DOE/IG-0562

AUDIT REPORT

SYNCHROTRON RADIATION LIGHT SOURCES AT LAWRENCE BERKELEY NATIONAL LABORATORY AND STANFORD LINEAR ACCELERATOR CENTER

JULY 2002

U.S. DEPARTMENT OF ENERGY
OFFICE OF INSPECTOR GENERAL
OFFICE OF AUDIT SERVICES

U. S. DEPARTMENT OF ENERGY
Washington, DC 20585

July 22, 2002

MEMORANDUM FOR THE SECRETARY

FROM: Gregory H. Friedman (Signed)
Inspector General

SUBJECT: INFORMATION: Audit Report on "Synchrotron Radiation Light Sources at Lawrence Berkeley National Laboratory and Stanford Linear Accelerator Center"

BACKGROUND

The Department of Energy's (Department) Office of Basic Energy Sciences maintains four Synchrotron Radiation Light Source facilities designed to collect data on the structure of matter on the atomic and molecular scale. The Department refers to these facilities as "user facilities" because they are made available to a variety of private sector, commercial, and educational research entities and are, as such, major instruments for enhancing the nation's science base. Our audit focused on two of the four facilities, the Advanced Light Source, located at Lawrence Berkeley National Laboratory and the Stanford Synchrotron Radiation Laboratory, located at the Stanford Linear Accelerator Center. Both of these facilities generate and deliver soft x-ray and vacuum ultra-violet light in the form of beams. Scientists at Berkeley and Stanford are allocated beam time (shifts) to perform a variety of research.

There are two categories of users at Berkeley and Stanford, participating research teams and independent investigators. Participating research teams submit proposals, assist in funding the construction of beam lines, and receive a percentage of beam time (usually 75 percent) for a period of three years. Independent investigators also submit proposals and receive beam time based on the scientific merit of their proposals; however, because the independent investigators provided no funding for the construction of beam lines, they were only awarded the time that had not been allocated to participating teams.

Because of the high demand for user time and the proposals for new beam line construction, the objective of the audit was to determine whether beam lines at Berkeley and Stanford were being used fully.

RESULTS OF AUDIT

We found that the beam lines at the Stanford facility were being used to the fullest extent practicable. In contrast, however, this was not the case at the Berkeley facility. Specifically, the beam lines at Berkeley were idle 35 percent of the time, during a period in which 150 scientifically-valid research proposals had been rejected. Berkeley did not have a centralized scheduling system and, therefore, was unaware that additional beam time was available. As a consequence, independent researchers were unnecessarily turned away. We found, in addition, that the Office of Basic Energy Science did not provide guidance on tracking and reporting actual use of the Synchrotron facilities or establish useful performance measures to evaluate their use. As a result, opportunities to conduct valuable research with the potential to benefit the researcher, the Department, and the public were lost.

The President's Fiscal Year 2002 Management Agenda placed a high priority on the need to improve the Department's research and development investment criteria, urging that every federal research and development dollar be invested as effectively as possible. In addition, the Office of Inspector General identified Research and Development Investment as one of the most significant challenges the Department faces (*Management Challenges at the Department of Energy*, DOE/IG-0538, December 2001). The audit report includes a series of recommendations designed to address the concerns raised at the Berkeley Synchrotron Facility.

During the audit, we noted that the Office of Basic Energy Science plans to construct seven additional beam lines at Berkeley in 2002 at an estimated cost of $5 million to $10 million per line. Since we found that existing beam lines are not fully used, we discussed with management our concern regarding the efficacy of constructing additional lines. Under the circumstances noted during the audit, we believe further expansion of the Berkeley facility should be carefully considered.

MANAGEMENT REACTION

The Office of Basic Energy Sciences concurred with the finding and recommendations and will require: (1) centralized scheduling systems at all user facilities, (2) annual reporting of actual use of synchrotron facilities, and (3) that these new requirements be considered by peer reviewers in the formal evaluations of our facilities. Implementation of these actions will facilitate better accountability of time by participating research teams at Berkeley. Lawrence Berkeley Laboratory officials were given an opportunity to comment on our findings. They raised several questions concerning the audit conclusions. A synopsis of the Laboratory's comments and our response is appended to the report.

