Performance Report of the

U.S. Department of Energy's

Thomas Jefferson National Accelerator Facility

June 2001

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Jefferson Lab is managed and operated for the U.S. Department of Energy by the Southeastern Universities Research Association (SURA) under contract DE-AC05-84ER40150.

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Executive Summary

Jefferson Lab (JLab), the newest of the U.S. Department of Energy's 16 national laboratories, has been functioning effectively since its inception in 1984, first during construction and now during operations. As shown in this report, JLab aligns itself directly with DOE's strategic planning, both in terms of laboratory visions and plans and in terms of actual laboratory performance. Most importantly, JLab contributes significantly to DOE's Science and Technology mission in the area of nuclear physics, under the Office of Science. The laboratory practices continuous improvement and has made a number of important effectiveness and efficiency enhancements in recent years. Laboratory performance has been demonstrated by completion of the construction phase on cost and schedule, by exceeding technical specifications when coming on-line for physics research, and now during operations by earning ratings of "outstanding" relative to the performance measures in the laboratory's performance-based contract with DOE.

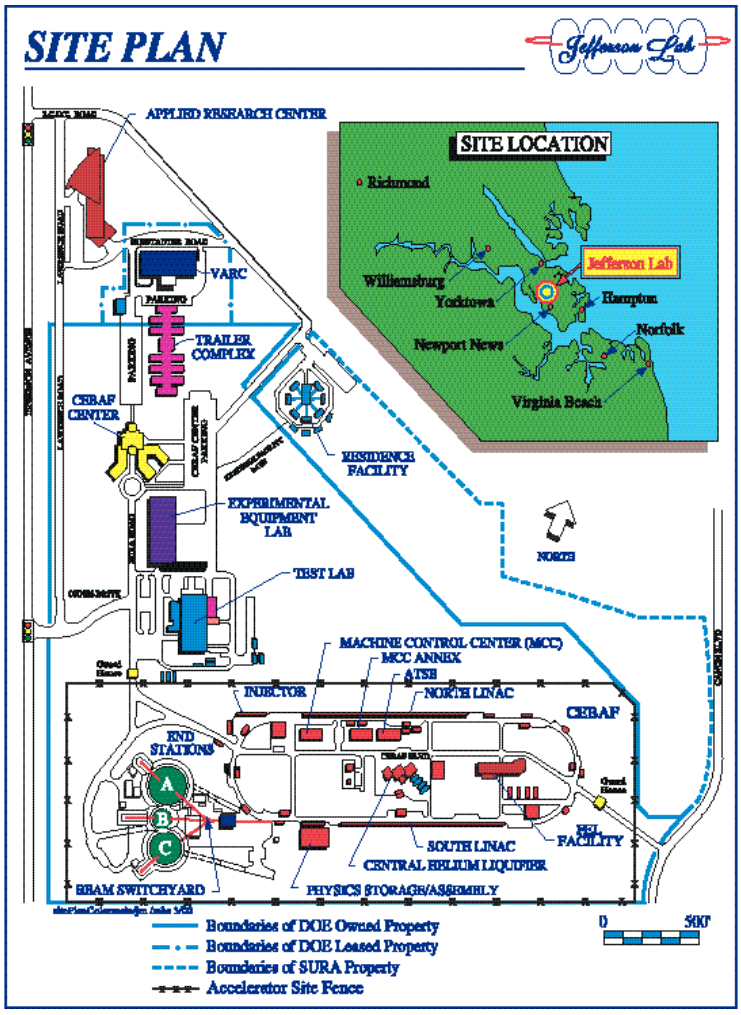
Lab Overview

History

Jefferson Lab (JLab), the newest of the Department of Energy's 16 national laboratories, centers on a continuous-electron-beam accelerator nearly a mile in circumference. In the mid-1990s, nuclear physics experimenters from across the country and around the world began using this highly precise, multi-billion-electron-volt (multi-GeV) research tool for studies that are elucidating the quark structure of the atom's nucleus.

Aerial view of the CEBAF accelerator complex at Jefferson Lab. Service buildings above ground trace the underground accelerator's racetrack shape. Nuclear physics users conduct their experiments in the earthen-topped, domed, semi-underground experiment halls in the foreground. They use house-sized electronics arrays to observe and record the interactions of the accelerated beam's electrons with nuclei inside hand-sized targets.

The need for such studies was identified in the late 1970s, and the envisioned research was made a national priority. As nuclear constituents, quarks had recently become well confirmed, though they remained little understood. As useful probes of the nuclear realm, electrons had long been well understood. So the Nuclear Science Advisory Committee (NSAC) of DOE and the National Science Foundation called for construction of a national electron accelerator like the one now operating at JLab.



The Jefferson Lab research campus.

The laboratory was originally called the Continuous Electron Beam Accelerator Facility. CEBAF construction began in 1987 in Newport News, Virginia. Though originally slated to use conventional accelerating technology, JLab's CEBAF machine uses superconducting radio-frequency (SRF) technology to provide beams of electrons simultaneously to experiments in each of three experiment halls. CEBAF became the first large-scale US use of SRF. This superconducting technology reduces CEBAF's operating power costs to less than 2% of those that would be incurred with conventional technology.

Designed for 4 GeV energy, the CEBAF SRF accelerator has reached 6 GeV in tests and is used operationally at over 5.7 GeV, much to the delight of its scientific users. In fact, SRF technology has been the basis for much of JLab's success to date. Besides its intrinsic operating-cost advantage, SRF provides superb beam quality, ease of upgrading to higher energy, and opportunities for technology transfer benefiting science, national defense, and US industrial competitiveness.

Electrons are accelerated by 1497 MHz radio waves while passing lengthwise through pairs of JLab's five-cell SRF accelerating cavities. The accelerator contains over 150 such cavity pairs. When cooled to the accelerator's operating temperature of 2 degrees Kelvin—near absolute zero—the niobium of these delicate structures is superconductive.

