials, and other approved materials •Deliver large, used experimental apparatus to the University of Singapore for reuse (avoids disposal)	√ √ √ √ √

Fig. 4.1

rizes the Objectives and Targets for 2010.

ENVIRONMENTAL PERFORMANCE MEASUREMENT

Jefferson Lab conducts a quarterly review of contract performance for various topical areas, including the implementation of the environmental program. The DOE then grades this performance annually. In 2010, the Lab received a score of A- for its ability to "Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health, and Environmental Protection."

Additionally, Jefferson Lab evaluates the Environmental Management System performance in several ways. First, the completion rate of the improvement targets summarized in Figure 4.1 is tracked. The lab successfully completed 92% of these targets in 2010. Second, Jefferson Lab reports on the health of the EMS annually to the Office of the Federal Environmental Executive, which is housed within the President's Council on Environmental Quality. In 2010, Jefferson Lab received a perfect score.

AWARDS

DOE's Office of Science recognized Jefferson Lab for its "2010 Noteworthy Practice in Environmental Sustainability." The award was for a lab-initiated project to manage sulfur hexafluoride, more commonly referred to as SF6, the most potent of the greenhouse gases in its negative effect on the atmosphere. SF6 is used at the lab to suppress arcing in high-voltage DC electron sources, and is widely used in the commercial power transmission industry in circuit breakers, gas-insulated substations, and other switchgear to manage the high voltages carried between generating stations and customer load centers. Before its impact to the environment was understood, the gas was vented into the atmosphere. But, early on, in an effort to save time and money, the lab's Free Electron Laser (FEL) team designed and built a recovery system to capture and store the gas when the FEL high-voltage system was opened for maintenance. Once evidence was clear that SF6 has a greenhouse gas potential at least 20,000 times greater than carbon dioxide, efforts to capture and store it intensified.

The Hampton Roads Sanitation District presented Jefferson Lab with a Gold Pretreatment Excellence Award, and a Pollution Prevention Partnership certificate for its 2010 performance.

ENVIRONMENTAL RADIOLOGICAL PROTECTION PROGRAM AND DOSE ASSESSMENT

ENVIRONMENTAL RADIOLOGICAL MONITORING

Ionizing radiation and a variety of radioactive materials are by-products of research activities at JLab. 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 was required by DOE Order 5400.5 in 2010, "Radiation Protection of the Public and the Environment").

Radiation in the Environment

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
- man-made sources of radiation, notably from medical procedures

Radiation exposure or "dose" is quantified in units of rems, and may be expressed as an individual dose or average amounts among groups or populations. Usually the millirem (mrem) is used to express the small doses associated with occupational and environmental exposure (1 mrem is 1/1000 of a rem).

The Standard International (SI) unit in which dose is expressed is the Sievert or milliSievert. A Sievert is equal to 100 rems, so 1 milliSievert is equal to 100 mrem.

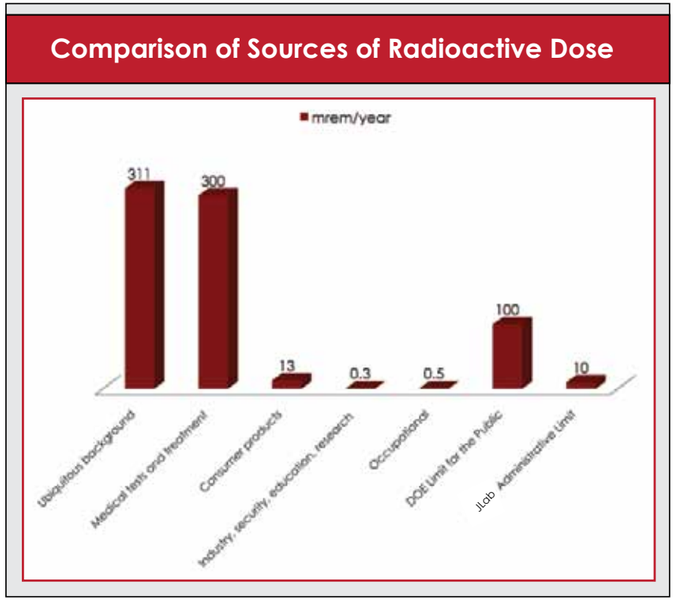
Figure 5.1 "Comparison of Sources of Radioactive Dose" shows the relative significance of various sources of radioactivity exposure to the average member of the public. According to the National Council on Radiation Protection and Measurements (NCRP), as of 2006, the average individual radiation exposure in the U.S. from all sources now totals 620 mrem per year, up from an estimated 360 mrem in the early 1980's. The increase can be attributed to medical uses of radiation.

