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August 8, 2016

Dr. Cherry A. Murray
Director
Office of Science
U.S. Department of Energy
1000 Independence Avenue
Washington, D.C. 20585

Dear Dr. Murray:

On behalf of the Basic Energy Sciences Advisory Committee (BESAC), I am forwarding to you the report of the 2016 Committee of Visitors (COV) for the Scientific User Facilities Division. The COV met for three days in April 2016, to address the standing charge to BESAC to review annually one of three BES Divisions on a rotating basis. Dr. John Tranquada from Brookhaven National Laboratory chaired this committee.

The recommendations of the COV and the contents of this report were unanimously accepted and endorsed by the members of BESAC at our June 2016 meeting.

I would like to thank you for the opportunity to involve BESAC in this very important review process.

Sincerely,

John C. Hemminger

Digitally signed by John C. Hemminger
DN: cn=John C. Hemminger, o=UC Irvine, ou=Department of Chemistry, email=jchemmin@uci.edu, c=US
Date: 2016.08.08 20:03:11 -07'00'

John C. Hemminger
Chair
Basic Energy Sciences Advisory Committee

Enclosure

cc: Dr. John Tranquada, BNL
Patricia Dehmer, SC-2
Harriet Kung, SC-22
Katie Runkles, SC-22

Report
to the
Basic Energy Sciences Advisory Committee

# Committee of Visitors
# for
# Basic Energy Sciences
# Scientific User Facilities Division

**April 12 - 14, 2016**
**Germantown MD**

# I. Introduction and Overall Conclusions

A Committee of Visitors (COV) process is well established for all divisions within the DOE Office of Science. Within the Office of Basic Energy Sciences, the Basic Energy Sciences Advisory Committee (BESAC) appoints the COV, provides the charge, and receives the report every three years. The 2016 COV for the Scientific User Facilities Division (SUFD) met in Germantown on April 12 - 14, 2016 to assess the three-year period 2013-2015. Membership of the COV is listed in Appendix A. The agenda is included as Appendix B.

BESAC has given the panel the following charge:

(1) For the scientific user facilities including the accelerator and detector program, assess the efficacy and quality of the processes used to:
    (a) solicit, review, recommend, and document proposal actions and
    (b) monitor active projects, programs and facilities.

(2) Within the boundaries defined by DOE missions and available funding, comment on how the award process has affected:
    (a) the breadth and depth of portfolio elements, and
    (b) the national and international standing of the portfolio elements.

This report is organized as follows:
Section II contains findings and recommendations that are related to the entire portfolio of the Division. Section III presents the individual reports of the four teams that examined the major components of the portfolio

- Construction Projects
- Light Sources, Accelerator & Detector R&D
- Nanoscale Science Research Centers
- Neutron Scattering Facilities

The overarching conclusions of the Committee are:

- **SUFD is commended for effective use of its available funding for constructing and operating a set of facilities that deliver world-leading science.**
- **The efficacy of the processes to review, recommend and document proposal actions is excellent.**
- **The efficacy of the processes to monitor and review active projects, programs and facilities is also excellent.**
- **SUFD staff are to be commended for rigorous and pragmatic program management in a highly constrained budget environment.**
- **Within the scope of DOE missions and available funding, the award processes continue to enhance the breadth and depth of portfolio elements as well as their national and international standing.**
- **International competition in scientific user facilities is stiff; maintaining U.S. scientific leadership will require increasing investments for the facilities and for user support.**

# II. SUFD-Wide Findings and Recommendations

## A. Review Scope

This review covers the period from FY2013 to FY2015. During that time, SUFD supported the operation of a broad set of user facilities:

- Six X-ray Light Sources, including the NSLS, which was closed at the end of FY14, and the NSLS-II, which began operations in FY15
- Three Neutron Scattering Facilities, including the Lujan Center at Los Alamos, which was closed in FY14
- Five Nanoscale Science Research Centers (NSRCs)
- Three Electron-Beam Microcharacterization Centers (EBMCs), which were administratively merged with the NSRCs in FY15

A significant set of Line Item Construction (LIC) and Major Items of Equipment (MIE) projects were funded and managed during this period:

- Ongoing Projects: LCLS-II, APS-U, NEXT
- Completed Projects: NSLS-II, SING-II
- Terminated Projects: NGLS, PUP, TEAM-II
- On Hold Projects: STS

Most of these projects are managed through systematic monitoring and periodic review. The one program that involves the solicitation of proposals is the Accelerator and Detector Research (ADR) program. This is the one area in which PAMS is used to capture proposals, reviews, and decisions.

## B. Implementation of previous COV recommendations

FINDING:

- The COV generally found the responses of SUFD to prior recommendations to be appropriate. A few carryover items are discussed in the body of the report.

COMMENT:

- The COV was pleased to learn that the Office of Science is now collecting a broader range of user statistics. In particular, there is now a defined category of "remote user". Information is available at http://science.energy.gov/user-facilities/. Furthermore, as of FY14, the BES Annual Facilities Questionnaire now requests the number of On-Site Users, Remote Users, and Co-Proposers. These changes are very consistent with past recommendations.

## C. Assessment of COV process effectiveness

FINDINGS:

- Exhaustive sets of electronic files were made available to the COV members on individual computers.