Attachment

cc: Chief of Staff
Under Secretary for Energy, Science and Environment
Administrator, National Nuclear Security Administration
Director, Office of Science

SYNCHROTRON RADIATION LIGHT SOURCES AT LAWRENCE BERKELEY NATIONAL LABORATORY AND STANFORD LINEAR ACCELERATOR CENTER

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Overview

INTRODUCTION AND OBJECTIVE

The Department of Energy's (Department) Office of Basic Energy Sciences maintains four Synchrotron Radiation Light Source facilities:

- Lawrence Berkeley National Laboratory's (Berkeley) Advanced Light Source;
- Stanford Linear Accelerator Center's (Stanford) Synchrotron Radiation Laboratory;
- Brookhaven National Laboratory's National Synchrotron Light Source; and,
- Argonne National Laboratory's Advanced Photon Source.

These facilities are designed to generate and deliver intense light in the form of beams, which are used to study the structure of matter at the atomic and molecular scale. The Department makes the Synchrotron facilities available to researchers from national laboratories, universities, and industry to enhance the Nation's overall science base.

The Berkeley and the Stanford facilities, on which our audit focused, have 27 and 25 beam lines, respectively. Both facilities operate three shifts a day, seven days a week at an average annual cost of $28.9 million at Berkeley and $26.8 million at Stanford. Segments of beam line time are allocated to two categories of researchers: participating research teams and independent investigators. Participating research teams, composed of researchers who helped fund the construction of the beam lines, receive the majority of the time – typically 75 percent of the available time for up to three years – while independent investigators are awarded beam line time from the remaining available time. To be awarded time, investigators must develop proposals that describe the nature of their research, identify the specific beam line capable of meeting their research requirements, and estimate the amount of time needed on that line. Proposals written by independent investigators are submitted to a proposal review panel that evaluates them for scientific merit and assigns a score. Based on availability, time is awarded beginning with the highest scoring proposals until all remaining time is allocated.

Because of the high demand for user time and the proposals for new beam line construction, we conducted the review to determine whether the beam lines at the Berkeley and Stanford Synchrotron facilities were being used to the fullest extent.

CONCLUSIONS AND OBSERVATIONS

While beam lines at the Stanford facility were being fully used, those at the Berkeley facility were not. Specifically, beam lines at Berkeley were idle during 35 percent of our observations. In addition, although beam time was available, 150 scientifically valid proposals requesting time were rejected. Although Berkeley has increased the number of users per beam line by 12 percent over the past three years, we concluded that additional users could have been accommodated. Researchers had been denied time because Berkeley did not have a centralized scheduling system and was, therefore, unaware that beam time was available. In addition, the Office of Basic Energy Sciences did not provide clear guidance on tracking and reporting use and did not have performance measures to evaluate the effectiveness of its user facilities. As a result, opportunities to conduct valuable research with the potential to benefit the researcher, the Department, and the public were lost. Unless Berkeley improves its ability to identify and allocate beam line time, it may continue to deny proposals based on the assumption that its beams are fully utilized.