Description, Distinctive Competencies, and Major Facilities (taken from the DOE Laboratory Mission Profile Worksheet)

Description

Thomas Jefferson National Accelerator Facility, formerly known as the Continuous Electron Beam Accelerator Facility, is a national user facility for scientific research using continuous beams of high-energy (0.5 - 6.0 GeV) electrons to elucidate the underlying quark and gluon structure of nucleons and nuclei. The facility was constructed between 1987 and 1995 on a green site for $600 million. Complemented by the planned research at the Relativistic Heavy Ion Collider recently completed at Brookhaven National Laboratory, the Facility offers users unique capabilities for experiments studying atomic nuclei using electrons, our best understood probe particle. Machine capabilities include energies in the multi-GeV range - providing spatial resolutions ranging from the size of a large nucleus down to about one-tenth the size of a proton; high currents - permitting the study of reactions with very small cross sections; highly polarized beams – permitting investigation of the spin and weak neutral current structure of nucleons and nuclei; and continuous beam operation - supporting precision coincidence experiments. The user community includes about 1600 members, with 869 actively engaged in experiments. The innovative design and technology of the accelerator allow a cost-effective upgrade to 12 GeV as driven by the user community and the science potential. The accelerator has the potential to go to 24 GeV. A spin-off of the Laboratory's accelerator technology is the 1-kW Infrared Free-Electron Laser developed in collaboration with industrial, Navy, and university partners for industrial, defense, and research applications.

Distinctive Competencies

- Design, execution, and analysis of precision experiments involving studies of nucleons and nuclei by both electron scattering and photon-induced reactions, and involving: state of the art simulations; the design, construction, and operation of superconducting spectrometers, advanced detectors, and polarized and cryogenic targets; and the use of very high-rate data acquisition and analysis systems.
- Theoretical calculations in both the quantum chromodynamics and conventional nuclear physics frameworks to interpret, analyze, and plan experiments, and to identify future research directions.
- Accelerator technology and accelerator physics expertise necessary to produce high brightness and highly-polarized continuous wave electron beams, including: superconducting radiofrequency technology; very large scale 2K (superfluid) He cryogenics; large real-time control systems (>100,000 control points); and photocathode electron sources and advanced laser systems.

Major Facilities

- The Continuous Electron Beam Accelerator Facility (CEBAF) provides continuous wave electron beams with energies from 0.5 to 5.7 GeV (6 GeV capability demonstrated), with currents from 100 pA to 200 μA and with polarization approaching 80% to three endstations simultaneously.
- Three endstations each with a set of complementary experimental equipment. Hall A has a pair of superconducting, high-resolution magnetic spectrometers optimized for precision electron scattering coincidence experiments. Hall B houses the CEBAF Large Acceptance Spectrometer (CLAS), a nearly 4π detector and ancillary equipment that supports studies of both electron and monochromatic photon-induced reactions with loosely-correlated particles in the final state. Hall C contains a pair of moderate resolution spectrometers (one capable of high momentum particle detection and the second optimized for detection of short-lived reaction products) and provides additional space and infrastructure for supporting major experiment setups optimized for specific measurements that cannot be carried out using available instruments.
- The Testlab and Applied Research Center (ARC), providing state of the art surface science and superconducting radiofrequency research and development and production capability.
- The Infrared Free-Electron Laser (IFEL), designed to provide 1 kW of infrared light with picosecond pulse length, transform limited bandwidth, and diffraction limited emittance.

Hall C with short orbit spectrometer and high momentum spectrometer.

Budget

JLab's FY2001 budget of $96.9 million in DOE funds includes funding associated with JLab's work on the Spallation Neutron Source. The Commonwealth of Virginia provides approximately $1.4M of additional annual funding, and also provided substantial funding for construction of the FEL user facility. The city of Newport News provided the funds for the purchase of the land for the lab, for the construction of the residence facility, and for the construction of the Applied Research Center (ARC) building, which provides leased office space for some JLab staff members, freeing on-site office space for JLab users and bringing JLab technical staff into productive contact with ARC researchers from universities and industry.

Workforce

JLab has a total of 595 employees in full- or part-time regular or term status, and another 86 casual, student, and temporary employees. Supplementing these staff members are 16 Commonwealth of Virginia employees permanently detailed to JLab. CEBAF's user community numbers about 1600 members from 296 institutions in 38 countries; about half the members are actively working on approved experiments.

Vision, Goals, and Strategic Plans

Vision

The vision for JLab is to:

- Foster user-driven nuclear physics research of international significance as part of the US national laboratory system.
- Leverage resources to support national goals and objectives.
- Prepare a broadly educated next generation of scientists and engineers, including traditionally underrepresented populations, for a globally competitive research environment and economy.
- Contribute to public science literacy and appreciation through community outreach and involvement and via motivational math and science educational programs for young students.
- Maintain and further develop a world-class workforce.
- Lead responsibly by conducting environmentally sound, safe and secure operations.

Goals

This vision translates into specific goals and underlying assumptions for JLab's strategic and institutional planning:

1. Enable and conduct a physics research program of the highest scientific priority at the nuclear/particle physics interface.
   - Provide leadership and technical and theoretical support for the user-driven experimental program.
   - Optimize beam time and accelerator and experimental equipment reliability within available resources.

- Upgrade the accelerator to 12 GeV as soon as possible to extend the scientific reach of the experimental program and prepare for future upgrades as the science demands.

2. Maintain and develop world leadership position in underlying core competencies.
   - Begin a program of non-project specific R&D in superconducting radio-frequency and related accelerator technologies.
   - Continue leadership in electron source development.
   - Develop and enhance our innovative detector technologies.

3. Apply JLab technologies to achieve Department of Energy mission and national goals and objectives.
   - Contribute our unique expertise as a member of the DOE national lab system to current and planned facilities.
   - Realize the potential of high-power, energy- and cost-efficient, compact infrared/ultraviolet free-electron lasers for research, industrial and defense applications.
   - Build on detector expertise for medical diagnostics and other applications.

4. Achieve an effective balance between the current program and making necessary investments in the future scientific vitality of the facility.
   - Improve accelerator and experimental equipment availability.
   - Enhance business systems efficiency and effectiveness.
   - Demonstrate performance through quantitative metrics (performance contract, DOE productivity metrics).

5. Continue as a recognized leader in safe, secure and environmentally sound operation.
   - Continued good performance as monitored by regulators.
   - Integration of safety and security management with continuous improvement and proactive management.