- The electronic documentation was thorough, well organized, and easy to access.
- In a few cases, items of interest not available on the computers were quickly provided in paper form.
- Staff was fully available and cooperative in answering questions. This was a valuable aspect of holding the review at the Germantown Headquarters.
- At the first breakout session of the COV subpanels, the cognizant SUFD program manager provided a brief, but effective, overview of the facility type being assessed.
- Access to the Germantown Headquarters venue was aided by bus transport made available to the entire committee, together with good weather that motivated some members to walk. Delays due to the need for security screening were minimized by the advanced preparations made by the SUFD staff.

**D. Facility review process description and effectiveness.**

FINDINGS:

- The 3-year reviews of the facilities are well organized and well executed.
- The facility review teams are carefully selected for subject matter competence and absence of conflict of interest.
- In response to SUFD guidance, each facility has developed a strategic plan with articulated and measurable goals.
- Each facility has undergone a separate budget review.
- In the future, SUFD intends to include a budget review as part of each triennial facility review.
- Review results and BES guidance have sometimes been sent 9 to 12 months after the relevant review.

COMMENTS:

- SUFD staff is commended for initiating and successfully executing the facility budget reviews. This is a necessary and practical effort in providing guidance to the facility directors within an environment of constrained funding.
- To effectively include future budget reviews within the triennial facility reviews will require some careful planning. COV members had some concern that there could be conflicts between the advice provided by reviewers looking separately at the science and the budget. Reconciling such conflicts will be the responsibility of SUFD program managers. Their degree of success will be judged by future COVs.
- Timeliness of guidance is important. Pragmatic recommendations may be challenging to implement if they arrive well into a fiscal year, when much of a facility's budget has already been committed.

**RECOMMENDATIONS:**

- **Consider how to incorporate effective and efficient budget reviews into triennial facility reviews.**

- **Strive to send review results and guidance to facilities within 6 months of the review.**

**E. Breadth and quality of the portfolio elements**

COMMENT:

- SUFD did an excellent job partnering with BESAC to evaluate the international competition in light sources, resulting in a revised plan for facility upgrades that is essential for ensuring world-leading capabilities into the future

**F. General Issues**

FINDINGS:

- The travel funds available to program managers have not been commensurate with the needs for effective project oversight and community engagement.
- The fraction of facility users who are from industry has been gradually decreasing over the last three decades.
- A positive impact of BES facility investments on the US economy, especially in the area of energy applications, has been an interest of the Office of Science.
- Each facility maintains information on use by industrial scientists, but it is not apparent that such information has been collected in a way that allows the evaluation of BES impact.

**RECOMMENDATIONS:**

- **Provide sufficient travel support for program managers to have direct knowledge of their projects and constituencies.**

- **Consider partnering with the National User Facility Organization to collect and evaluate facility experiences with outreach to industrial users, and to identify best practices.**

# III. Reports on the components of the portfolio

## 1. Construction Projects

### A. Efficacy and quality of the review and monitoring processes

**Purpose and scope of the 2016 COV review.** The Construction Project subpanel reviewed and assessed the efficacy and quality of the processes used by SUFD to monitor active construction and Major Items of Equipment (MIE) projects. A total of 9 construction and MIE projects were reviewed, as summarized in Table 1.

**Construction Project review process description.** The subpanel identified the key relevant processes in this area, DOE Order 413.3B and the SC-28 Office of Project Assessment (OPA)-led peer reviews of projects and reviewed and assessed the efficacy and quality of their use by SUFD staff. The subpanel discussed the elements of the charge with SUFD staff and management, OPA management, and reviewed records and detailed reports on the projects identified within the scope of the COV.

**Metrics and User definitions**. Metrics utilized to evaluate the Construction projects and MIE component for the COV include standard cost and schedule indices (Table 1) for the projects that are in progress, and final costs, schedules, and delivered scopes versus approved baselines for completed projects.

FINDINGS:

- The following, Table 1, identifies the Project portfolio falling within the scope of the SUFD responsibility during the 2013 - 2015 review reference period. The table also indicates some of the metrics used by the Construction Program managers to monitor project performance:

| | | | Performance Metrics | | | | |
|---|---|---|---|---|---|---|---|
| Project | TPC | CD | % Complete | Cum CPI | Cum SPI | Status | CD-4 Date |
| STS | $800-1500M | CD-0 | N/A | N/A | N/A | On Hold | 12 years |
| APS-U | $770M | CD-1 | ~11% | N/A | N/A | 1/2016 | 3/2025 |
| NEXT | $90M | CD-3 | 75% | 0.94 | 0.95 | 1/2016 | 9/2017 |
| LCLS-II | $1045M | CD-3 | 26.5% | 0.98 | 0.95 | 1/2016 | 6/2022 |
| NSLS-II | $912M | CD-4 | 100% | 0.96 | 1.00 | 1/2015 | 3/2015 |
| SING-II | $60M | CD-4 | 100% | 0.99 | 1.00 | 8/2014 | 9/2014 |
| PUP | $89.6-96.1M | CD-1 | N/A | N/A | N/A | Terminated | 12/2012 |
| NGLS | $900-1500M | CD-0 | N/A | N/A | N/A | Terminated | 11/2014 |
| TEAM-II | $14-18M | CD-0 | N/A | N/A | N/A | Terminated | 1/2013 |