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

Radiation Exposure Pathways at Jefferson Lab

Two broadly-defined sources of potential radiation exposure exist at the lab: direct radiation and induced radioactivity. Both types are produced during accelerator operations, but direct radiation

Fig. 5.1



has a potential impact only within close proximity to an operating 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 is extremely small at the site boundary.

Jefferson Lab has an extensive monitoring network in and around the accelerator. There are approximately 50 active, real-time radiation monitors and a series of passive integrating detectors deployed around the accelerator site. Five site boundary monitoring stations also collected direct radiation data in 2010. 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 (induced radioactivity). 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.

All materials exposed to the beam or to potential sources of transferable contamination are monitored for radioactivity prior to being released from local control. JLab adhered 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.

Controls are in place to minimize exposure from both direct and induced radiation to lab personnel, the environment, and the public. Access to the accelerator site and to areas containing radioactive material is strictly limited. Fencing, safety interlocks, signs, training, and other engineered and administrative controls prevent inadvertent or unnecessary exposures to direct radiation and induced radioactivity.

Monitoring of Potentially Activated Wastewater

Water that could potentially become activated is sampled and analyzed, and is discharged under HRSD Permit No. 0117 to the Hampton Roads Sanitation District (HRSD). These wastewaters can include:

- CEBAF accelerator enclosure and experimental hall floor drainage*
- Beam dump and target cooling water
- Environmental samples, once analyzed

* 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.

Figures 5.2 and 5.3 summarize the 2010 monitoring data for the potential radiological constituents of Jefferson Lab's wastewater discharge to HRSD.

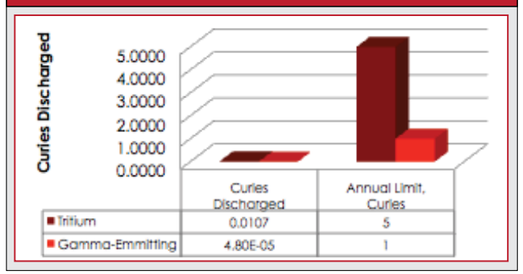
Fig. 5.2

Releases of Radioactivity via Liquid Effluent, 2010 (Curies)

^{3}H (Tritium)	^{7}Beryllium	^{54}Manganese	^{22}Sodium	^{60}Cobalt
1.07E-02	<4.24E-05	<3.80E-06	<3.59E-06	3.23E-06

Fig. 5.3

Radioactive Discharges to HRSD, 2010



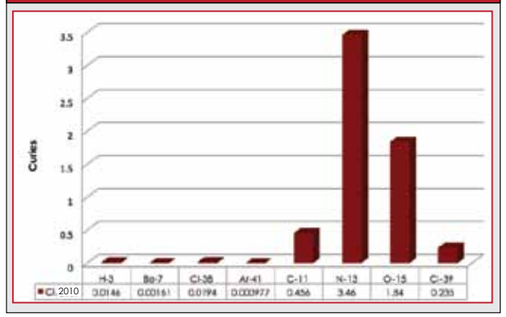
DOE regulates wastewater effluents under DOE Order 5400.5. The Order requires wastewater treatment using to reduce radioactivity content at specified concentration thresholds, in keeping with the ALARA principle. Average discharge concentrations in 2010 remained a small fraction of the best available technology (BAT) treatment threshold.