6. Serve as an asset to and an integral member of our community.
   - Expand outreach programs to increase science literacy and awareness of JLab's role in the community.
   - Increase impact of programs that motivate students' achievements in math and science through participation in hands-on opportunities.
   - Build partnerships with regional universities.
   - Participate in community activities where JLab offers special resources or expertise.

Strategic Plan

At the summary level, JLab's Strategic Plan includes the following six elements:

- As the highest priority, running its internationally preeminent nuclear physics research program in balance with key investments needed for the scientific future of the lab.

- Beginning the 12 GeV upgrade as warranted by scientific priorities and endorsed by the DOE/NSF (national Science Foundation) Nuclear Science Advisory Long Range Planning Group.
- Advancing JLab's core competencies and enabling technologies, specifically superconducting radio-frequency (SRF) technology, polarized and high-intensity electron sources, and detector technologies, to support JLab's program, other DOE missions, and as a national resource.
- Applying core competencies to advance national goals and objectives, symbiotic with the nuclear physics mission, via an SRF free-electron laser for scientific, industrial, and possible defense applications.
- Participating in partnerships mutually beneficial to DOE, the lab, the region, and the nation.
- Engaging our diverse stakeholders and customers in discussions of their interests and needs, including providing security and preservation of environment, health, and safety, and in light of JLab's capabilities and core competencies, developing initiatives that will create a dynamic and responsive portfolio to address challenges and opportunities applicable to DOE's mission.

JLab's Performance Aligns with DOE's Strategic Planning

JLab's vision and plans, as well as its actions and performance are well aligned with DOE's Strategic Plan of 2000. Briefly reported below are the many cases in which JLab's DOE-aligned visions and plans are being concretely realized. Appendix 1 explicitly correlates JLab efforts with specific statements in the plan.

In line with DOE's National Nuclear Security strategic planning:

JLab aided national assessment of tritium-replenishment alternatives.
With technical analyses and workshop-style consultations, JLab supported Los Alamos National Laboratory's investigation of the Accelerator for Production of Tritium (APT) concept for producing replacement quantities of warhead-vital tritium, the radioactive hydrogen isotope that decays by half every 12.5 years. JLab studied and advised about the possibility of basing APT on SRF acceleration, JLab's core technological competency.

In line with DOE's Science strategic planning:

JLab's scientific output is perennially confirmed "outstanding."
In every year since annual peer reviews began providing ratings, the quality and relevance of JLab's science and technology have received the very highest rating: outstanding. All three of JLab's experiment halls were in full operation by the end of FY1998, and have continued in full operation since. The scientific users regularly publish their findings and JLab's Program Advisory Committee, which evaluates the scientific quality and relevance of experiment proposals, continues to identify top-quality experiments among the proposals. Multi-year backlogs of approved and highly rated experiments exist for all three halls.

JLab operates around the clock over 30 weeks per year to maximize scientific output.
JLab's operational pace more than meets stated expectations. The lab maintains over-30-weeks-per-year accelerator operations in support of nuclear physics experiments.

JLab is part of the Spallation Neutron Source initiative, key for materials science.
JLab senior staff members participated in SNS design reviews and JLab is now one of the six labs that are building the SNS. Building on its core competency in superconducting radio-frequency technology, JLab is responsible for the design and construction of the SNS SRF linac and central helium liquefier.

JLab supports Energy Science Network development to enhance U.S. scientific collaborations.
An internationally recognized JLab scientific computing expert has played a key role in ESnet development—the effort to exceed a billion bits per second in Internet transmission speed.

JLab contributes to advanced high performance computing.
In collaboration with other DOE labs JLab has been funded under SciDAC (Science Discovery through Advanced Computing) to achieve 1 teraflop/s peak and 0.5 teraflop/s sustained processing speeds.

JLab models open, competitive, affiliation-neutral access to scientific opportunities.
All "beam time" is allocated based on competitive experiment proposals, openly solicited and openly peer-reviewed by the JLab Program Advisory Committee. The criteria are scientific excellence and the likelihood of successful experiment completion. Proposers' organizational affiliations are not considered.

JLab leverages research through national and international partnerships and collaborations.
With a scientific User Group numbering about 1600 and representing 296 institutions in 38 countries, JLab's nuclear physics research program benefits from users' construction of experiment equipment and from a wealth of user expertise.

JLab develops technologies with economic, energy, environment, and national security benefits.
JLab's technology transfer efforts derive directly from the accelerator-based main mission of nuclear physics research. Contributions so far include:

- Accelerating technologies that, thanks to JLab development work, provide 460% more acceleration per meter than was the state-of-the-art when CEBAF construction began.
- An initial energy-efficient free-electron laser—200 times more powerful than predecessors—in a program aiming at scientific, defense, and industrial FEL applications, including the replacement of environmentally harmful chemical industrial processes.
- Medical imaging devices that improve resolution and reduce the need for biopsies.
- Collaborative development of a widely applicable control system for large, complex systems; in the case of CEBAF, it can simultaneously handle 130,000 input-output control points.
- Polarized electron sources that deliver orders of magnitude more charge than predecessors.

JLab partners with others to develop, commercialize, and implement beneficial technologies.
JLab collaborates with universities, industry, other laboratories, and defense organizations in technology development. Commercialized technologies include production processes for superconducting accelerating cavities, a reliable cryogenic liquid-level sensor, a medical imaging device, and a control system. In 1999 JLab's private sector partner, Dilon

Technologies, received FDA approval to market their medical imaging equipment that was jointly developed with the Lab. These technologies have increased the productivity of industry, improved medical care, and improved the quality of commercially available products. JLab also directly implements new technologies: its longer-lifetime polarized electron source and higher-power FEL were tested and placed into research use during FY1999.

JLab management practices bring leading-edge results at low cost—and a Hammer Award too.
JLab was designed and constructed on schedule and within budget, and has exceeded its technical specifications. The biennial Institutional Management Peer Review has found a high level of satisfaction among scientific users. Annual peer reviews have found administrative excellence in quality of service, effectiveness, and efficiency. In collaboration with the DOE Site Office, DOE administrative requirements were reviewed and custom-tailored specifically for JLab. Some of this work received the Vice-President's Hammer Award.