- During 2013-2015, the SUFD managed approximately $130 million to $200 million of construction project work (both line items and MIEs) annually.
- Within the Division, travel budgets have been limited with priority given for Program Managers to attend Triennial science reviews and construction project reviews. Other travel to sites occurs as budgets permit.
- Review Material/Documentation. Project documentation was made available to the review team. The files were organized in accordance with the major deliverables as defined by the DOE O 413.3B process. The files were complete and orderly.
- Projects selected for execution are peer-reviewed in accordance with the DOE Order 413.3B Critical Decision criteria and OPA process. Projects getting funding are subject to review approximately every 6-12 months. While SC has been exempt from Order 413.3B, SC management considers 413.3B to be best practice and adheres to it to the maximum extent possible.
- Watchlist, Dashboard, and Operations meetings are monthly Director-level meetings that are supported by the Construction group.
- Project documentation reviewed appeared to be using the most current OPA guidance and templates.
- Record copy for key documentation supporting the Energy Systems Acquisition Advisory Board (ESAAB) process is being archived by OPA.
- A very good working relationship between SUFD staff and management and OPA is evident.
- Other processes used to monitor project progress include weekly Federal Project Director (FPD)/Construction Program Manager calls, bi-weekly (or more often) project phone calls, problem-specific reporting, structured ad-hoc telecoms to focus on risk areas, and Watch-list reporting as appropriate.
- Construction Program Managers' participation in Light Sources/Neutron Sources Operations telecom discussions as a tool to learn of emerging issues and resource constraints was noted.
- Construction Program Managers stay in regular communication with the Federal Project Directors for their projects.
- Meeting notes and structured formal agendas were used in some cases.
- Mini reviews are conducted as needed.
- Monthly reports tend to contain data that is typically 1-2 months old by the time they reach program staff.
- LCLS-II has had 3 different Construction Program Managers since the last COV review.
- Overall project performance has been excellent. For example, one of the projects within the portfolio, NSLS-II completed all scope within budget and schedule objectives and subsequently received the Secretary's Award for Excellence and the Federal Project Director received the FPD Of The Year award, both for 2015.

COMMENTS:

- Informal discussions, telecoms, and reports that occur more frequently than prescribed by 413.3B are not formally documented, but written notes are kept in program managers' files.
- Continuing to build strong relationships with the FPD's will remain a key element in ensuring robust communication/authority flow/coordination and will help contribute to better decision making at the Program Office.
- Having structured agendas for meetings as well as taking notes (e.g. detailing action items) is a good practice.
- The program appears to be appropriately focused on project planning and execution and is doing a good job balancing ownership of the project and allowing others to perform their duties.
- Continuity of Construction Program Management staff during the execution of a Major Systems Acquisition project could reduce risk. High turnover in program management staff was identified in the 2013 review and continues to be an area of leadership attention.

RECOMMENDATION:
- Keep up the good work.

# 2. Light Sources, Accelerator & Detector R&D

### A. Implementation of previous COV recommendations

FINDING:
- BES provided a comprehensive and well-reasoned response to the previous COV findings.

COMMENT:
- Beam line staff development, career path and especially workload continues to be a concern as evidenced by reviewer comments in various triennial reports. Ideally, positions providing beam line support should be perceived as highly attractive to talented scientists, as the caliber of beam line science support staff is very important to the quality and quantity of science. However, we recognize that BES has limited influence when it comes to career path issues at individual facilities.

**RECOMMENDATION:**
- **Continue to pay attention to the issues of beam line staff development, career path and workload as part of the facility review process, particularly beam line staffing levels.**

FINDING:
- The previous COV recommended that a pipeline for highly skilled future beam line scientists and engineers be developed.

COMMENT:

- As indicated by BES in their response, the DOE Early Career Program is an excellent mechanism for helping with this problem and is encouraging unique instrument developments by young scientists working at the facilities. COV supports this approach.

FINDING:

- The previous COV indicated that travel funding for SUFD staff should be great enough to allow one trip per year to each facility in their portfolio, one trip to a scientific conference and one trip to a flagship international facility, in addition to attending all the reviews that they are responsible for.

COMMENT:

- The ability to stay up to date on developments both nationally and internationally is very important for the performance of SUFD staff duties. However, travel funding as previously recommended by the COV is still not available. While we recognize the difficulty of obtaining enough travel funding, we believe that BES should continue to seek additional travel funds for SUFD staff.

FINDING:

- The previous COV recommended an increased budget for the Accelerator & Detector R&D (ADR) program.

COMMENT:

- The recommended funding increment did not occur in full during the last performance period and yet the program augmented its portfolio to include beamline-optics projects.

**RECOMMENDATION:**

- **Increase the ADR program budget to support its broadened mission.**

**B. Efficacy and quality of the review and monitoring processes**

FINDING:

- The current triennial review process does not contain a formalized benchmarking of scientific strengths against similar international facilities, although reviewers are asked to comment on the facility's view of how it fits into the Light Source ecosystem.

COMMENT:

- Benchmarking against peer (international) facilities would provide insights into the strengths and weaknesses of US facilities, and feed into the strategic planning process. In some cases reviewers provide unsolicited comparisons with other facilities. However, the review process could be improved by explicitly asking the

facility directors to compare their facilities capabilities and performance against other international facilities of the same caliber, and asking reviewers to comment on the benchmarking. Reviewers who are either frequent users of international facilities, or are well aware of relative strengths and weaknesses, should be used.

**RECOMMENDATION:**

- **Modify the facility triennial review process to explicitly include benchmarking against international peer facilities.**

FINDING:

- The triennial reviews of facilities (and bi-monthly conference calls) and budget reviews are generally very well organized and provide a highly detailed and very valuable picture of facility performance.

COMMENT:

- BES is to be commended on the very high quality of the review process and the pursuit of efficiency. The letters from the reviewers are very informative as they dig into real issues that should be addressed by facility management. The follow up by BES is commendable, as it articulates very clearly the issues that the facilities need to address. This level of review is clearly essential for the health of the facilities, but the facility management workload associated with preparing for these reviews is very high.