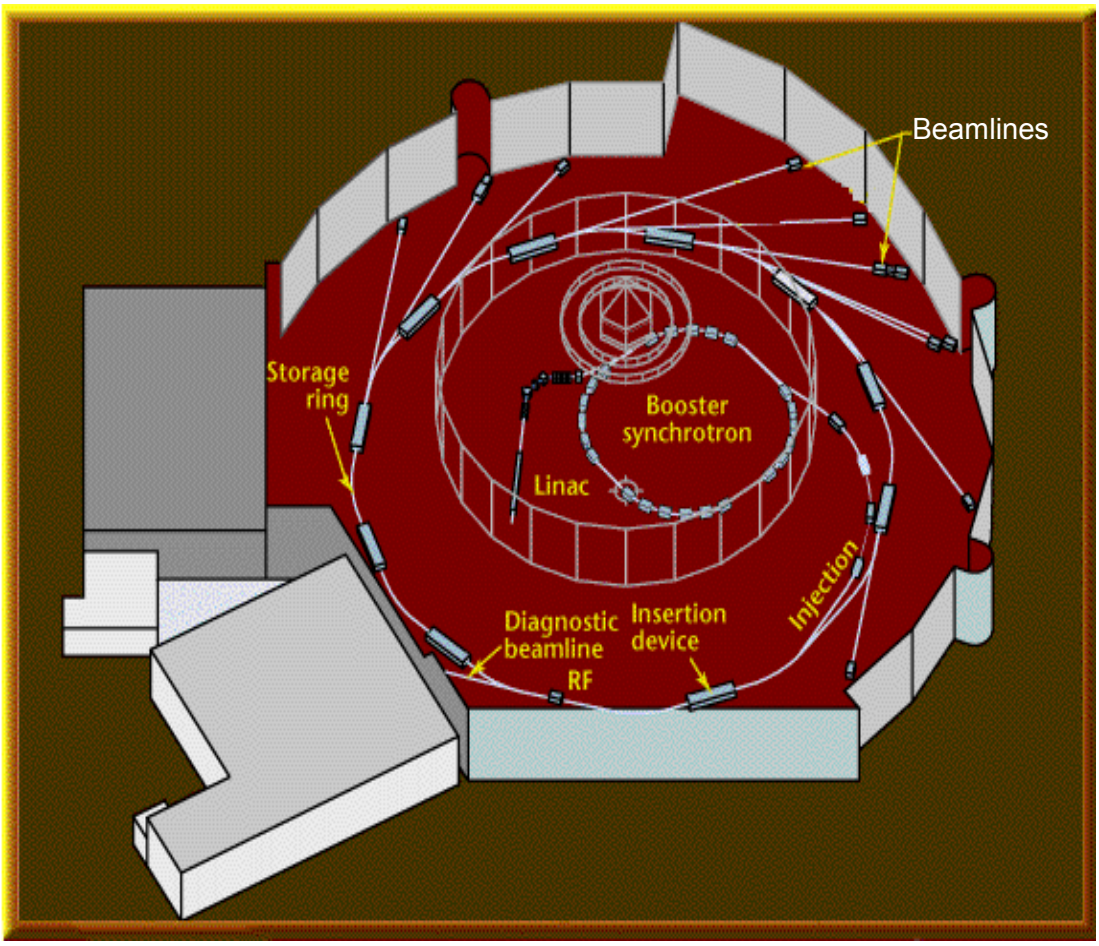
In our opinion, the matters discussed in this report represent material internal control weaknesses within the Department that should be considered when preparing the yearend assurance memorandum on internal controls.

(Signed)
Office of Inspector General

Utilization of Beam Lines

Beam Lines Not Used

Beam lines at Berkeley's Advanced Light Source facility were not fully utilized even though researchers with valid scientific projects had requested time to use the lines. The diagram below illustrates the floor plan of the Advanced Light Source and shows examples of the location of the experiments conducted using the beam lines.



We performed observations, based on a statistical sampling methodology, of 18 of Berkeley's beam lines and found that the lines were idle during 25 of the 72 observations, or 35 percent of the time. In some cases, beam lines had been previously reserved by participating researchers and, in other cases, no one had reserved the lines. Projecting the 35 percent idle time rate over the total number of available shifts, we determined that the lines were idle for 10,576 out of 30,458 shifts.

Given the projected number of idle shifts, all 150 of the rejected proposals from the independent investigators could have been accommodated. For example, beam line 6.3.2 was idle during three of our four observations even though at least 39 research proposals requesting the use of this specific line had been submitted and subsequently rejected based on insufficient time available.

At the Stanford facility, in contrast, we determined that the use of beam lines closely matched the schedule. In fact, out of 75 observations, we observed only three instances in which the beam was not in use.

The Department's Annual Performance Plan Goal

The Department's *Annual Performance Plan for FY 2000* set a goal to improve the management of its research enterprise to enhance the delivery of leading-edge science and technology at reduced costs. To do so, the Department established a long-term strategy to manage user facilities in a more integrated, responsive, and cost-effective way.