JLab raises public science literacy and promotes diversity in education and research.
JLab collaborates with highly diverse local school systems to conduct programs for K-12 students and teachers, holds public-outreach programs, reaches well over 40,000 people at the Virginia State Fair and via the JLab Web site, and has programs for both undergraduate and graduate student research. JLab's most recent Open House, in the spring of 2001, brought over 5000 people on site to tour the FEL, linac tunnel and one of the experimental halls. The number of graduate students performing thesis research within experiment collaborations has increased significantly in recent years. An annually increasing number of JLab researchers hold JLab-supported bridge and joint positions with historically minority colleges and universities.

In line with DOE's Corporate Management strategic planning:

JLab models sound environment, safety, and health (ES&H) management and training practices.
In the more than 15 years of JLab's existence, there have been no fatalities, one disabling injury, and no releases causing significant environmental damage. DOE validated the laboratory's Integrated Safety Management System in May 1999. JLab maintains a comprehensive self-assessment program which involves line self-assessments, line inspections, independent self-assessments, corporate auditing, and semi-annual performance reporting, all to identify ES&H and other deficiencies and vulnerabilities for correction. As part of a comprehensive labwide ES&H training program, JLab supervisors identify training and other competency requirements for employees performing hazardous work. Competency is established by testing and supervisory observation.

JLab communicates constructively and effectively with official stakeholders and the public.
The most recent biennial Institutional Management Peer Review of JLab's relationships with its various stakeholders in DOE and in regulatory agencies deemed the laboratory "a respected community asset." The most recent annual scores for JLab's contract performance concerning media reports on JLab's work and on mentioning JLab as a DOE lab were both "outstanding."

JLab continuously improves human resources systems and practices.
The annual Administrate Peer Review and the biennial Institutional Management Peer Review have consistently evaluated JLab's performance as "excellent" or "outstanding" in these areas.

JLab uses self-assessments to ensure optimal resource use and safe and secure operations.
The independent peer review of JLab's administrative area is conducted annually. Line self-assessments and independent internal self-assessments also are used to ensure that resources are used efficiently and that operations are safe and secure.

Effectiveness and Efficiency Improvements

Overview

The cost of operating CEBAF at JLab was established in FY1995 through actual experience that year. Since then, JLab management has undertaken a number of measures to improve effectiveness and efficiency. Since the measures were not implemented in isolation from other changes, improvements and cost savings or avoidance associated with each one cannot be precisely determined. However, the total cost savings can be determined by the total operations cost in subsequent years and the amount of operation achieved in each of those years. The total savings was $14.0 million for FY1996 through FY1998, and continues at approximately $4 million per year. This savings is invested in programmatic activities which would not otherwise be possible. The specific improvement measures taken are described below.

Programmatic Improvements

More physics results per accelerator operations dollar

- Enhanced power efficiency. To minimize accelerator power consumption, transformer tap settings are customized to correspond with the combination of energy and beam current specifically needed for the experiments underway at any given time.
- Maximized experiment concurrency. The accelerator schedule and three experiment hall schedules are carefully arranged, on a 15 month rolling and 6 month fixed basis, to maximize the number of experiments which can run simultaneously. The ability to run simultaneously is enhanced by the capability of the accelerator to deliver three different (although correlated) energies simultaneously, each at a customized current.
- Faster scientific data collection. The rate at which data can be collected by the experiment equipment continues to be increased, thereby increasing the rate at which nuclear physics information can be collected.

More capability per accelerator technology dollar

- Better accelerating-structure processing. Chemical processing techniques for accelerating cavities have been improved so that newly produced accelerating cavities can provide more acceleration and lower power dissipation than previously.
- In-place accelerating-structure enhancement. A procedure called "helium processing" has been used to increase the voltage capability of *in situ* accelerating cavities, thereby providing the ability to meet increasing physics demands for higher accelerator energy without the expensive process of replacing cavities.

- Shared control-system efforts. EPICS was adopted as the control system for the accelerator in order to share development and maintenance efforts with other labs that are also using this system.
- Injector improvements. Using two horizontal polarized guns instead of one vertical polarized gun and the improvements made in cathode lifetimes during 1999 have greatly improved accelerator availability. The focused effort on the polarized source has led to world-leading results: a beam with 75% polarization at more than 50 μA is now produced reliably. Further developments are underway; in a January 2000 test of a new type of laser 400 μA of high polarization beam was delivered. Plasma-source ion implantation has been shown to dramatically reduce DC field emission from large area electrodes.

Management Improvements

Structural measures for productivity enhancement

- Organization flattened. Selected portions of the organization were flattened, reducing the level of management needed, and simplifying vertical communication.
- Well-targeted manpower. Term positions were used during construction, and not continued into operations. Staff in regular positions are cross-trained so that they are able to work on the accelerator when it is not operating, and on the experiment equipment in one experiment hall while the accelerator and the other two halls are operating. Quarterly priorities meetings with senior management, together with ongoing coordination between accelerator managers and experimental physics managers, ensure that this process works well.
- Streamlined business services organization. The Procurement Department and the Finance Department were merged into the Business Services Department to eliminate duplication of document systems, eliminate manual re-entry of information, and reduce management requirements.
- Director. A search is underway to find a replacement for Hermann Grunder who left JLab in the fall of 2000 to become the Director of Argonne National Lab.
- Deputy Director. As part of the succession planning process to ensure continuity in future years Christoph Leemann was named Deputy Director and is serving as Interim Director during the search for a new director.
- Associate Director – Accelerator Division. During 2000 Swapan Chattopadhyay became the new head of the Accelerator Division and Charlie Sinclair its Deputy AD.

Paperwork reduction and process simplification

- Less paperwork for managers. SURA and DOE adopted a performance-based contract with DOE which provides quantitative goals and methods of evaluation, and substantially reduces the management time required to provide evidence of performance.
- Red-tape overlaps among directives eliminated (Hammer Award). A directives review process was used by a joint DOE Site Office–JLab team to identify all ES&H, quality assurance, and operations requirements contained in the 89 DOE orders and other directives in Appendix E of JLab's contract. Deleted as redundant were those contained in law or regulation. Deleted as inappropriate were those requiring no JLab actions and those providing no net added value. As many as possible value-adding requirements were converted to performance measures, with the remainder replacing the corresponding

directives in contract Appendix E. The Vice-President's Hammer Award recognized this red-tape-cutting work.