**RECOMMENDATION:**

- **Continue to evaluate the optimal balance between a rigorous and useful review process and the considerable time demands on facility staff required to support it.**

FINDING:

- The documentation of monthly teleconferences consists of slide sets, which were presumably discussed during the call.

COMMENT:

- A written record of questions, answers and action items associated with these monthly meetings would be informative. This information will enable SUFD management to track better the progress or problems that may arise during the 3 years before the next triennial review.

**RECOMMENDATION**

- **Keep a written record of questions, answers and action items associated with monthly teleconferences with facility directors.**

FINDING:

- A&D Research supports work at ANL, BNL, LBNL, SLAC, as well as at Cornell and UCLA. Work at DOE Laboratories leverages BES facility operations funds and ensures that a tangible outcome can be integrated and embedded into a Light source facility. Work at Cornell and UCLA builds on their long-term expertise in high brightness electron sources, pixel array detectors, simulation capabilities, as well as long-standing strong ties to DOE facilities. We note that only 20% of the funded proposals are from University groups. BES-sponsored workshops encourage collaboration and force a strategic "brainstorming" to identify opportunities and needs for special instrumentation development. We note that the most recent workshop on Neutron and Photon Detectors was held in 2012.

COMMENT:

- The intentional focus on near- to mid-term R&D, of benefit to existing facilities, constrains the pool of successful proposals from Universities to the historically funded University PIs. This in turn might limit the evolution of innovative new approaches that could significantly impact instrument performance. BES should facilitate partnerships between new university based teams and DOE facilities to obtain proposals from universities that align well with SUFD objectives. Specific topics well-suited to University research include simulations to better understand source dynamics and instrument performance.

**RECOMMENDATION**

- **Expand the pool of new ideas coming into the ADR program by encouraging the submission of proposals from new university groups. Workshops on topics relevant to ADR, such as photon and neutron detectors, would help connect University groups with DOE labs.**

FINDING:

- The Accelerator & Detector R&D (ADR) program is part of an open "continuation of funding" Funding Opportunity Announcement (FOA) accepting proposals over the full fiscal year. Potential applicants are usually informally asked to submit whitepapers for discussion with program manager(s). We find the whitepapers to be widely different in format and content (some were one-page abstracts while others were close to a full proposal).

COMMENTS:

- We value the dialog that the program manager has with applicants and the efficiency of whitepapers in guiding the proposal process while using an open solicitation. However, variability in the structure of submitted whitepapers can mask key points needed for comparison over time or by others.
- Discouraged whitepapers are not included in the submission statistics. This leads to an overall underestimation of proposal submissions. This gets in the way of comparing funding demand with complementary funding programs (GARD, HEP). Formally tracking the whitepaper process would provide useful statistics on proposal demand for the ADR program.

**RECOMMENDATION:**

- **Formalize the whitepaper submission process in the FOA for ADR, such that whitepapers with a well-defined format are submitted through, and recorded in, PAMS.**

### C. Quality and standing of the portfolio elements

FINDING:

- The ADR portfolio exclusively focuses on short and mid-term developments relevant to facilities in operation or under construction. Advanced (and higher risk) concepts, which might have high-impact in the longer term, are deferred to the general accelerator R&D (GARD) program under HEP division.

COMMENT:

- Although the BES light-source accelerator program has benefited from research funded under the HEP's GARD program (e.g. laser R&D). Some developments specific to light sources (optical undulator, compact light sources, beam manipulations etc.) or ultrafast electron diffraction may be challenging to fund under the GARD program.

**RECOMMENDATION**

- **Expand the ADR program scope to include longer term R&D projects specific to light sources that cannot be supported by HEP's General Accelerator R&D program.**

## 3. Nanoscale Science Research Centers

### A. Efficacy and quality of the review and monitoring processes

*Context*

FINDING:

- For the purposes of our COV, we recognize that the Nanoscale Science Research Center (NSRC) program does not involve processing proposals, but instead centers on monitoring the performance and direction of the five NSRC's, including their user proposal processes. Accordingly our response to charge 1 is limited to (b), monitoring and helping to guide the NSRC projects, programs, and facilities.

*Review processes*

FINDINGS:

- The operational triennial review process is a well-vetted and excellent process. It is led by the SUFD program manager who convenes a panel of experienced peers for a site visit. It is thorough, meaningful, and very well structured. The panels explore the science program, user program, operations, and management of each of the NSRC. Individual panel reviews appear complete, thorough, and well-written. Individual reports from panel members are submitted to the program manager, who in turn extracts the principle findings and recommendations. These results are reviewed by SUFD management and a letter is provided to the Center Director from the Facilities Director with the review highlights, recommendations, and full panel reports. The letter instructs the Director to provide a quick itemized response to the letter, to be followed within 90 days with a detailed plan and set of milestones for remedying the indicated actionable items. The process is highly beneficial to both the program managers and the centers and should be continued.
- The prior COV in 2013 produced a fairly long list of recommendations, all of which were addressed by SUFD.

COMMENT:

- We did observe variability in the time lag in providing some of the Letters to Directors. Timely feedback is a useful element in the process. Therefore SUFD should strive to complete the process of preparing and transmitting the Letter to the Director within six months of the review.