The importance of these facilities is also highlighted in the Department's *Strategic Plan* (September 2000). This document emphasizes that user facilities provide scientists the only means of conducting the world-class research that has made the United States a leader in the physical, biological, environmental, and computational sciences. To provide as many research opportunities as possible at facilities like those at Berkeley and Stanford, the Department must make certain that managers minimize idle time and ensure that time is available for proposals having scientific merit.

Weaknesses in Reporting and Scheduling Controls

Independent researchers had been denied beam time because Berkeley did not have a centralized scheduling system and, thus, management was unaware that beam time was available. In addition, the Office of Basic Energy Sciences did not provide guidance on tracking and reporting actual use of the Synchrotron facilities or establish useful performance measures to evaluate the use of the Synchrotron facilities.

Berkeley had a decentralized and fragmented approach to scheduling. That is, Berkeley allowed beam line scientists to establish and maintain their own schedules and did not ascertain whether a beam line was actually in use. This situation can be illustrated through the perceived unavailability of beam line 5.3.1. In this case, a participating research team was scheduled to use this line during each of our four observations; therefore, it should have been operating each time.

However, we found the beam line idle during all four observations. If Berkeley had assessed actual use or had a centralized system for scheduling, it would have known this line was, in fact, idle. This example also illustrates the impact of providing preferential scheduling to participating research teams. Specifically, once this or any participating research team had its scheduled time, it was not required to operate the beam lines during all the allotted shifts and did not have to report idle time or provide that time to others.

In contrast to Berkeley's approach, Stanford required that beam time be scheduled through a centralized system run by administrative personnel. This group, which focused on efficient use of the beam lines, followed established procedures to assess time available and assign it accordingly. Further, Stanford's participating research teams were not given preferential scheduling; that is, they were required to schedule beam line time through the centralized system. By using this system, Stanford ensured that the beam lines were used to their fullest extent.

In addition, the Office of Basic Energy Sciences did not provide clear guidance that outlined how facility managers were to track and report beam line use. Although the guidance stipulated that facilities were to report on an individual beam line basis, it did not clarify whether this tracking should be done through actual or scheduled use. Thus, facilities could report beam line use either way. However, the Office of Basic Energy Sciences allowed Berkeley to report on a facility-wide or aggregate basis, thereby severely reducing its ability to obtain a realistic picture of actual beam line use.

Finally, the Office of Basic Energy Sciences had not established performance measures to evaluate the use of beam lines at its user facilities. Although it required these facilities to submit annual reports, these documents were used for informational purposes only and not as tools to evaluate performance. Thus, the Office of Basic Energy Sciences did not determine whether a facility was operating its beam lines in an integrated, responsive, and cost-effective way.

Limitation of Research Opportunities

Since Berkeley did not assign all available time, scientific research opportunities were limited. Specifically, scientists whose proposals did not receive time were, in effect, denied opportunities to perform research. Previous research efforts at the Berkeley facility have led to scientific discoveries in the fields of biological science, earth and environmental science, and semiconductor material. Scientists have also discovered methods to make solar cells more efficient and devised effective strategies for fighting diseases. By unnecessarily denying new proposals, the Department lost any potential research findings that might have been generated. Unless Berkeley improves its ability to identify available beam line time, it may continue to deny proposals based on the assumption that its beam lines are being fully used.

We are also concerned about the Office of Basic Energy Sciences' plan to construct seven additional beam lines at Berkeley in Fiscal Year 2002. These additional lines are estimated to cost between $5 million to $10 million per line. Since existing beam lines are not being used to their fullest extent, we are concerned that constructing additional lines will exacerbate this situation.

RECOMMENDATIONS

We recommend that the Director, Office of Basic Energy Sciences:

1. Require that Berkeley management:

    a. Establish a centralized scheduling system; and,

    b. Ensure that participating research teams use their scheduled time.

2. Require facility managers to report actual use of Synchrotron facilities; and,

3. Establish meaningful performance measures of beam line use that can be used to evaluate management of user facilities.