Airborne Radionuclides

Essentially all airborne radionuclide emissions from the lab are the result of the release of air from accelerator enclosure vaults containing activation products resulting from beam interactions with the air. The interaction of the beam with air produces short-lived radionuclides such as ^{15}Oxygen, ^{13}Nitrogen, and ^{11}Carbon, and smaller amounts of the longer-lived ^{3}Hydrogen (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. See Figure 5.4 below for a summary of estimated atmospheric releases from Jefferson Lab in 2010.

Fig. 5.4

Atmospheric Releases of Radionuclides, 2010



Compliance with EPA regulations (40CFR61) requires JLab to determine the potential for the maximum exposure to this radioactivity by a member of the public. Annual calculations using an EPA-approved computer model (CAP-88, Ver. 3), show that the Lab's operational emissions remain several orders of magnitude lower than the EPA's 10 mrem/yr dose limit for a member of the general public. Jefferson Lab continued making measurements to verify the very low calculated release rate. The calculated 2010 dose to the maximally exposed individual (MEI) of the public was 0.009 mrem due to airborne releases. The location of the MEI was 300 meters due south of the accelerator, in the Oyster Point office park.

Direct Radiation Monitoring

Figure 5.5 "Direct Radiation Dose at Site Boundary, 2010" displays the radiation doses in mrem at the detector that saw the largest dose from accelerator and experimental hall operations in 2010 (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. 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 dose was approximately one fifth of the Lab's design goal of 10 mrem/year (which is one-tenth of the DOE dose limit).

Active (real-time) radiation measurement devices installed along the accelerator site boundary continued to be used to measure dose from direct radiation attributable to lab operations. Figure 5.6 "Environmental Monitoring Locations" shows the approximate locations of these monitors. These electronic detectors - radiation boundary monitors (RBMs) - measure and log radiological information.

Fig. 5.5

Direct Radiation Dose at Site Boundary, 2010

Period	Neutron (mrem)	Gamma (mrem)	Total (mrem)
Jan-June (RBM-3)	1.07 ± 0.02	0.27 ± 0.02	1.34 ± 0.03
July-Dec (RBM-3)	0.57 ± 0.02	0.14 + 0.02	0.71 ± 0.03
TOTAL	1.64 ± 0.03	0.41 ± 0.03	2.05 ± 0.05 (0.0205 ± 0.0005 mSv)

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.*

Groundwater Monitoring

The CEBAF tunnel and experimental end stations are underground in the Yorktown Formation. Groundwater occurs site-wide at a depth of approximately 3 to 25 feet below grade. Groundwater quality in the soil surrounding the accelerator complex is the Commonwealth's greatest concern with site operations.

Under VPDES Permit No. 0089320, JLab monitors groundwater that is pumped from around the experimental halls and is discharged under permit to the surface. The vast majority of the surface water leaving the site flows to the Big Bethel recreation area via Brick Kiln Creek.

Jefferson Lab's groundwater well monitoring program, also under VPDES Permit No. 0089320, serves to assess the effect of Lab activities on groundwater quantity and quality. No accelerator-produced radioactivity that was statistically different than background was detected in site groundwater or surface water in 2010.

Figure 5.6 "Environmental Monitoring Locations" shows the facility's network of groundwater monitoring wells. Fifteen of these wells were 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 were sampled quarterly. B-ring wells are further from potential sources of activation, and were sampled semi-annually. The C-ring wells are positioned to represent conditions near the Lab's boundary, and were sampled annually.

Fig. 5.6

Environmental Monitoring Locations

Groundwater samples are analyzed for: ^{3}H (tritium), ^{7}Be, ^{54}Mn, ^{22}Na, and gross beta activity. The VPDES permit specifies limits for radioactivity in the wells based on their location with respect to the accelerators.

Only gross beta activity, attributable to naturally occurring geologic materials, was occasionally detected. Figure 5.7 "Permit Limits and Maximum Possible Activity" shows permit levels associated with the monitoring wells. No tritium or gamma-emitting radionuclides were found in site groundwater wells in 2010. Figure 5.7 also shows the detectable levels for the radionuclides that were not found, thus representing the potential maximum activity for that nuclide.

Other Environmental Surveillance

Jefferson Lab routinely collects environmental samples not required by any regulation or permit. 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.