*Communications - Management*

FINDING:

- Communications between the NSRC program director and the NSRC directors is excellent, involving monthly all-directors teleconferences, monthly discussions of the NSRC program director and each NSRC director, and a variety of other communications. High quality minutes of the all-directors teleconferences are taken, edited, circulated and retained. Our understanding is that these efforts have resulted in a collegial, mutually supportive atmosphere among the NSRC directors and with the BES program manager.

*NSRC Program Manager*

FINDING:

- Since taking the position as NSRC program manager, George Maracas has served the role adeptly and enthusiastically. He communicates with the NSRCs effectively through monthly Directors' teleconferences (and thorough minutes of them), discussions with individual directors, and a variety of other venues. By cultivating personal relationships, he has built a positive community of NSRC directors, in part from his infectious enthusiasm for the program.

*Travel budgets*

FINDING:

- Serious concerns persist regarding the reality of insufficient travel funds for program managers to monitor, guide, and interact with the NSRC's and the community, as well as to create program visibility in wider circles.

COMMENT:

- BES should significantly increase travel budget for the NSRC program so that the Program Manager can visit each Center at least every other year and attend at least one conference where nano researchers are present in large numbers (e.g. Materials Research Society).

*Budget review and strategic plan*

FINDING

- A budget and operation review of all five NSRCs was carried out in 2015. This provided a clear picture of the budget and operations at each NSRC.

COMMENTS:

- We complement BES for initiating this process and the NSCR staff for engaging in the process.
- We concur that this activity is important and that it should properly be incorporated into the triennial reviews, as is the current plan.
- We commend the program for developing a strategic plan for each NSRC, which are publicly available on the respective websites and are used to guide priorities for personnel, instrumentation, and their links to the scientific activities.

**B. Quality and standing of the portfolio elements**

*Context*

FINDING:

- For the purposes of our COV, we recognize that the NSRC program is aimed at providing a valuable function to the nano research community. Hence for this part of the charge we assess the value of this NSRC contribution.

*Uniqueness*

FINDINGS:

- The five SUFD funded nanoscience research centers comprise a significant portion of the National Nanotechnology Initiative (NNI) infrastructure portfolio and are unique among open user facilities. The NSRCs provide a no-cost , merit-based access to top notch synthesis, modeling, fabrication, and characterization facilities. In addition, access is hosted by subject matter experts who can guide efficient use and collaborative insights and interpretation to design and implementation of experiments. National Nanotechnology Coordinated

Infrastructure (NNCI) and NIST facilities, in contrast are fee-based usage models and are not generally able to accommodate multiple facilities (synthesis, nanofab, theory and modeling, and advanced characterization, etc.) under a single roof. In addition, the NSRCs are each co-located near major DOE facilities (NSLS2, ALS, SNS, MESA, APS), thereby combining offerings not available anywhere in the world. This recognition among researchers has 2800 users per year finding their way to these centers.

- The five NSRC's feature important and distinguishable differences in their expertise and capability. First, each has areas of capability in which they are unique and world leading (such as hard x-ray nanoscience at CNM, Discovery Platforms at CINT, or combinatorial methods at TMF), a consequence of the expertise of NSRC staff scientists and the facilities available. Second, as mentioned above, the NSRC's are collocated with unique user facilities, providing for synergy in research carried out by NSRC users and staff scientists. As evidence of the dependence of BES research on the NSRC's, we note that nearly 1/3 of NSRC users are supported by BES awards from the materials and chemistry divisions.
- The NSRC Directors and program manager have increasingly collaborated (see NSRC portal) to identify where their expertise and capabilities are distinct and to guide their strategic evolution to a portfolio of broad scope and complementarity. Thus, the portfolio includes: (1) unique, cutting edge capabilities that are different among the NSRC's; and (2) a set of tools that are more routine, available in most of the NSRC's, but applied to different research problems.

**RECOMMENDATION:**

- **Explore ways to enhance the visibility of the NSRCs – particularly their uniqueness for nano research – both within and outside of DOE.**

*Budget*

FINDINGS:

- Each NSRC has its own portfolio of unique capabilities, world-leading research programs and nanofabrication, synthesis and characterization infrastructures. Equipment recapitalization is essential in maintaining the leadership of NSRCs in their fields, productivity and their services to the user community.
- New instrument development/acquisition are central to the strategic planning of each NSRC, as they help to capture new scientific opportunities and serve the needs of users.
- Currently, the labs have helped to meet some of major equipment needs.

COMMENTS:

- The five NRSCs started their full user operations between FY 2006 and FY 2008, and they all have major needs for equipment recapitalization.
- We are concerned that the NSRC budget has been essentially flat for 10 years. This is a problematic situation given the importance of capital facilities to the success of a user-oriented NSRC program. The recent change in MIE cutoff point

from $2M to $5M provides more flexibility in budgeting. The 10% budget reserve requested by BES for capital equipment will help somewhat, but it imposes other difficulties given that most of the budget is devoted to salaries, and it is thus far from ideal.

- Another concern is that, because the NSRC program is much smaller than other programs in SUFD, the capital needs of the NSRC may not be sufficiently visible.