- Well-clarified ES&H-standard applicability. A joint Site Office-laboratory team used the DOE Necessary and Sufficient process (or Work Smart Standards process) to agree upon a set of ES&H standards which would provide an appropriate level of protection at the Laboratory. This process clarified which standards are applicable. This set of standards is reviewed and updated as required. For instance, identification of a new hazard initiates a change to the set.
- Fewer reviews. The number of DOE ES&H functional reviews—major diversions of management attention—has been substantially reduced in response to the performance-based contract, the directives review process, and the Necessary and Sufficient process.

Idea generation for productivity enhancement

- Staff-generated productivity enhancements. An employee suggestion program has been implemented. A cross-cutting team screens suggestions for potential productivity enhancements and recommends that important ones be implemented. Examples include posting of notices on doors to improve visibility and scheduling the DMV monthly at JLab for driver's license renewal, vehicle registration, etc.
- Staff-identified and staff-prioritized plant projects. A cross-cutting team is used to identify and prioritize plant maintenance and improvement projects, thereby helping ensure that the appropriate projects receive the needed resources each fiscal year.
- Inter-laboratory sharing of productivity ideas. JLab participates in the DOE National Laboratories Improvement Council, which permits the lab to learn about high-productivity practices at other labs, and to share its own.

Self-assessment and training for productivity enhancement

- Line self-assessments. The conduct of line self-assessments has been formalized to enable the most knowledgeable people to identify productivity enhancement opportunities. Each year all parts of JLab carry out line self-assessment.
- Independent self-assessments. Independent self-assessments, which focus on ES&H practices in the line organizations, are carried out on a repeating three-year schedule.
- Individual self-assessments. Employee performance appraisals have been enhanced by the incorporation of individual self-assessments to ensure recognition of all significant contributions and by use of rating definitions which enhance employee morale without overstating performance.
- Motorola training for managers. On-site Motorola University training was provided for 80 staff and managers, and has increased their knowledge of techniques for analyzing and improving productivity.

Administrative and Business Practice Improvements

Direct economizing measures

- Fare minimization via advance travel booking. When travel needs are known well in advance and are relatively certain, advance booking is used to obtain lower air fares. Staff are encouraged to stay over Saturday night when doing so results in savings to the Lab.
- Optimized benefits package rates. The employee benefits package is carefully negotiated to obtain rates below market rates.

- Repackaged telecommunications subcontracts. The telecommunications subcontracts have been repackaged to reduce overall cost and improve service.
- Injury prevention and good case management. The Medical Services Department works with an injured employee and his/her health care provider to minimize lost work days. This case management combined with a commitment to safe work practices has resulted in a significant cost saving on the Lab's workers compensation premium.

Simplified documentation and recordkeeping

- Electronic timesheets. A process improvement team has improved the timesheet system. Timesheets are completed and signed on-line, and the timekeeping process for exempt employees has been simplified.
- Optimized records-preservation process. A process improvement team has clarified which official records must be preserved, and for how long. A handbook is being prepared to offer guidance to Lab staff in records management.
- Statistical inventorying. Statistical property sampling has replaced a 100% inventorying process, thereby greatly reducing the work involved and permitting concentration on the highest-risk property.
- Electronic document retrieval. Selected sets of documents have their keywords and category numbers kept in a database to improve reliability and speed of retrieval.
- Paperless business practices. An increasing fraction of documents are transferred electronically, reducing paper procurement and handling costs.
- Enhanced real-time managers' finance tracking. The previous financial management software has been replaced with a system which provides tailored reports for managers without extensive manual post-processing of the information. The information is available to managers in real time rather than monthly.
- Web-automated training sign-up. Training course sign-up via the Web has been implemented, providing real-time enrollment information and reducing paperwork.
- Automated training status tracking. Employee training is centrally tracked in a database to reduce the total cost and to improve reliability. Automated e-mail messages are sent to employees to advise them when their training is about to expire. Automated e-mail messages also advise supervisors when an employee's training has lapsed.
- Travel cards. Travel cards are replacing cash advances for most staff travel.

Best business practice procurement processes

- Private-sector procurement methods adopted. The lab has adopted private sector procurement processes to the extent permitted, such as credit cards for small purchases, credit card use by the procurement group for intermediate-size purchases, the use of single-source procurements where cost-effective, and use of the DOE consortium purchase program where applicable.
- Simplified procurement process. In response to the work of one process improvement team, the number of steps involved in placing a procurement has been reduced. Computer-based requisitions have replaced a paper system for small- and medium-sized procurements.

Improvements in subcontracting

- Fixed-price subcontracting. Fixed-price subcontracts are used whenever the scope of work can be adequately specified, which occurs in practically all cases.
- Improved subcontractor ES&H. Incentive/penalty clauses are included in civil construction subcontracts to enhance ES&H performance at little net cost.

Savings via outsourcing

- Outsourced services. Security, janitorial, and shipping and receiving are subcontracted to reduce costs.
- Copy service consolidation, control, accountability. The Lab's assortment of copiers was replaced with a copy service subcontract under which the subcontractor provides and maintains a uniform type of copier, provides user and on-demand copying services, and provides off-site copying services for high peak demands. Keypad entry of user access codes promotes user accountability.
- Outsourcing plant engineering tasks. Plant engineering outsources its work to the maximum extent practicable.
- Just-in-time business supplies. The business supplies stockroom has been replaced with a just-in-time supply delivery contract.

Efficient plant and site management

- Centralized alarm monitoring. Alarms from the site's variety of building alarm systems are routed, along with identifying information, to the continuously occupied guard station. This system frees guards, who monitored alarms, for other duties such as more site patrols.
- Card-key access. A card-key access system to reduce needed off-hour staffing of entrance doors and to provide more reliable access control is now operational.
- Leased space. The Applied Research Center (ARC) adjacent to JLab provides leased office space for some staff members, freeing on-site office space for users and bringing JLab technical staff into productive contact with ARC researchers from universities and industry.
- Bar-coded plant gauge data entry. Plant engineering gauges which must be regularly read have been bar-coded to reduce manual data-entry labor and to improve data accuracy.