MANAGEMENT COMMENTS

The Office of Basic Energy Sciences concurred with the finding of the draft report and planned to address the recommendations of the draft report by requiring: (1) centralized scheduling systems at all user facilities, (2) annual reporting of actual use of synchrotron facilities, and (3) that these new requirements be considered by peer reviewers in the formal evaluations of our facilities. Implementation of these actions would compel participating research teams at Berkeley to be accountable for their scheduled time.

Berkeley National Laboratory officials provided additional comments which are addressed in detail in Appendix 2.

AUDITOR COMMENTS

Management's comments were responsive to the finding and recommendations.

Appendix 1

Department of Energy
Washington, DC 20585
June 17, 2002

MEMORANDUM FOR FREDERICK D. DOGGETT
DEPUTY ASSISTANT INSPECTOR GENERAL FOR
AUDIT SERVICES, OFFICE OF INSPECTOR GENERAL

FROM: RAYMOND L. ORBACH
DIRECTOR
OFFICE OF SCIENCE

SUBJECT: Comments on IG Draft Report, "Synchrotron Radiation Light Sources at Lawrence Berkeley National Laboratory and Stanford Linear Accelerator Center"

The Office of Science concurs with the findings of the draft report and will address the "Recommendations" of the draft report by requiring 1) centralized scheduling systems at our user facilities, 2) annual reporting of actual use of synchrotron facilities, and 3) that these new requirements be considered by peer reviewers in the formal evaluations of our facilities.

Additional comments are attached.

Attachment

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Appendix 2

DISCUSSION OF ADDITIONAL COMMENTS

While the Office of Science and Berkeley officials acknowledged that scheduling could be made more efficient, Berkeley officials disagreed with the some of the specific findings and conclusions in the report. Their concerns and our responses our outlined below.

Berkeley Comments

Berkeley officials disagreed that 150 proposals could have been accommodated during the audited period (Fiscal Year 1999 through 2001). They stated that the OIG did not "take into account changing demand as new beam lines were built…" and added that the majority of the proposals for 2 of the 18 beam lines reviewed were rejected during the first half (1.5 years) of the audit scope and only 1 proposal was rejected during the second half.

Auditor Response

During our review we analyzed demand for and usage of each of the 18 beam lines individually – evaluating the number of proposals submitted for each particular beam and calculating idle time for that beam. In using this methodology, we accounted for the "changing demand" of the beam lines. In addition, the fact that the majority of the proposals were rejected at the beginning of the three-year window rather than the end does not alter the determination that the beamlines could have accommodated additional users.

Berkeley Comments

Berkeley officials stated that an error was made regarding the calculation of idle time on beam line 8.0.1. They believed that the line was being utilized for data taking during all four of the beam line observations and, therefore, could not have accommodated any of the 78 rejected proposals.

Auditor Response

Beam line 8.0.1 was found idle during two of the four floor observations. During the observations that the lines were idle, no one was present at the beamline, the beamline status monitors verified that the shutters were closed, and the beamline scientist could not provide data to validate the use of the beamline during the time of the floor checks.

Berkeley Comments

Berkeley also raised objection to the 35 percent idle time calculation. They believed that some of the beam lines should not have been included in the review because two of the beams were fully funded by industry and fully utilized and one was a "purely accelerator and machine physics beam having no regular use program." Finally, Berkeley indicated that some of the time calculated as idle was time spent for "experiment setup," and therefore should not be considered idle time.

Auditor Response

The 35 percent idle time is an average based on the percentage of time the beams were scheduled for use, but were not actually in use. While some of the lines were operating 100 percent of the time, like those indicated above, others were operating less often than 65 percent of the time – creating a 35 percent average over all 18 lines during our observations. The one line, cited as not having a regular use program, had accepted and allowed independent investigators to operate the beamline, disputing Berkeley's claim that it has no "regular use program." Lastly, as stated previously, we only identified a beamline as idle if no one was present at the line; therefore, if researchers were involved in “experiment setup,” someone would have been present, and we would not have counted the line as idle.

Appendix 3

SCOPE

The audit was performed at Lawrence Berkeley National Laboratory in Berkeley, California, and the Stanford Linear Accelerator Center in Menlo Park, California, from August 1, 2001, to March 15, 2002. The audit covered beam line utilization during FY 1999 through FY 2001.