**RECOMMENDATION:**

- **Keep the NSRC's competitive and cutting-edge by pursuing means to significantly enhance the NSRC capital budget.**

*Outreach*

FINDINGS:

- NSRC's are inherently less visible than the much larger SUFD facilities. In addition, the NSRC's engage a large number of experimental tools that serve diverse areas of research, ranging from unique and sophisticated instruments to a portfolio of fabrication and characterization equipment common to nano and micro scale research environments. As nanoscale science continues to diffuse into other disciplines, the pool of researchers who can benefit from this national asset grows.
- While the number of proposals each year from new users is substantial (~40%), the total number of users is relatively flat, and some portions of the community are underrepresented, particularly industry (<5% of users). This highlights the ongoing of communicating the research opportunities and uniqueness of the NSRCs to a broad and diverse audience.
- The new NSRC web portal at www.nsrcportal.sandia.gov constitutes a valuable vehicle toward this end – a very good start deserving of considerable further development, including e.g.: explaining the unique benefits the NSRC's offer; ensuring bidirectional hyperlinking between the portal and individual center website; incorporating effective search functions; displaying selected high impact publications, etc.
- To the extent that the portal provides "one-stop shopping" for the multitude of capabilities of the NSRC's, it is worthwhile to explore what commonality might be adopted for registration, proposal preparation/submission, and submission schedules. The portal could at least manage a database of user information that could then be transferred into individual NSRC forms. Such capabilities reduce the burden on users, optimize facility utilization, and convey a favorable image of the NSRC world.
- Additional outreach is opportune through presence and presentations at professional conferences (e.g., the AIP's Industrial Physics Forum, MRS, AVS, APS, ECS). Such experiences also offer an opportunity to identify what roadblocks might confront the expansion of the user base. Finally, a slide or two summarizing the NSRC's could be developed which highlights their benefit and points to the portal.

**RECOMMENDATION:**

- **Continue development of the NSRC Portal, including clear descriptions of the unique advantages of the NSRCs for research in nano and micro science.**

*Merger of EBMCs with NSRCs*

FINDINGS:

- The Electron-Beam Microcharacterization Centers (EBMCs) have provided world-class leadership in the development of electron microscopy science and service to the wider scientific communities. Like the NSRC's, the EBMC's provide unique staff expertise and instrumentation.
- The EBMCs at LBNL, Argonne and ORNL were recently merged into their respective NSRCs, enhancing technical synergy between the two, simplifying budgets, and conveying a larger profile for both. To date the merger appears to be successful, though there has been no formal feedback yet on these mergers since it was done after the last triennial review. The upcoming triennial review will enable a full assessment of the consequences of the merger, an important goal, and to reiterate the important role the instruments and staff of the former EBMC's hold.

# 4. Neutron Scattering Facilities

## A. Introduction

The COV subgroup on neutron facilities would like to thank the BES staff for their assistance and discussions during this review. They were available to answer all of our questions and we appreciated their candor. We would also like to acknowledge BES for making available all of the core documentation electronically, and for providing additional information when requested. The organization of the electronic documents which included all review materials was logical and easy to review.

**The BES-funded neutron scattering facilities.** The high flux neutron sources coupled with a modern neutron scattering instrument suite supported by DOE-BES-SUFD provide unique capabilities to measure the structure and dynamics of materials from the nanoscale to laboratory length scales. The exceptional neutron facilities currently operating at the Oak Ridge National Laboratory have world-class neutron scattering instruments and very good scientific productivity.

**Context.** In order to place this review into a broader context, we briefly review the national and international situation of the neutron scattering facilities. There are two locations in the United States with neutron user facilities. The Commerce Department operates the NIST Center for Neutron Research in Gaithersburg, MD and the DOE operates the Spallation Neutron Source (SNS) and High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory. During this review period (2013-2015), BES ceased funding the Lujan Center, thus eliminating open user access to a number of neutron

scattering instruments. The loss of Lujan decreased the total neutron measurement capacity (as measured by the total number of neutron scattering instruments in a general user program) by 10% to 45. Total number of instruments is also a predictor of scientific productivity. The number of good neutron scattering instruments is directly related to the number of users, publications, and high-impact publications. Using all of these measures, the US neutron scattering capacity and scientific impact is about 1/3 of that of the European neutron user facilities.

**Emphasizing a user-centric approach to neutron user facility operation.** The documentation we reviewed made some very clear observations related to the need to operate HFIR and SNS as user-focused research facilities. It is an important observation (and thus relevant to this COV review) that a successful and scientifically productive national user facility must have robust user support. BES clearly recognizes that this is an important part of meeting their stated goal for facilities to produce *the best science possible*. The following are some observations we made relevant to this BES goal as well as the context described above based on our review of the documentation during the course of the COV.

COMMENT:

- Neutrons, the sources that produce them, and the neutron scattering instruments used to measure material samples are a rare measurement resource and also represent a sizeable capital investment. Thus it is essential that these facilities are operated in a manner that has the broadest possible benefit for the U.S. scientific community.

FINDINGS:

- BES continues to provide strong support for neutron scattering science through its support of the Neutron Sciences Directorate at ORNL.
- There is a growing number of users who use neutron facilities only once or a few times during their graduate research – i.e., "occasional users" versus the traditional "expert users" whose research is neutron-centric.
- The stated goal of BES for their user facilities is the "best science" and the metrics used to measure success are based on scientific productivity. The growth and expansion of the use of the user facilities to address ever-broader scientific questions is a sign of the facilities' success and BES should recognize and reward this.
- Since the last COV review, there has been documented evidence of improved user support and subsequent higher scientific productivity at ORNL NScD. Beam time utilization can be further improved by having beam line scientists take a holistic approach to neutron experiments at their facilities- including involvement in educating new users (especially students and post-docs), experimental design, proposals, proposal feedback, experimental execution, data acquisition and subsequent data analysis when warranted.
- An access mechanism that encourages new users and enables them to ultimately be more successful in the peer-review proposal system is warranted.

- A reward structure for beamline scientists is needed to encourage this enhanced engagement.