POTENTIAL DOSE TO THE PUBLIC AND TO BIOTA

Dose to the Public by Proximity

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 direct dose and air emissions are the only sources for which any expected contribution to public dose exists. In Figure 5.5 "Direct Radiation Dose at Site Boundary, 2010," the maximum possible dose to the public assumes a 24-hour a day, 365-days-a-year exposure to the highest levels measured at the site boundary. However, it is not credible under any possible conditions for a member of the public to actually receive this dose. The southern and western boundaries of the site, where the monitors are located, are heavily wooded and either undeveloped (to the south) or a major roadway (Jefferson Avenue, to the west). All site boundaries are also posted with "U.S. Government – No Trespassing" signs.

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. A reasonably conservative scenario could involve exposure at the boundary in which an individual spent two hours per day walking along the site boundary or waiting for a Jefferson Avenue bus, and did so for 250 days of the year. We will conservatively assume 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 0.117 mrem in 2010 from direct radiation, or 1.2 % of the lab's design goal of 10 mrem, and 0.12 % of the DOE limit of 100 mrem.

Further, if one combines 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 2010 is 0.126 mrem.

There is no public or private use of the shallow aquifer in the vicinity of Jefferson Lab; thus, there is no exposure to the public via contact with or ingestion of groundwater. No accelerator-produced radioactivity was detected in any of the samples from the End Station Sump or in surface water. Considering the extremely small quantities of radioactivity that is potentially present in this effluent, 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.

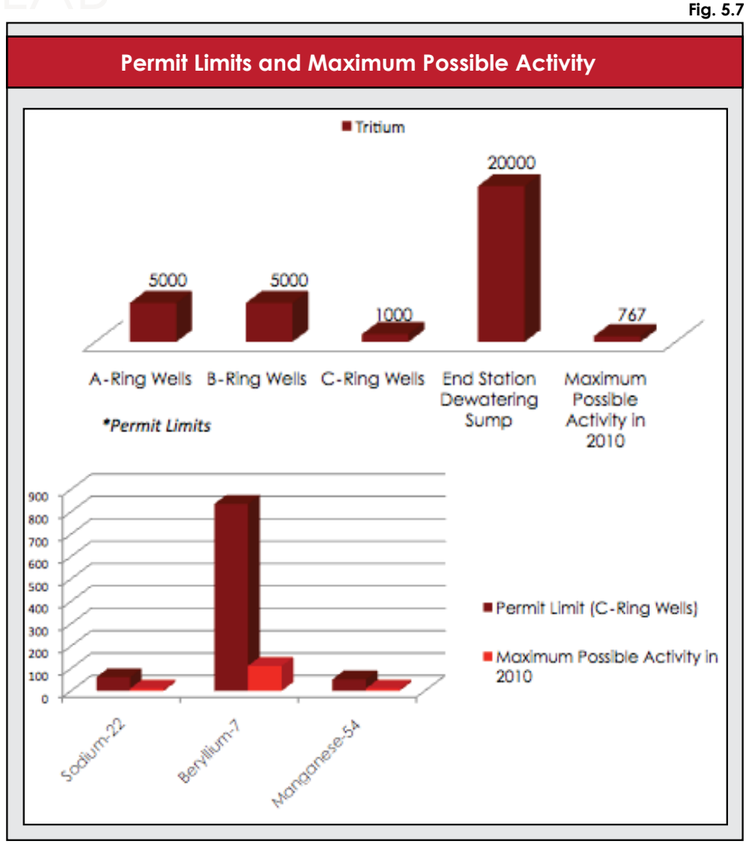
The total "potentially exposed population" reported herein is defined by DOE as those living within 80 km (50 miles) of the site. That total, and resulting population doses, are extreme overestimates for this site, where dose beyond the site boundary is so

low that it cannot be reliably measured.

Dose Via Unrestricted Release of Materials and Equipment

Jefferson Lab does not release any residual radioactive material, such as contaminated concrete or soil, so there are no resulting dose impacts to the public. The Lab has developed a process to determine if potentially radioactive materials are to be managed as material containing residual radioactivity or as non-radioactive. All potentially activated or contaminated material and equipment is monitored prior to release from control. This program involves literally hundreds of radiological surveys annually.