Communication Improvements

- Improved labwide general communication. A Malcolm Baldrige-type self-assessment was performed to find productivity improvement opportunities. The principal opportunity identified was improvement of communications, and a number of measures have been implemented in response, such as publication of the monthly newsletter "On-Target" and the weekly on-line "On-Target Briefs" and creation of the television-based Site Wide Information System. A further improvement has been an increase in the amount of Web-based information available to employees and users. "Core Manager" meetings have been instituted to enhance communications between senior and key mid-level managers.
- Improved labwide real-time communication. Internal communication of incidents has been enhanced by use of telephone extension 4444, identified on a tag attached to every lab phone, to contact the one continuously occupied guard station. The guard sends simultaneous communications of an incident to people needing to know about this type of incident; this is done through the use of alphanumeric pagers. Staff are instructed to first dial 911 if appropriate, and then to dial the internal notification number. The extension from which a 911 call is made is displayed at selected locations on site, including the guard station and Medical Services.
- On-line EH&S Manual. A comprehensive on-line EH&S Manual has been developed. It streamlines the tasks of providing or accessing ES&H information, incorporates legal and regulatory requirements (in addition to "common sense" safety practices), is continuously

improved based on lessons learned, reduces paper usage, and can be updated or modified simply and with a high level of change control. The manual attracts much use from outside JLab, as demonstrated when failure of our Web server for four hours evoked complaints from two other national laboratories.

- Institutional Plan summarized for staff. A condensed version of the Institutional Plan was distributed to all staff. The full Institutional Plan is now available on the Web.

Performance Results

Overview

JLab has had advantages relative to other DOE labs in three notable areas. One area is that, as the newest of DOE's labs, JLab is not faced with legacy environmental problems, and does not have an aging or badly deteriorating infrastructure.

The second area has been an excellent relationship with the DOE Site Office. This relationship contributed to a first contract in 1984 which contained very few requirements of questionable value. The contract renewal in 1995 contained additional requirements; working cooperatively with the Site Office, a graded approach for tailoring the application of these requirements was developed. The consistent result has been that JLab has very little cost associated with requirements of questionable value.

The third area also results from the excellent relationship with the DOE Site Office. JLab and the Site Office cooperatively developed the original set of performance measures incorporated into the 1995 contract renewal. These measures were developed to answer the question, "How do we know if the lab is being well managed?" The set of measures was result- and outcome-oriented, allowed either actual direct measurement or judgment by independent peer review, was numerical with adjectival descriptions assigned to various numerical ranges, and was intended to form a complete and balanced set, with appropriate weighting assigned to each performance measure. The performance measures have been fine-tuned each year, but the basic measures have not changed appreciably from the original set. The measures, some of which are roll-ups of contributory measures, cover the following seven areas (maximum points available in each area are shown at the right):

	Maximum Points
Outstanding Science and Technology	300
Reliable Operations	250
Production of Scientific and Technical Manpower	75
Corporate Citizenship	75
Quality Performance in Environment, Health, and Safety	100
Quality of Business and Administrative Practices	100
Responsible Institutional Management	100
Spallation Neutron Source (SNS)	30

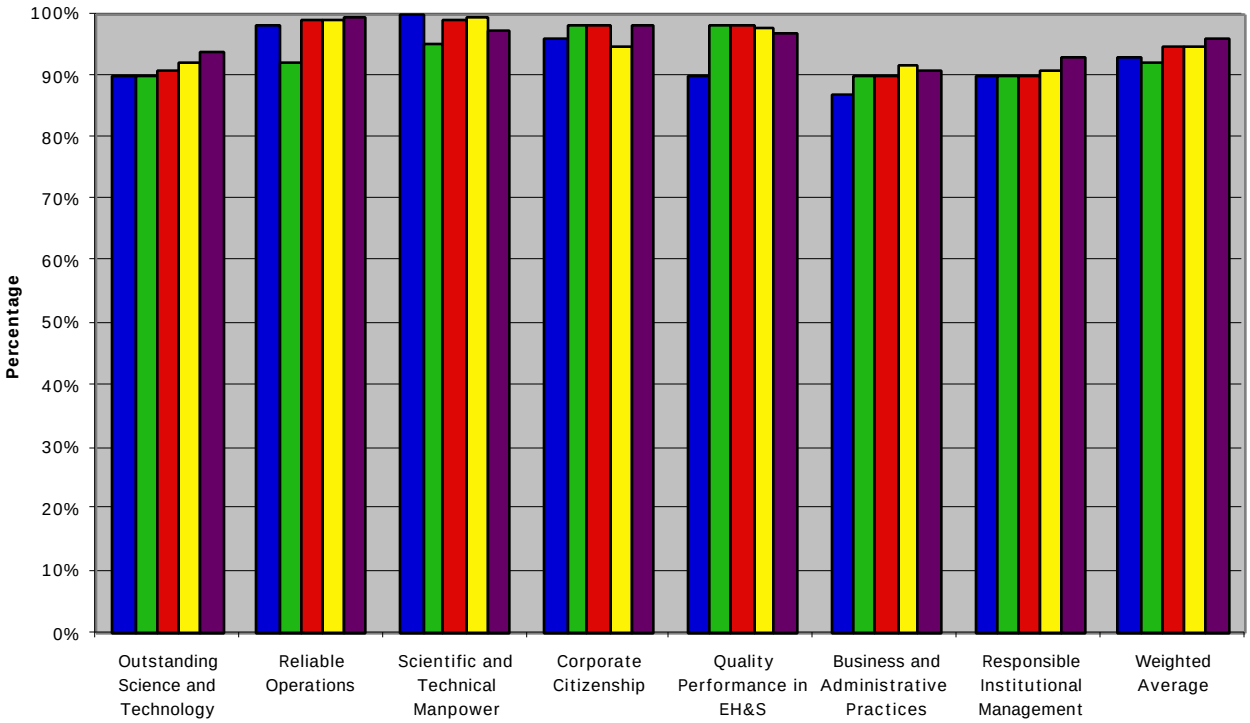
Inclusion of the SNS in the JLab performance measures is new for FY2001 and reflects the Lab's work on this project.

Three of these performance measures rely primarily on peer reviews. All of the reviews result in written reports by the peer review committees.