METHODOLOGY

To accomplish the audit objective, we:

- Discussed beam line construction, utilization, and scheduling processes with user facility managers;
- Reviewed the proposal submission, evaluation, and allocation process implemented by each facility to allocate beam time;
- Judgmentally selected beam lines and determined the availability and user (participating research team or independent investigator) of the beam line;
- Verified operation/non-operation of beam lines based on contractor established schedules through floor checks on December 22, 2001, and January 8, 11, and 15, 2002;
- Reviewed beam line construction and operational cost data;
- Reviewed Federal laws and regulations that disclose expectations of user facility utilization; and,
- Reviewed policies and procedures at user facilities that would promote efficient facility utilization.

To determine actual use, we judgmentally selected 18 beam lines. We identified times when these beam lines were scheduled to be used and then observed each line 4 times for a total of 72 observations. We established use by ascertaining that the shutters were open and by verifying that data was produced on the beam line during the time we were observing. We established that a beam line was idle when the line was scheduled for use, the shutter was closed, and the beam line scientist could not provide data to demonstrate usage during the time we were observing. We calculated the number of user shifts available for the 18 beam lines in our sample and determined that 30,458 shifts were available.

The audit was conducted in accordance with generally accepted Government auditing standards for performance audits and included tests of internal controls and compliance with laws and regulations to the extent necessary to satisfy the objective of the audit. Because our review was limited, it would not necessarily have disclosed all internal control deficiencies that may have existed at the time of our audit. We did not conduct a reliability assessment of computer-processed data because only a very limited amount of computer-processed data was used during the audit.

We held an exit conference with the Director, Office of Basic Energy Sciences on April 24, 2002.

Appendix 4

PRIOR REPORTS

- *Relativistic Heavy Ion Collider Project*, (DOE/IG-0543, March 2002). The audit found that when the Relativistic Heavy Ion Collider (RHIC) project was declared complete and designated as an operating facility in August 1999, beam collisions, which were expected for project completion, had not taken place; and the facility was not ready to begin operations with beam-collision experiments. Also, the cost of the project exceeded its $617 million budget by about $32 million. While the RHIC project's ultimate outcome was positive, the Department's experience offered a number of important project management lessons learned.

- *Progress of the Spallation Neutron Source Project*, (DOE/IG-0532, November 2001). The Spallation Neutron Source Project's technical scope was reduced to allow the cost and schedule components to be met. Specifically, the July 2001 baseline did not provide for instruments to address the initially planned areas of science, completion of user facilities, and critical spare parts to be available at the end of the construction project. This condition existed because the Department decided to meet the approved budget rather than ask Congress for additional funding.

- *Peer Reviewed Literature at the Department's Light Sources*, (DOE/IG-0520, August 2001). Peer-reviewed scientific journal articles generated from work performed at the Department's light sources in FY 2000 were not always available for public dissemination through Office of Scientific and Technical Information (OSTI). The abstracts were not available because OSTI did not establish procedures to ensure that peer-reviewed journal literature for research performed at the light sources was collected in the *PubSCIENCE* database. As a result, scientific advancement was not fully promoted, and research and development efforts are more likely to be duplicated, because scientists are not aware of research already performed. Also, although the Department reported it exceeded its performance target to increase the availability of all scientific and technical information (reports, journal articles, and reprints) by 25 percent from FY 1999 to FY 2000, our review indicated that the availability of peer-reviewed journal articles generated at the light sources had decreased.

- *Follow-up Audit of Program Administration by the Office of Science*, (DOE/IG-0457, January 2000). Although improvements were made in the funding process, the Department did not improve its process for evaluating contractors' progress on research projects. In FY 1999, the Department was still not evaluating research projects using milestones or metrics. Of the 241 FY 1999 work authorizations reviewed, 84 percent did not include any milestones or metrics to evaluate research progress. Milestones were not used because the Department's program managers did not believe that basic research lent itself to the identification of scheduled activities or numerical measures. As a result, the Department could not objectively measure performance of research projects and make sound budgetary decisions based on objective measures.

Report No.: DOE/IG-0562

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