**B. Implementation of previous COV recommendations**

BES responded to the recommendations of the neutron facilities sub-group to the COV in 2013. In at least one case, the context for a recommendation has changed, thus re-affirming the need to implement that recommendation. This recommendation is provided below.

**RECOMMENDATION:**

- **Join with other agencies, such as DOC, NSF, and NIH, in assessing the current status and future directions for neutron science in the U.S., which would include neutron measurement capacity and capabilities needed to enhance the international competitiveness of the U.S. scientific community.**

BES replied that they were open to discussions to enhance neutron science in the U.S., but to date, no working group has convened. Since DOE is the majority funder of neutron scattering in the U.S., it should play a significant role in this working group. It is important to note that since 2013, the context for such a working group has changed with the closing of the Lujan Center. In addition, a very recent National Academies report on converting the U.S. high performance research reactors from highly-enriched uranium to low-enriched uranium recommended convening an interagency working group to assess the neutron scattering needs of the U.S. for the next 50 years.[1] In light of the proposed Second Target Station (STS) at ORNL and considering that it has been 15 years since a holistic assessment of the U.S. neutron scattering facility needs was performed, it is timely and appropriate to convene such a working group. Such a group should look broadly at the entire U.S. complement of neutron sources and scattering instruments and assess the future needs.

Another past recommendation was to track a supplementary metric regarding users. We are pleased to note that the Office of Science is now officially tracking Remote Users, as well as On-Site Users, and that BES is now collecting additional metrics of On-Site Users plus Co-Proposers and Remote Users plus Co-Proposers. We strongly encourage BES to find a way to make use of these metrics in illustrating the impact of the facilities.

**C. Efficacy and quality of the review and monitoring processes**

*Lujan Center*

[1] *Reducing the Use of Highly Enriched Uranium in Civilian Research Reactors*, Committee on the Current Status of and Progress Toward Eliminating Highly Enriched Uranium Use in Fuel for Civilian Research and Test Reactors, National Academies Press, 2016, http://www.nap.edu/catalog/21818/reducing-the-use-of-highly-enriched-uranium-in-civilian-research-reactors.

FINDING:

- The loss of Lujan's neutron scattering instruments to the general user community represented ~15% loss of instrumentation nationally. BES is responsible for stewardship of much of the nation's neutron scattering facilities. This closure had a detrimental impact on users and BES acted to mitigate this effect, especially on students affected by this closure. However, the diffraction capabilities, in particular, were compromised by closing the facility prior to having comparable instruments available and operational at SNS. Unique aspects were identified in the last triennial review of Lujan. It should be noted that many of the letters of concern from the user community came from users geographically located west of the Mississippi.

**RECOMMENDATIONS:**

- **Be mindful of how the termination of support for general-user programs can affect the national neutron scattering scientific user community and scientific productivity.**

- **Make it a priority to recover, at other BES user facilities, the unique experimental capabilities that were lost to general users with the termination of BES funding for the Lujan Center.**

*SNS/HFIR*

FINDINGS:

- The triennial reviews are well-organized and well-documented.
- Responses by the facilities management to BES comments/questions were thoughtful and well-conceived.
- The COV reviewed documentation that BES and the facilities management follow up on the implementation of these recommendations.
- Facilities management and staff have largely embraced a strategic plan with articulated and measurable goals. We encourage the facility management and BES program managers to engage in robust discussions about performance expectations and opportunities for future facility developments.
- In order to best optimize the federal investment in neutron scattering sources in the U.S., it is important that the scientific user community, facilities management, and BES work together. The scientific community has been engaged in facilities-sponsored workshops and has defined the facilities/instrumentation needs now and for the future.

**D. Quality and standing of the portfolio elements**

FINDINGS:

- The facilities management and staff have embraced scientific productivity as a metric for some decision making. To that end, a $10M fund is established at SNS/HFIR for improvements and maintenance based on meeting this goal.

- Unique users, peer-reviewed publications, and publications in high impact journals are reported as metrics. The definition of "high impact" journals should be broad enough to fully capture the breadth and scope of scientific contributions of the neutron scattering community. Sustained scientific impact is not captured by these metrics alone and additional metrics, such as citations and/or a facility h-index, may be valuable for evaluation and planning purposes.

COMMENT:

- Industrial engagement at the neutron user facilities can broaden the scientific impact of those facilities. For example, engaging industry can motivate the development of novel sample environment equipment that can be used by those participating in research at the facility via the general user program. If DOE-BES would like to amplify the scientific impact of its neutron user facilities through industrial research participation then they could consider developing a strategy involving (1) incentives, and (2) non-traditional, non-proprietary access models. Metrics other than publications can be used for evaluation of the success of industrial engagement. Also the success of any access program for industrial engagement should include input from industrial researchers.