Fig. 5.7



Release limits for surface contamination are given in DOE Order 5400.5, and JLab adheres to those limits (although little material with surface contamination is generated here). The Order does not prescribe a specific limit for release of volumetrically-activated materials; therefore, the Lab has adopted methods and procedures that ensure equipment and materials being released contain no radioactivity distinguishable from background (IFB, indistinguishable 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.

Figure 5.9 "General Process for Materials Classification" summarizes Jefferson Lab's process. From a process perspective, these assessments are consistent with the approach agreed upon by a multi-agency task group regarding defining impacted areas and classifications of material.

The application of process knowledge comprises the first step in the characterization of materials for possible release. The approach at JLab has historically been a conservative one: if materials were in the accelerator enclosure during beam operations, it is assumed that they may be activated, and they are subject to further analysis. Surveys and sampling and analysis are conducted by trained technicians using written procedures. Results of the surveys or other analyses are documented appropriately.

In 2010, the estimated volume of materials released through the process described above was about 3 tons [TBD on release of solid materials, March 2009)] of waste and 17 tons of scrap metals for recycling (almost all of the scrap metal had been previously released and stored on site pending determination that it was not encumbered by a DOE restriction on metals recycling).

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 the Lab's 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.

The lab's process for releasing materials from radiological control was independently reviewed in 2010 as part of a peer-review process used for assessing the radiation control program. The review found no deficiencies in the Lab's program for clearance of materials.

No Authorized Limits for the release of material containing residual radiation have been sought by Jefferson Lab. All materials that exhibit radiation above background levels are managed as Radioactive Material, saved for beneficial reuse in the future, or disposed. The only radioactive waste JLab generates is Low-Level Radioactive Wastes (LLW). There are no higher level wastes or any that would be categorized as special nuclear materials. A total of 8.16 m3 (cubic meters) of LLW, comprising approximately 4700 pounds, was shipped in early 2010. Used protective equipment, contaminated materials from throughout the lab, and waste oil are typical LLWs.

The following documents provide further detail on the criteria for release of materials and management of waste:

- Technical Basis for the Characterization, Management, and Disposal of Radioactive Waste Generated at Jefferson Lab (January 2010)
- Technical Basis for the Release of Solid Material From Radiological Control When Residual Radioactivity Levels are Indistinguishable From Background (March 2009)

The Tech Notes listed above have been reviewed by DOE, with the understanding that the methods therein are being applied at Jefferson Lab.