- "Outstanding Science and Technology" is judged solely by an annual peer review. The most recent review was held September 25-27 2000 by DOE with the assistance of seven scientists who provided individual peer reviews.
- "Business and Administrative Practices" has 70% of its available points based on an annual peer review. The most recent review, held February 29 – March 2, 2000, was chaired by Jerry L. Jobe.
- "Responsible Institutional Management" is judged solely by a biennial peer review. This review considers the results of all other performance measures, plus other information obtained directly by the review committee. The most recent review, held November 1-2, 2000 was chaired by John McTague.

The results for the first seven of these measures for fiscal years 1996, 1997, 1998, 1999 and 2000: 34 "outstanding," 1 "excellent," and 0 "good" or below. The eighth measure, for the SNS, will be scored for the first time this year.

FY 96, 97, 98, 99 and 00 Contract Performance Measure Results



Appendix 1: Linkage Between JLab Work and the DOE Strategic Plan

Through its operation of the CEBAF user facility JLab supports DOE's Science Business Line in the area of nuclear physics. Although this represents JLab's primary contributions to DOE's Mission, the lab has also contributed to the National Nuclear Security Business Line and strongly supports the Department's efforts in Corporate Management. Examples illustrating this alignment between JLab and the measures and strategies in the DOE Strategic Plan (September 2000) are given below:

National Nuclear Security Business Line

GENERAL GOAL: Enhance national security through the military application of nuclear technology and reduce the global danger from weapons of mass destruction.

OBJECTIVE NS2: Achieve the robust and vital scientific, engineering, and manufacturing capability that is needed for current and future certification of the nuclear weapons stockpile and the manufacture of nuclear weapon components under the nuclear testing moratorium.

Measures/Strategies:

- Provide a reliable source of tritium no later than FY2007.

  Relying on its core competency in superconducting radio-frequency technology JLab supported Los Alamos National Lab in its "Accelerator for the Production of Tritium" project.

Science Business Line

GENERAL GOAL: Advance the basic research and instruments of science that are the foundations for DOE's applied missions, a base for U.S. technology innovation, and a source of remarkable insights into our physical and biological world and the nature of matter and energy.

OBJECTIVE SC1: Provide the leadership, foundations and breakthroughs in the physical sciences that will sustain advancements in our Nation's quest for clean, affordable, and abundant energy.

Measures/Strategies:

- Develop new metal and ceramics designed at the atomic level, capable of withstanding even greater levels of severe physical and chemical stresses and extremes of temperature, leading to applications in manufacturing processes and power production.

  Carbon nanotube production by carbon laser ablation has been demonstrated at the JLab FEL. The FEL's high rep rate, potentially a problem for certain material removal applications, may be an advantage for nanotube generation since it offers opportunity to irradiate the emerging plume at a wavelength to which critical precursor species may respond. Further, FEL-based production, if successful, is an excellent prospect for scale-up.

  Plasma-source ion implantation has been shown to dramatically reduce DC field emission from large area electrodes.

OBJECTIVE SC3: Explore matter and energy as elementary building blocks from atoms to life, expanding our knowledge of the most fundamental laws of nature spanning scales from the infinitesimally small to the infinitely large.

Measures/Strategies:

- Develop a quantitative understanding of how quarks and gluons provide the binding and spin of the nucleon based on quantum chromodynamics, further clarifying the theory of strong interaction as a component of the Standard Model.

  Development of this understanding of quarks and gluons is the *raison d'être* of JLab's Continuous Electron Beam Accelerator Facility (CEBAF). Physicists from around the world propose experiments which are reviewed and prioritized by a committee of eminent physicists. Typically the accepted experiments are done in collaboration with JLab staff. The results of this work test QCD leading to new insights.

- Advance the understanding of the nature of matter at the most fundamental level, with research emphasis on elementary particles and their interactions, nuclear matter and interactions, atoms and molecules, and biomolecular building blocks.

  JLab's annual Science and Technology Peer Review continues to rank the quality and relevance of JLab's science as "outstanding." JLab's Program Advisory Committee, which evaluates the scientific quality and relevance of experiment proposals, continues to identify top-quality experiments among the proposals.

OBJECTIVE SC4: Provide the extraordinary tools, scientific workforce, and multidisciplinary research infrastructure that ensures success of DOE's science mission and supports our Nation's leadership in the physical, biological, environmental, and computational sciences.

Measures/Strategies:

- ♣ Meet milestones for new accelerators, testbeds, and detectors for particle and nuclear physics, and (as supported by the physics communities) next generation machines such as the Next Linear Collider, Muon Collider, Rare Isotope Accelerator, and advanced laser-based optical accelerators.

  JLab designed and built the CEBAF accelerator, which was ranked by the Nuclear Science Advisory Committee as the highest-priority new construction in nuclear physics. The science and technology has been ranked "outstanding," the highest rating, by an annual review for each of the past five years (ratings were not provided by peer reviews prior to that time).

  JLab was designed and constructed on schedule and within budget, and exceeded its technical specifications. The Institutional Management Peer Review mentioned above evaluates the timeliness and cost-effectiveness of the operation, and finds it to be excellent.

- ♣ Meet commitments and make progress towards new and upgraded probes and instruments for investigating materials, chemical processes, and life, including the completion of the Spallation Neutron Source, fourth-generation light sources such as free-electron lasers, and new accelerator and reactor designs for the production of research and medical isotopes.

JLab senior staff members participated in reviews of this design, and JLab is using its core competency in superconducting radio frequency technology to help build the SNS linac. The SRF linac is on time and at budget.

♣ Implement effective programs for science education through fellowships in universities and colleges, teacher training for secondary schools, outreach to communities, and broad partnership programs in science and technology.

For many years, JLab has maintained a program of establishing bridge and joint positions with historically minority colleges and universities. The number of these positions, which involve research at JLab, has increased annually.

JLab has programs for both undergraduate and graduate student research. The number of graduate students performing thesis research within experiment collaborations at JLab has increased significantly over the last several years. Already more than 10 M.S. and 50 Ph.D. theses based on JLab work have been completed and 15 M.S. and 100 Ph.D. theses are in process.

JLab collaborates with local school systems to conduct a program for K-12 students and teachers. It frequently participates in the annual Virginia State Fair, and typically reaches 40,000 people through that medium.