**Appendix A**

# DOE/BES
# Scientific User Facilities Division
# Committee of Visitors (COV) Review Panel
# Germantown, MD
# April 12-14, 2016
# Committee Members

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**OTHER ATTENDEES:**

J. Hemminger, BESAC Chairperson **(1st day only)**
J. Tranquada, BNL **(Chairman of COV)**
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A. Schwartz, DOE/SC-22 (1st day only)
G. McLean, DOE/SC-22.1 (1st day only)
L. Horton, DOE/SC-22.2 (1st day only)
J. B. Murphy, DOE/SC-22.3
P. Kraushaar, DOE/SC-22.3
P. Lee, DOE/SC-22.3
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V. Nguyen, DOE/SC-22.3
J. Rhyne, DOE/SC-22.3
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**Appendix B**

COMMITTEE OF VISITORS
**Scientific User Facilities Division**
**DOE/Germantown Complex**
**April 12-14, 2016**

*AGENDA*

## Tuesday, April 12th, 2016

| | | |
|---|---|---|
| 7:30 am – 8:00 am | Arrive at DOE Complex | |
| 8:00 am – 8:30 am | Security Entrance - Committee to Assemble in North Lobby to check in. Committee will then be escorted to **Conference Room: A-410** ***(Continental Breakfast Available)*** | COV members and BES staff |
| 8:30 am – 8:45 am | Executive Session, Committee Assignments (**John Tranquada**) | COV members |
| 8:45 am – 9:00 am | BESAC and COV Process (**John C. Hemminger**) | COV members and BES staff |
| 9:00 am – 9:30 am | Welcome and Introduction to BES and the COV process (**Harriet Kung**) | COV members and BES staff |
| 9:30 am – 10:15 am | Overview of the Scientific User Facilities Division and the peer review process (**James Murphy**) | COV members and BES staff |
| 10:15 am – 10:30 am | Executive Session (**Conference Room: A-410**) | COV members |
| 10:30 am – 11:00 am | ***Break*** | |
| 11:00 am – 12:30 noon | Executive Session – Review files<br><br>***(Introduction by Program Managers for each group)***<br><br>• ***Construction Projects (Conference Room: F-441)***<br>• ***Light Sources, Accelerator & Detector Research Committee (Conference Room: E-401)***<br>• ***Nanoscience Committee (Conference Room: G-426)***<br>• ***Neutron Facilities Committee (Conference Room: E-301)*** | COV members<br>(BES staff on call) |
| 12:30 pm – 1:30 pm | ***Lunch*** | ***DOE GTN cafeteria (on your own)*** |
| 1:30 pm – 4:30 pm | Executive Session – Review files<br><br>• ***Construction Projects (Conference Room: F-441)***<br>• ***Light Sources, Accelerator & Detector Research Committee (Conference Room: E-401)***<br>• ***Nanoscience Committee (Conference Room: G-426)***<br>• ***Neutron Facilities Committee (Conference Room: E-301)*** | COV members<br>(BES staff on call) |
| 4:30 pm – 5:30 pm | Questions and Answers with BES staff **(Conference Room: E-401)** | COV and BES Staff |
| 5:30 pm | Adjourn for the day | |
| 6:30 pm | ***Dinner (Señor Tequila's)*** | ***No Host Dinner*** |

## Wednesday, April 13th, 2016

| | | |
|---|---|---|
| 7:30 am – 8:00 am | Arrive at DOE Complex | |
| 8:00 am – 8:30 am | Security Entrance - Committee to Assemble in North Lobby to check in. Committee will then be escorted to **Conference Room: A-410** ***(Continental Breakfast Available)*** | COV members and BES staff |
| 8:30 am – 9:30 am | Full Committee Executive Session (**John Tranquada)** (**Conference Room: A-410**) | COV members |
| 9:30 am – 10:30 pm | Executive Session – Review files<br>• ***Construction Projects (Conference Room: F-441)***<br>• ***Light Sources, Accelerator & Detector Research Committee (Conference Room: E-401)***<br>• ***Nanoscience Committee (Conference Room: G-426)***<br>• ***Neutron Facilities Committee (Conference Room: E-301)*** | COV members<br>(BES staff on call) |
| 10:30 am – 10:45 am | ***Break*** | |
| 10:45 am – 12:30 pm | Executive Session – Review files<br>• ***Construction Projects (Conference Room: F-441)***<br>• ***Light Sources, Accelerator & Detector Research Committee (Conference Room: E-401)***<br>• ***Nanoscience Committee (Conference Room: G-426)***<br>• ***Neutron Facilities Committee (Conference Room: E-301)*** | COV members<br>(BES staff on call) |
| 12:30 pm – 1:30 pm | ***Lunch*** | ***DOE GTN cafeteria (on your own)*** |
| 1:30 pm – 3:30 pm | Begin Draft report and recommendations –<br>• ***Construction Projects (Conference Room: F-441)***<br>• ***Light Sources, Accelerator & Detector Research Committee (Conference Room: E-401)***<br>• ***Nanoscience Committee (Conference Room: G-426)***<br>• ***Neutron Facilities Committee (Conference Room: E-301)*** | COV members<br>(BES staff on call) |
| 3:30 pm – 4:30 pm | Questions & Answers for COV Members and BES Staff | COV members and BES staff |
| 4:30 pm -5:30 pm | Executive Session | COV members |
| 5:30 pm | Adjourn for the day | |
| | Dinner on your own | |

**Thursday, April 14th, 2016**

| | | |
|---|---|---|
| 8:00 am | Arrive at DOE Complex | |
| 8:00 am – 8:30 am | Security Entrance - Committee to Assemble in North Lobby to check in. Committee will then be escorted to:<br>**Conference Room: A-410**<br>***(Continental Breakfast Available)*** | COV members and BES staff |
| 8:30 am – 9:00 am | Executive Session | COV members |
| 9:00 am – 9:30 am | Closeout | COV members and BES staff |
| 9:30 am | Adjourn (Except Team Leads) | |
| 9:30 – 9:45 am | Break | |
| 9:45 am – noon | Team Leads complete written draft report | Team Leads and BES staff (on call) |
| 10:30 am | Depart for BESAC Prioritization Meeting | Relevant COV members and BES Staff |