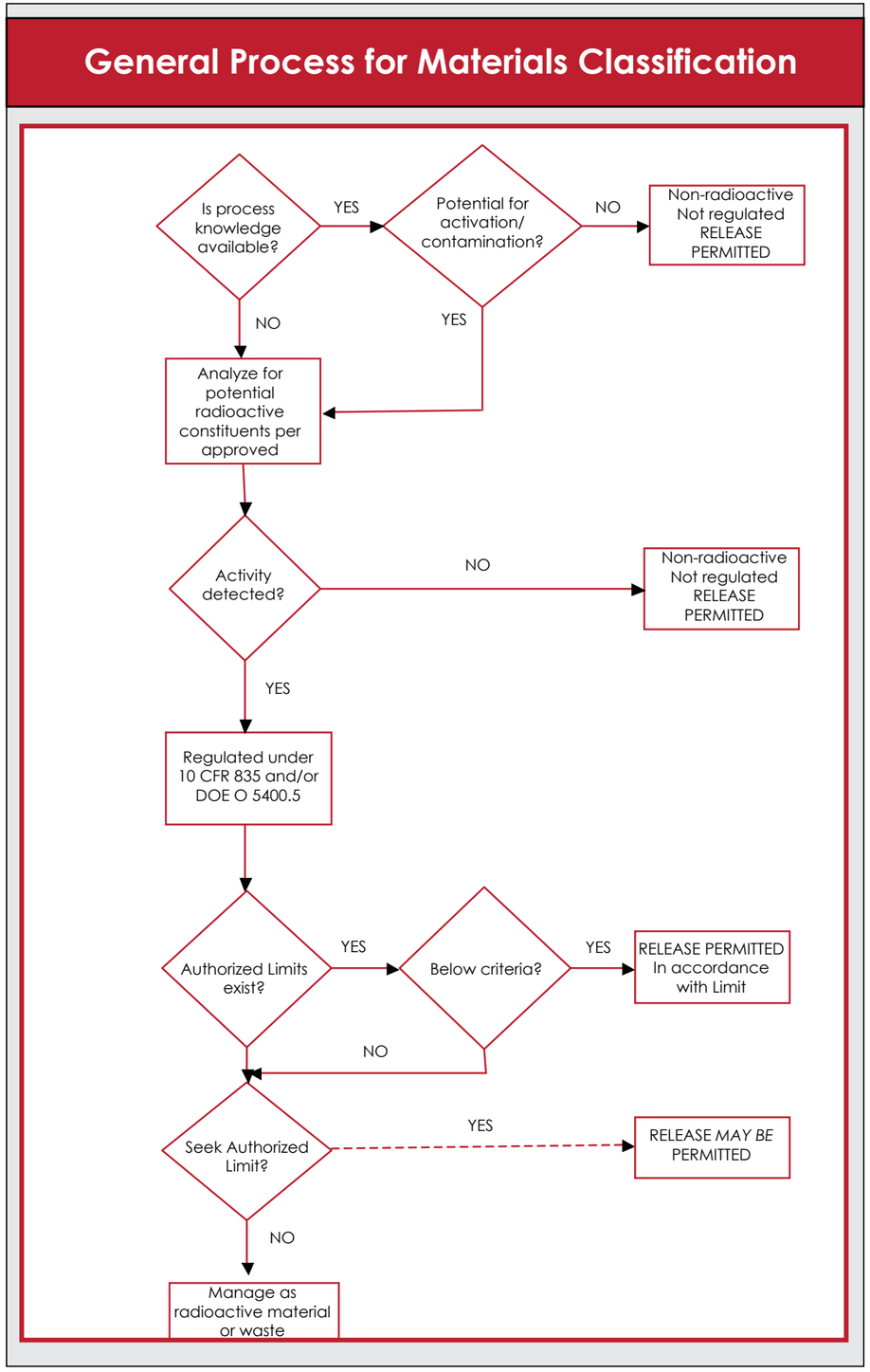
Fig. 5.8

Jefferson Lab Radiological Dose Summary for 2010

Pathway	Dose to Maximally Exposed Individual, mrem	% of 100 mrem/yr DOE Limit	Estimated Population Dose, person-rem	Population within 80 km
Air*	0.009 (0.00009 mSv)	0.009	0.871	1,743,270
Water	~0	~0	~0	~0
Release of materials	<1	<1	<1	<1
Direct radiation**	0.117 (0.00117 mSv)	0.117	~0	-
Total, all pathways	0.126 (0.00126 mSv)	0.126	0.871	1,743,270

From 2010 atmospheric modeling results for NESHAP reporting.
***** From Boundary Radiation Monitors, with conservative exposure scenario applied (see text).***
mSv = milliSievert

Fig. 5.9



Dose to Local Biota

The absorbed dose to any local biota (aquatic or terrestrial) from lab operations can only be estimated. 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. The internationally recommended dose limit for terrestrial biota, 0.1 rad/day, is the lowest limit for any biota. Therefore, if doses do not exceed 0.1 rad/day, then all criteria are met.

The "rad" is a unit of absorbed radioactive dose. 1 rad is roughly equivalent to 1 rem 0.1 rad = 0.1 rem = 100 mrem.

The best indicators of dose to biota are the passive dosimeters placed at various locations around the property. These are the same types of dosimeters used to monitor worker exposure.