The BEAMS - Becoming Enthusiastic About Math and Science - program brings classes of sixth, seventh, and eighth grade students along with their teachers to JLab for formal and informal interaction with lab staff. The success of this program has led to "BEAMS at Siemens" and "SUNBEAMS" (NASA-Goddard Space Flight Center).

♣ Provide leading research facilities and instrumentation that expand the frontiers of the physical and natural sciences, with emphasis on accelerators and detectors for high-energy and nuclear physics; light sources and neutron beam facilities; and specialized scientific facilities.

JLab operates around the clock for more than 30 weeks per year.

All of JLab's experiment operating time is allocated based on open, competitive solicitations for experiment proposals.

All of JLab's experiment operating time is allocated based on the scientific excellence of the performers, as evidenced by their proposals, and the ability of the performers to conduct the proposed experiments successfully. The evaluation is independent of their organizational affiliation.

♣ Advance scientific computation and simulation as a fundamental tool for discovery, with emphasis on science applications software, ultra-high performance computation and communication facilities, and computer science and enabling technologies.

One of JLab's scientists has played a key role in the development of ESnet, the high-speed data communications network that serves DOE scientists and their collaborators. .

JLab is a participant in the Particle Physics Data Grid collaboration whose goal is to provide computing and data "grid" services to enable transparent, efficient, and secure access to data and computing resources.

In January 2000 JLab and MIT led the creation of the Lattice Hadron Physics Collaboration, a major initiative to apply the tools of lattice QCD to

hadronic nuclear theory. This collaboration is an active participant in the Office of Science's Scientific Discovery through Advanced Computing program (SciDAC).

♣ Strengthen the Nation's institutional and human resources for basic science and multidisciplinary research, with emphasis on the national laboratory system, disciplines essential to our missions, scientific and technical information access and use, science education, and broadening the scope of research performers.

An Institutional Management Peer Review of JLab's management is conducted every two years. Among other things, the peer review committee interviews users to determine their level of satisfaction, and has found a high level of satisfaction among the users.

JLab has established scientific partnerships with many universities and laboratories, in both the U.S. and elsewhere. These partners have contributed to the construction of the experiment equipment, and are the primary contributors to the performance of experiments.

Corporate Management

GENERAL GOAL: Demonstrate excellence in the Department's environment, safety, and health practices and management systems that support our world-class programs.

OBJECTIVE CM1: Ensure the safety and health of the DOE workforce and members of the public, and the protection of the environment in all Departmental activities.

Measures/Strategies:

- Reduce the Total Recordable Case Rate, which measures work-related death, as well as injury or illness that results in loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment beyond first aid.

  JLab's lost workday case rate is better than the average of DOE laboratories.

- Reduce the Occupational Safety Cost Index through vigilance in reducing those types of safety-related injuries/illnesses that have the greatest direct and indirect dollar costs as measured by the Cost Index formula.

  JLab's goal (set in its performance based contract) is to better the DOE lab average by at least 50%. Again in FY2000 that goal was met.

- Reduce the Reportable Occurrences of Releases to the Environment which include: releases of radionuclides, hazardous substances, or regulated pollutants that must be reported to Federal, State, or local agencies.

  JLab had no environmental exceedences again in FY2000.

- Implement Integrated Safety Management Systems in all major management and operations contracts.

  JLab's Integrated Safety Management System was validated by DOE on May 24, 1999.

- Conduct oversight activities to provide information and analysis in order that DOE, contractor management, and the public have an accurate, comprehensive understanding of the effectiveness, vulnerabilities, and trends of the Department's environmental, safety, and health policies and programs.

  JLab maintains a comprehensive self-assessment program which involves line self-assessments, line inspections, independent self-assessments, corporate auditing, and semi-annual performance reporting. All of these activities, review of which is part of the DOE Site Office oversight, identify ES&H deficiencies and vulnerabilities which are tracked and lead to appropriate corrective actions.

- Implement an agency-wide program of pollution prevention and energy efficiency to ingrain environmental accountability into the Department's daily decision-making process.

  The generation of hazardous waste at JLab has been reduced by approximately 55% since 1993. No mixed waste has been generated at JLab.

OBJECTIVE CM2: Manage human resources and diversity initiatives and implement practices to improve the delivery of products and services.

Measures/Strategies:

- Improve DOE human resources management.

  JLab's administrative functions are peer reviewed annually for quality of service, effectiveness, and efficiency. These peer reviews, in addition to providing useful recommendations for improvement, have found the administrative functions, including HR management, to be excellent. In collaboration with the JLab DOE Site Office, JLab has tailored DOE requirements to be appropriate for this particular laboratory; some of this work received the Vice-President's Hammer Award.

- Achieve the Department's diversity goals for hiring and competitive promotions consistent with current Civilian Labor Force statistics.

  By aggressively seeking out opportunities and establishing relationships with professional affiliations JLab reached all of its diversity commitments in FY2000. These commitments are part of the Lab's performance based contract. The lab continues to increase internal awareness and provide effective outreach programs.

OBJECTIVE CM3: Manage financial resources and physical assets to ensure public confidence.

Measures/Strategies:

- Ensure equitable opportunities for minority educational institutions and small, minority and women-owned business to compete for grants and contracts.

  The percentages of total available purchasing dollars awarded to small business concerns, small women-owned business concerns, and small disadvantaged business concerns are tracked as one of the performance metrics in JLab's performance based contract with DOE. In FY2000 JLab again exceeded its goals in this area.

In FY2000 minority universities granted 6 advanced degrees based on work done at JLab.

- Plan, program, budget, and execute DOE's projects on schedule and at budget.

  CEBAF was completed on schedule and at budget.

  JLab is one of six DOE partner labs building the Spallation Neutron Source. JLab's responsibilities, the SRF linac and central helium liquefier, are on schedule and on budget.

OBJECTIVE CM4: Manage information technology systems and infrastructure to improve the Department's efficiency and effectiveness.

Measures/Strategies:

- Ensure economical and effective management of information resources to support DOE missions and objectives.

  JLab regularly upgrades its computing power and storage capacity to satisfy the data acquisition and analysis needs of the physics community for which JLab is a user facility.