During 2010, a significant portion of the Lab's property was undergoing construction; however, the site still provided habitat for deer, foxes, raccoons, squirrels, groundhogs and other small mammals, reptiles, aquatic macroinvertebrates, and a wide variety of birds. The birds and some of the mammals roam the site, but others (like the groundhogs) live in an established burrow. The biota expected to receive the maximum dose would be ground-dwelling animals living in the earthen domes over the experimental halls.

Figure 5.10 "Frequency Distribution of 2010 Dose Recorded by Environmental Dosimeters" shows the frequency distribution of annual (2010) doses from the network of dosimeters. The mean of the values is 41.9 mrem/year, and the median is 18 mrem/year. The maximum recorded dose was 395 mrem/year, measured on the dome of one of the experimental halls. Dividing this value by 365 days yields a daily dose of 1.08 mrem/day, or 0.00108 rem/day, or approximately 0.00108 rad/day, far below the most stringent criteria.

Unplanned Radiological Releases

Jefferson Lab had no unplanned radiological releases in 2010.

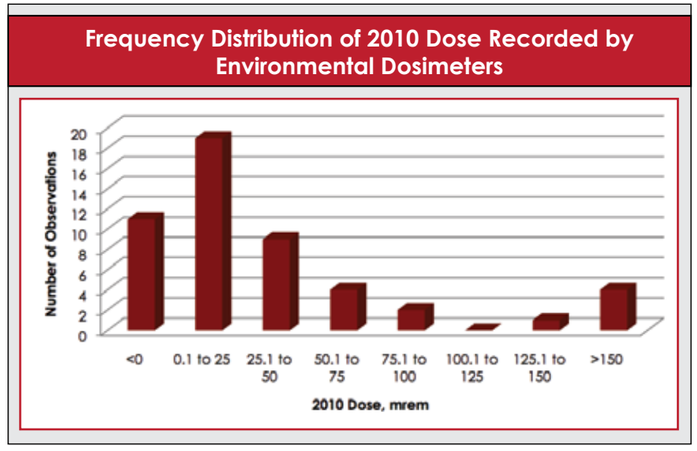


Fig. 5.10

GROUNDWATER PROTECTION PROGRAM

Figure 6.1 is a "Typical Geologic Cross-Section at Jefferson Lab." The CEBAF tunnel and experimental end stations are underground in the Yorktown Formation. Activation of the groundwater is possible, and soil activation is also a potential source of groundwater contamination. Groundwater occurs site-wide at a depth of approximately 3 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 2010. 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.

Fig. 6.1

Typical Geologic Cross-Section at Jefferson Lab

Depth, ft.	Description
0	Loose to stiff, gray, sandy CLAY
5	Loose, orange-brown clayey fine SAND
7	Loose gray silty fine SAND
12	Loose to firm, gray fine to medium SAND
22	Very stiff, gray, shelly, sandy SILT
27	Firm, white, cemented shells
32	Firm, gray, very silty, fine SAND with shell fragments
37	Very stiff, very sandy SILT with shell fragments
40	Boring Terminated

QUALITY ASSURANCE

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

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

In addition to the internal QA performed by the Lab's Radiation Control (RadCon) Department, independent assessments are performed by JLab's Quality Assurance & Continuous Improvement (QA/CI) 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 2010.

An independent laboratory (Universal Laboratories) collected most VPDES and HRSD permit-required water samples. Other samples that involve radiochemicals, including some required by the HRSD permit, are collected by the ESH&Q Division and analyzed in Jefferson Lab's radiological analysis lab. Eberline Services performed all subcontracted radiological analyses. Audits of Universal Lab's 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 cross-checks, 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.

On-going 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 Jefferson Lab to validate compliance with the QA requirements in the permit.

Jefferson Lab and Eberline participated in the Mixed Analyte Performance Evaluation Program (MAPEP) conducted by DOE's Radiological and Environmental Services Laboratory, which 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.

Figures 7.1 and 7.2 represent the results of Jefferson Lab's and Eberline's participation in water analysis comparisons in 2010. Measured values within 20% of the established, or reference, value are considered acceptable. Deviation of >20% but <30% are acceptable with a warning.

Eberline's QA analyses were consistently below the Reference (true) Value, but all were in the acceptable range.

Fig. 7.1

Percent Deviation from Reference Value, MAPEP 23, Jefferson Lab

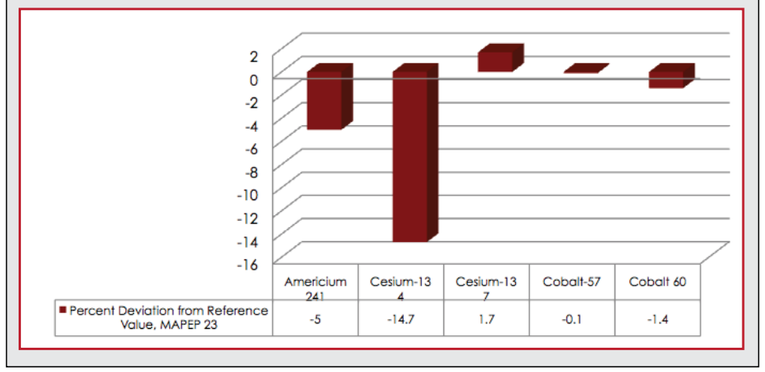
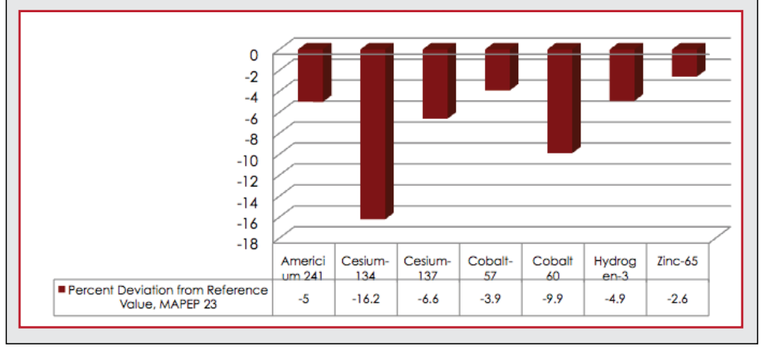


Fig. 7.2

Percent Deviation from Reference Value, MAPEP 23, Eberline Services



ACRONYM LIST

ALARA	As Low As Reasonably Achievable
BAT	Best Available Technology
CAA	Clean Air Act
CEBAF	Continuous Electron Beam Accelerator Facility
Ci	Curie
CX	Categorical Exclusion
DEQ	Department of Environmental Quality (Virginia)
E2	Energy Efficiency
EA	Environmental Assessment
EH&S	Environment, Health and Safety
EMS	Emergency Management System
EPCRA	Emergency Planning and Community Right-to-Know Act of 1986
FEL	Free Electron Laser
FONSI	Finding of No Significant Impact
GeV	Billion (Giga)-electron Volts
HPSB	High Performance and Sustainable Building
HRSD	Hampton Roads Sanitation District
ISM	Integrated Safety Management
JSA	Jefferson Science Associates, LLC
kW	Kilowatt
LINAC	Linear Accelerator
LLW	Low Level Radioactive Waste
MDA	Minimum Detectable Activity
Mrem	Millirem
MS4	Municipal Separate Storm Sewer Systems
MSDS	Material Safety Data Sheet
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
ODS	Ozone-Depleting Substance
P2	Pollution Prevention
PV	Photovoltaic
QA	Quality Assurance
RBM	Radiation Boundary Monitor
RCRA	Resource Conservation and Recovery Act
R&D	Research & Development
RF	Radiofrequency
SER	Site Environmental Report
SQG	Small Quantity Generator
SRF	Superconducting Radiofrequency
SURA	Southeastern Universities Research Association, Inc.
TIP	Target Implementation Plan
UV	Ultraviolet
VPDES	Virginia Pollutant Discharge Elimination System

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Environment, Safety, Health & Quality Division

To inquire about this Report please contact:

Patty Hunt

Thomas Jefferson Site Office
12000 Jefferson Avenue, Suite 14
Newport News, Virginia 23606

Telephone: (757) 269-7039

Email: phunt@jlab.org

Jefferson Lab

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